DELAWARE RIVERKEEPER NETWORK

March 30, 2018

Commission Secretary
Delaware River Basin Commission
P.O. Box 7360
25 State Police Drive
West Trenton, NJ 08628-0360

Re: Proposed New 18 CFR Part 440 - Hydraulic Fracturing in Shale and Other Formations; Proposed revisions and additions to section 18 CFR 401.35 relating to project review classifications

Dear Commission Secretary and Commissioners,

The Delaware Riverkeeper Network (DRN) submits these comments regarding the Proposed New 18 CFR Part 440 - Hydraulic Fracturing in Shale and Other Formations; Proposed revisions and additions to section 18 CFR 401.35 relating to project review classifications ("Proposed Rules") that were publicly noticed by Delaware River Basin Commission (DRBC) on November 30, 2017.

I. THE DELAWARE RIVERKEEPER NETWORK

DRN is a non-profit organization established in 1988 to protect and restore the Delaware River, its associated watershed, tributaries, and habitats. This area includes 13,539 square miles, draining parts of New Jersey, New York, Pennsylvania and Delaware, and it is

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within this region that a portion of the Project's construction activity and operations will take place.

The Upper Delaware River is a federally designated "Scenic and Recreational River" administered by the National Park Service. The National Wild and Scenic Rivers System also includes large portions of the Lower Delaware and the Delaware Water Gap. The Lower, Middle and Upper Delaware River have high water quality and are subject to Delaware River Basin Commission Special Protection Waters Designation. The Basin and River are home to a number of federal and state listed endangered or threatened species including, but not limited to, the dwarf wedgemussel, Indiana bat, Timber Rattle snakes, bog turtle, Northeastern bulrush. Over 200 species of migratory birds have been identified within the drainage area of the Upper Delaware River within the Basin, including the largest wintering population of bald eagles within the Northeastern United States. The ecologically, recreationally and economically important American Shad population migrates up through the nontidal portions of the Delaware River to spawn, American Shad populations in the Delaware River are currently at depressed numbers. Migratory birds breed in or migrate through the high quality riparian corridors of the Basin. The Delaware River is also home to dozens of species of commercially and recreationally important fish and shellfish species.

In its efforts to protect and restore the watershed, DRN organizes and implements stream, wetland and habitat restorations, a volunteer monitoring program, educational programs, environmental advocacy initiatives, recreational activities, and environmental law enforcement efforts throughout the entire Delaware River Basin. DRN is a membership organization headquartered in Bristol, Pennsylvania, with more than 20,000 members with interests in the health and welfare of the Delaware River and its watershed. DRN is uniquely qualified to comment on and provide relevant information concerning associated impacts to human health and the environment.

These comments include and reflect the findings of technical experts engaged by DRN to analyze and comment on the Proposed Rules. All reports are submitted with these comments and are appended to this document.

Delaware Riverkeeper Network supports DRBC's proposal for the prohibition of high volume hydraulic fracturing (HVHF) in hydrocarbon bearing rock formations within the Delaware River Basin ("the Basin"). We provide more detail and additional recommendations regarding the prohibition under DRN's Section 440.3 comments and the proposed revisions and additions to section 18 CFR 401.35 relating to project review classifications under Section 3.8 of the Compact. These comments conclude that the prohibition is essential to provide needed protection to the Delaware River Watershed, but that it must go further.

DRN opposes the diversion, transfer or exportation of water from sources within the Basin of surface water, groundwater, treated wastewater or mine drainage water for utilization in hydraulic fracturing ("fracking") of hydrocarbon carbon bearing rock formations outside the Basin as proposed at Section 440.4. These comments conclude that the water export proposal constitutes a failure of the DRBC to protect the water resources of the Delaware River Basin. We provide more detail and additional recommendations regarding the prohibition under DRN's Section 440.4 comments.

DRN opposes the importation, transfer, treatment, storage, disposal, or discharge in the Basin of produced water and Centralized Waste Treatment (CWT) wastewater generated by fracking operations, as proposed at Section 440.5. These comments conclude that the wastewater proposal constitutes a failure of the DRBC to protect the water resources of the Delaware River Basin. We provide more detail and additional recommendations regarding the prohibition under DRN's Section 440.5 comments.

DRN respectfully requests the DRBC remove all reference to the allowance of water exports from the Basin for fracking and the import and storage, processing, disposal and discharge of CWT wastewater and produced water from fracking in the Basin, as described at Sections 440.4 and 440.5. DRN also requests that Section 440.3(b) is expanded to include prohibition of the activities related to fracking, specifically including the export of water and water resources out of the Basin for fracking elsewhere and the prohibition of the importation, transfer, treatment, storage, disposal, or discharge in the Basin of produced water and Centralized Waste Treatment (CWT) wastewater generated by fracking operations.

The Delaware River's waters are protected under the terms of the Delaware River Compact, the DRBC's Special Protection Waters Program, and regulations adopted in its Comprehensive Plan and Rules of Practice and Procedure. The Proposed Rules at Sections 440.4 and 440.5 fail to ensure protective management of the water resources of the Delaware River. DRN supports a complete ban on fracking and its activities, including a ban on water export out of the Basin for fracking and the import and storage, processing, disposal, and discharge of wastewater produced by fracking in the Basin.

DRN engaged six experts to review and assess the Proposed Rules, develop conclusions and make recommendations. These comments incorporate and rely upon the comments, recommendations and conclusions of these expert reports. The expert reports are submitted as Attachment 1. The curriculum vitae for these experts are collectively submitted as Attachment 2. DRN also relied upon information referenced in DRN's comment letter, documented by Endnotes and References.

LEGAL FRAMEWORK

a. Delaware River Basin Compact

Under the Delaware River Basin Compact of 1961, the DRBC is charged with conserving and managing the water resources of the Delaware River and its watershed.

Article 13, Section 13.1 of the Compact provides for the development and adoption, and periodic review and revision, of a Comprehensive Plan "for the immediate and long range development and use of the water resources of the basin. The plan shall include all public and private projects and facilities which are required, in the judgment of the commission, for the optimum planning, development, conservation, utilization, management and control of the water resources of the basin to meet present and future needs."

The DRBC implements the Compact's directives and objectives and the Comprehensive Plan through the Water Code and the Administrative Manual: Rules of Practice and Procedure ("RPP") (codified at 18 CFR §§ 401.81–90).

Article 3, Section 3.8 of the Delaware River Basin Compact requires that

> No project having a substantial effect on the water resources of the basin shall hereafter be undertaken by any person, corporation, or governmental authority unless it shall have been first submitted to and approved by the commission, subject to the provisions of Sections 3.3 and 3.5. The Commission shall approve a project whenever it finds and determines that such project would not substantially impair or conflict with the Comprehensive Plan and may modify and approve as modified, or may disapprove any such project whenever it finds and determines that the project would substantially impair or conflict with such Plan. The Commission shall provide by regulation for the procedure of submission, review and consideration of projects, and for its determinations pursuant to this section. Any determination of the Commission hereunder shall be subject to judicial review in any court of competent jurisdiction.

See also 18 C.F.R. § 401.32.

b. <u>Comprehensive Plan</u>

Sections 3.2 and 13.1 of the Compact require the creation of a Comprehensive Plan, which binds private parties and agencies to the Commission's vision for immediate and long term development within the Basin. Compact §§ 3.2, 13.1. The Commission has created a Comprehensive Plan which seeks to optimize the conservation, control, and management of the Basin's limited water resources and determine what type of development is consistent with the public interest. DRBC, *Comprehensive Plan* § I.A.b.; I.A.d. (July 2001). Activities which may have a substantial impact on the Basin are examined in the context of this Plan, and in order for a project to be approved by the DRBC, the Commission must determine that the project "provide[s] beneficial development of the water resources in a given locality or region,…the project conforms with accepted public policy," and the project does "not adversely influence the development of the water resources of the basin." *Id.* § I.A.d.

DRBC's duties under the Comprehensive Plan require the Commission to consider whether and where an activity, as a whole – such as unconventional gas development – fits in the Basin, and its cumulative impacts. The Commission must also consider if there are particularly fragile areas of the Basin, such as Special Protection Waters, where a particular activity should *not* occur. *Wayne Land & Mineral Grp., LLC v. Delaware River Basin Comm'n*, No. 3:16-CV-00897 (M.D. Pa. Mar. 23, 2017), ECF No. 22-1.

c. <u>The Water Code</u>

DRBC's Water Code requires the conservation of the Basin's water resources, a consideration of present and future public interest when planning groundwater withdrawal projects, and the maintenance of basin water quality, *inter alia*. *See, e.g.,* Water Code §§ 2.20.2, 2.20.3, 2.20.5, 2.200.1; 18 C.F.R. § 410.1.

Section 3.40 of the Water Code regulates groundwater quality and requires its maintenance "in a safe and satisfactory condition…" Water Code § 3.40.3A. Section 3.40.4(B) explains that "[i]t is the policy of the Commission to prevent degradation of ground water quality" and that "[n]o quality change will be considered which…may be injurious to any designated present or future ground or surface water use." *Id.* §§ 3.40.4.

Similarly, Sections 2.20.2 and 2.20.3 of the Water Code authorize and require the DRBC to preserve and protect underground water-bearing formations, and to safeguard the public interest from projects that withdraw underground waters. *Id.* §§ 2.20.2, 2.20.3.

The Water Code also protects the areas of the Delaware River and its tributaries that have exceptionally high water quality, known as Special Protection Waters. *Id.* § 3.10.3.2 *et seq*. Marcellus Shale natural gas deposits in the Basin are found *exclusively* within the area designated as Special Protection Waters. *Wayne Land & Mineral Grp., LLC v. Delaware River*

Basin Comm'n, No. 3:16-CV-00897 (M.D. Pa. Mar. 23, 2017), ECF No. 22-1. Section 3.10.3A.2.b. of the Water Code protects these waters "at their existing water quality." *Id.* § 3.10.3A.2.b. Additionally, the Water Code recognizes the need to protect water quality for other, nonhuman users, stating that "[t]he quality of the Basin waters shall be maintained in a safe and satisfactory condition for…wildlife, fish, and other aquatic life." *Id.* § 2.200.1.

Natural gas extraction and its related activities have the potential to negatively affect ground and surface water, and as such, are subject to regulation under the DRBC's Water Code.

d. Rules of Practice and Procedure

Section 1.2(g) of the Compact defines a "project" as including any work or activity identified by the Commission. Compact § 1.2(g). The DRBC's Rules of Practice and Procedure ("RPP"), published at 18 C.F.R. Part 401, establish thresholds under which Compact Section 3.8 project reviews take place. The following are sections of the RPP which grant DRBC the authority and duty to review natural gas development activities.

A project is subject to Commission review when the Executive Director "specially direct[s] by notice to the project sponsor or land owner as having a potential substantial water quality impact on waters classified as Special Protection Waters." *Id.* § 401.35(b)(18). The Executive Director has determined that *all* natural gas development projects may have a substantial effect on water resources of the Basin.

Additionally, RPP Sections 2.3.5A and 2.3.5C allow federal agencies such as the U.S. Fish and Wildlife Service and the National Park Service to refer projects to the Commission for review. 18 C.F.R. §§ 401.35(a), (c) (RPP §§ 2.3.5.A, C). Citing the need to protect the Basin's water quality and natural gas development's potential adverse effects, both the U.S. Fish and Wildlife Service and the National Park Service referred all projects that involve the development of natural gas wells to the DRBC for project review. *Wayne Land & Mineral Grp., LLC v. Delaware River Basin Comm'n*, No. 3:16-CV-00897 (M.D. Pa. Mar. 23, 2017) ECF No. 33-1, 2. The Commission *must* take action under Section 3.8 of the Compact once it receives such a referral. 18 C.F.R. § 401.35(c).

In addition to the DRBC's need to review natural gas well development when referred by an agency such as the U.S. Fish and Wildlife Service or the National Park Service, the Commission must review projects that "have or may have a substantial effect on the water resources of the basin" or that result in the discharge of pollutants into surface or ground waters of the Basin. *Id.* §§ 401.35(b), (b)(6).

Some natural gas development activities are also explicitly subject to Commission review; natural gas transmission lines and appurtenances are reviewed when "they would pass in, on, under or across an existing or proposed reservoir or recreation project area as designated in the Comprehensive Plan; [or] such lines would involve significant disturbance of ground cover affecting water resources;…" *Id.* § 401.35(a)(12). Natural gas pipelines are also subject to review under § 401.35(b)(7). *Id.* § (b)(7). In these instances the Commission directly recognizes that the disturbance of ground cover affects water resources.

Both water quantity and water quality are indisputably at issue with natural gas development.

e. <u>DRBC's Special Protection Waters Program</u>

The Delaware Riverkeeper Network petitioned the Delaware River Basin Commission (DRBC) in 1990 to develop a program to protect the exceptional water quality and outstanding resources of the designated Wild and Scenic Delaware River pursuant to the Outstanding Natural Resource Waters (ONRW) provision of the federal Clean Water Act.

In response, the DRBC amended its Water Code to include its unique version of ONRW, the Special Protection Waters program. In 1992 the DRBC granted the Upper and Middle Delaware Wild and Scenic River segments Outstanding Basin Waters status under their Special Protection Waters (SPW) program.

In 2001, after the Lower Delaware River was designated by Congress as Wild and Scenic, DRN again petitioned DRBC to classify the Lower Delaware River as SPW. As a result of DRN's efforts, the DRBC permanently designated the Lower Delaware River as Significant Resource Waters, a type of SPW, in July 2008.

The entire non-tidal Delaware River is protected by Special Protection Waters anti-degradation regulations. This designation requires strict regulation to protect the water quality of all SPW waters, which is documented as "exceptional" through regular water quality testing by the DRBC. The agency must maintain the high existing water quality so that there is **"no measurable change"** except towards natural conditions. Water Code § 3.10.3 *et seq.* codifies the anti-degradation program of the DRBC's Special Protection Waters program. (DRBC Resolution Nos. 70-3, 92-21, 94-2, 2008-9); *see also* 18 C.F.R. Part 410; Water Code §2.200.1*(*Resolution No. 67-7*)*("[t]he quality of Basin waters shall be maintained in a safe and satisfactory condition for...wildlife, fish and other aquatic life"); Water Code §2.20.2 ("[t]he underground water-bearing formations of the Basin, their waters, storage capacity, recharge areas, and ability to convey water shall be preserved and protected"); Water Code §2.20.5 ("[n]o underground waters, or surface waters which are or may be the sources of replenishment thereof, shall be polluted in violation of water quality standards duly promulgated by the Commission or any of the signatory parties"); Water Code §3.40.4.B ("[i]t is the policy of the Commission to prevent degradation of ground water quality.…No quality change will be considered which, in the judgment of the Commission, may be injurious to any designated present or future ground or surface water use").

The Draft Regulations fail to ensure that there will be no measurable adverse change to the quality of the Basin's water resources.

f. National Environmental Policy Act

The National Environmental Policy Act ("NEPA"), the nation's bedrock environmental law, seeks to ensure sound policy making by requiring that federal agencies evaluate the potential adverse impacts of their proposed activities before undertaking them. To achieve this goal, NEPA requires the preparation of an environmental impact statement for all "major Federal actions significantly affecting the quality of the human environment." 42 U.S.C. § 4332(2)(C). There can be no doubt that the DRBC is a federal agency subject to the requirements of NEPA. The language of the DRBC Compact itself provides that the Commission is a federal agency and thus subject to NEPA, stating that the "compact shall not enlarge the authority of <u>any federal agency other than the commission</u>." DRBC Compact, §15.1(o) (emphasis added). The Council on Environmental Quality's ("CEQ") regulations for NEPA also recognize DRBC as one of the "federal or federal-state agencies with jurisdiction by law" over NEPA issues, alongside the United States Environmental Protection Agency and numerous other federal agencies. NEPA Implementation Procedures, Appendix II, 49 Fed. Reg. 49750 (December 21, 1984).

Further, the issuance of regulations governing hydraulic fracturing activities within the Delaware River Basin is plainly a major federal action for purposes of NEPA. The CEQ regulations define a "major federal action" as an action "with effects that may be major and which are potentially subject to Federal control and responsibility," and such an actions involve "new and continuing activities, including projects and programs entirely or partly financed, assisted, conducted, regulated, or approved by federal agencies; new or revised agency rules, regulations, plans, policies, or procedures . . ." 40 C.F.R. § 1508.18. By this definition, the issuance of these regulations is clearly a major federal action because it creates a new program that adopts new agency rules and regulations, and is partly financed, regulated and approved by the DRBC and by the Army Corps of Engineers, the DRBC's federal member.

Moreover, for all the reasons set forth below and in the accompanying expert reports, the regulation of hydraulic fracturing within the Delaware River Basin is an activity that has the potential to have significant environmental effects. As such, it is evident that the DRBC is bound, subject to NEPA, to prepare a full environmental impact statement ("EIS") evaluating the range of potential adverse environmental impacts of its proposed regulatory program before issuing new regulations governing gas development within the Basin. 42 U.S.C. § 4332(2)(C); 40 C.F.R. §§ 1502.4, 1508.18. Nonetheless, the DRBC has issued its draft regulations without undertaking any NEPA environmental review measures whatsoever.

The purpose and benefits of NEPA's requirements are clear. NEPA's EIS requirement aims "to ensure both that an agency has information to make its decision and that the public receives information so it might also play a role in the decisionmaking process." *Dep't. of Transportation v. Public Citizen*, 541 U.S. 752 (2004). The statute is intended to insure that environmental concerns are integrated into the very process of agency decision-making. *Andrus v. Sierra Club*, 442 U.S. 347 (1979); *Lower Alloways Creek Tp. v. Public Service Elec. & Gas Co.*, 687 F.2d 732 (3d Cir. 1982). When the federal government conducts an activity, NEPA imposes procedural requirements to ensure that in making decisions, an agency will have available, and will carefully consider, detailed information concerning environmental impacts. To issue detailed regulations for new gas development in the Delaware River Basin without having reviewed the potential environmental impacts that may result therefrom is not only short-sighted but unlawful, and is likely to result in flawed and incomplete regulation of this risky industrial activity.

g. Cumulative Impacts Analysis

Adequate regulations based on a comprehensive environmental assessment are essential to protect the water supply for over 15 million people and to assure that the

Delaware River's Special Protection Waters (SPW) and all the Basin's water resources are protected from pollution and degradation. The Commission's Draft Regulations do not achieve the goal of preventing pollution, avoiding degradation, and helping to improve where needed the water resources of the Basin.

The Commission recognized the potential cumulative impacts of hydraulic fracturing activities on the water resources of the Basin to be so significant that the Commission applied for federal funding for a cumulative impact study. The U.S. House of Representatives Appropriations Committee Subcommittee on Interior, Environment, and Related Agencies approved $1 million for the U.S. Geological Survey (USGS) and the Commission to conduct that study but due to the lack of needed action on the federal budget, these funds were not granted in the Congressional session. The foresight the Commission has shown in seeking these funds is exemplary. We are in full support of this effort and have continued to seek funding sources for the Commission ourselves.

The Commission's Water Resources Program FY2010-2015 (WR Program) calls for the Commission to "Perform Cumulative Impact Analysis on water supply 2011-2012 Funding permitting" (DRBC 2010b, p. 17) under its Natural Gas Development regulation program. The lack of a cumulative impact analysis undermines the Commission's ability to implement effective and sufficiently protective regulations. The Commission's WR Program states that "Additional demand for use in energy exploration, e.g. natural gas drilling, is increasing, although the full effect of this demand sector has yet to be identified" (DRBC 2010b, p.4) and "There will need to be more analysis of the water needs for energy projects and energy needs for water treatment as well as an evaluation of the carbon and water footprints" (DRBC 2010b p.11).

The impacts of hydraulic fracturing activities on the subsurface geology and ground water resources in the Delaware River Watershed are unknown and have not been studied or modeled by the Commission or any other agency. A cumulative impact analysis or environmental study should be completed to assess the subsurface changes that would occur and the resulting environmental impacts.

There is tremendous debate over the safety of hydraulic fracturing activities. The large number of incidents of pollution, methane gas migration, blowouts and other problems throughout Pennsylvania is well documented by PADEP. (*see* www.dep.state.pa.us/dep/deputate/minres/oilgas/OGInspectionsViolations/OGInspviol.htm).

One of the most disturbing aspects of the Draft Regulations is the obvious lack of information about the watershed and the lack of data about the expected impact. This information, gathered through an impact analysis, would serve as a foundation for the decision-making process and regulations. It is surprising that, in an area of high ecological importance and the presence of powerful economic interests (New York City, Philadelphia, utilities and the mining industry), there is no comprehensive model of the watershed allowing for the simulation of future scenarios.

Unfortunately, the Commission issued draft natural gas regulations without the benefits of the findings of such a study. In our opinion, a cumulative impact analysis of the potential effects of natural gas development on the Basin's resources is essential to developing appropriate rules that will fulfill the DRBC's mandates. We consider the Draft Regulations lacking in the critical limits and management policies that this analysis would provide. In addition to specific deficiencies detailed in this comment, this is an inescapable fatal flaw in the Draft Regulations.

Proposed Regulatory Changes Sections 403.3, 440.4, and 440.5

This comment submission examines the proposed regulatory changes in three parts:

- the prohibition of high volume hydraulic fracturing (HVHF) in hydrocarbon bearing rock formations within the Basin;
- the export of water and water resources outside of the basin for fracking elsewhere;
- the import and storage, processing, disposal, and discharge of wastewater produced by fracking in the Basin.

Comment in Support of the Prohibition of HVHF at Section 440.3 (a) and (b)

DRN supports the complete prohibition of fracking throughout the Delaware River Watershed.

Marcellus and Utica Shale geologic formations underlie approximately 40% of the Basin, primarily in Pennsylvania and New York (a small portion of the Utica underlies the northwestern corner of New Jersey). These shales are considered the largest petroleum-producing deposits in the nation; approximately 5% of the total area of the Marcellus underlies the Delaware River Basin. (Schmid & Company, Inc., "Comments on Proposed

Regulations of the Delaware River Basin Commission Concerning High Volume Hydraulic Fracturing to Produce Oil and Gas, 3.18.2018). New Jersey and Pennsylvania also contain the South Newark Basin gas-bearing rock formation, identified by the U.S. Geologic Survey as potentially productive, although it is not being developed at this time. The potential for substantial adverse impacts from development of shale gas within the Basin is enormous.

The entire non-tidal Delaware River is protected by Special Protection Waters (SPW) anti-degradation regulations due to the exceptional values of the River. The strict regulations adopted by DRBC to protect the water quality of SPW waters requires that the existing high existing water quality be maintained so that there is **"no measurable change"** except towards natural conditions. Approximately 50% of SPW are located in Pennsylvania, 35% in New York, and 15% in New Jersey. (Schmid) Of the SPW sections of the Basin, approximately 98% is underlain by Marcellus Shale in New York and 67% of the area in Pennsylvania. (Schmid). SPW designation applies to the entire watershed regions that drain to SPW waters. The anti-degradation provision of these waters would be unattainable if fracking were to occur in these regions due to the adverse impacts that accompany it.

Surface Development of Fracking Well Sites

The use of hydraulic fracturing to extract and develop natural gas from shale formations include several phases of the fracking process. The first stage is the development of the well site and adjacent operations which require the removal and clearing of vegetation and the reforming of the natural landscape. At this stage impacts include: destruction of vegetation; forest loss and forest fragmentation; soil compaction and destruction of the natural soil mantle and land contours; watershed drainage pattern alterations, and disruption of local hydrologic systems such as wetlands and vernal ponds.[i]

These impacts are part of the process of developing a gas well and are unavoidable, as found in a study of the potential impacts of fracking, based on the industry's practices since the modern shale boom began. "Disturbing the land is an unavoidable part of the fracking process to extract gas and move it to market. Specifically, well pads (generally taking up between 1-3 hectares) are needed to support equipment needed for drilling and fracking, access roads are required to bring equipment to the well pad, and gathering pipelines are needed to bring the gas from the well pad to an existing portion of the natural gas pipeline network."[ii]

The areas disturbed include the well pad; storage and ancillary equipment areas; freshwater basins or tanks and tanks or pits to store fracking fluid chemicals, flowback, produced water, fuel, and re-used or reusable frack fluids; containers to store proppants such as sand; driveways or access roads to the site; gathering pipelines, local compressors and related equipment to carry gas to a market pipeline; and in some instances, quarries for mining gravel for driveways and well pad pavement, and water lines, buried or on surface. The impacts of this activity can continue at varying levels during well drilling, stimulation, development, and production. Upon completion of construction activity, the invasion of non-native invasive species of plants into disturbed and cleared land and the transfer of destructive insects and pathogens result from the land use changes that have occurred at the well site. Compacted soil at the finished site can have a runoff coefficient close to concrete and the destroyed soil mantle can permanently retard the absorption and normal infiltration of precipitation. Accelerated runoff, both in volume and rate, is the consequence of this changed land condition, leading to the continuation of negative impacts on groundwater and receiving waterways.

Stormwater NPDES permits are generally not required for unconventional gas well pads. Only flowback from the well is regulated by the NPDES program.[iii] Due to inadequate regulation of stormwater from well sites, including the current practice by DRBC to use host state stormwater regulations to manage stormwater, polluted runoff, erosion and sediment loading to adjacent waterways from well sites causes several negative stream impacts. These include adverse impacts to water quality, the rate and volume of water flow, stream morphology, riparian buffers and vegetation, the loss of groundwater infiltration and recharge of aquifers, and the reduction of healthy base flow of streams. In turn, aquatic and riparian habitats and the flora and fauna species that rely on them are negatively impacted. Overall, the land is transformed from its current condition to an industrial site.

In a peer reviewed journal paper that examines the footprint of Marcellus shale gas and wind through scenario analysis, upwards of 1 ¼ million acres of new impervious surface can be expected across the Marcellus from gas well development. This has direct adverse impacts on water quality and water supplies, the maintenance of biological life in streams and causes increased polluted stormwater runoff, sedimentation and flooding to waterways.[iv] The report points out that much of the land is now forested (about 70% of the entire

Marcellus Shale play), that forests provide important water quality benefits and the loss of forested land increases the cost of providing safe drinking water to the urban areas that rely on it.[v] This is of particular importance to the downstream developed areas in the Delaware River Watershed and in communities outside of the Basin that use the Delaware River for drinking water.

The economic hardship caused by diminished water quality and supply must be considered in assessing the potential impacts of fracking. In the Delaware River Watershed, water supplies contribute 3.82 billion dollars in annual value to the regional economy and water quality brings $2.5M in annual economic benefit to the Basin, according to a study out of the University of Delaware.[vi] When water is depleted, it has real economic impacts for the source watershed that has lost the value of that water and can force externalized costs on to the consumer.

A study that examined the location and footprint of gas well sites found substantial land clearing and forest fragmentation in Pennsylvania's Marcellus Shale regions and reported on impacts to fauna and flora. "In a study of 242 drilling pads on the Marcellus Shale in Pennsylvania, half were located in forested areas and an average of 8.8 acres of forest was cleared for each drilling pad with its roads and other infrastructure."[vii] "Assuming an ecological edge effect of 330 feet extending into intact forest from cleared areas, each drilling installation affected 30 acres of forest. Black-throated blue warblers, scarlet tanagers, ovenbirds, and other forest songbirds are adversely affected by fragmented forests because they avoid open areas."[viii] The openings in the forest canopy also increase exposure to predation and nest parasitism for these species. Other organisms that can be negatively affected by forest fragmentation include woodland pool-breeding amphibians, forest floor wildflowers with ant-dispersed seeds, and plants whose pollinators or herbivores are affected."[ix]

The amount of acreage disturbed is now trending upwards in size due to supersized wells with longer well bores. Mega-sized well pads are the trend, starting in 2016 and becoming more common in 2017. Therefore, the impacts will be greater as the disturbance and actively used areas of a well site expands. This is discussed in more detail in this Comment on page 24.

The documented benefits of forest ecosystem services to water purification are discussed in a U.S. Forest Service report; the loss of these services can degrade water quality.[x] Scientific literature explains the clear link between forests and water quality, verifying that reductions in forest cover correlate with negative changes in water chemistry, such as increased levels of nitrogen, phosphorus, sodium, chlorides and sulfates as well as reduced levels of macroinvertebrate diversity.[xi] Approximately 85% of the lands underlain by Marcellus Shale in the Delaware River Basin is forested. (Schmid) Approximately 85% of the Appalachian Basin in the Delaware River Watershed is forested.[xii]

Researchers at the Academy of Natural Sciences have discovered that where high density of natural gas wells occur, adjacent streams in Pennsylvania's Marcellus are experiencing decreased water quality as demonstrated by lower macroinvertebrate density and higher levels of specific conductivity and total dissolved solids.[xiii] A publication of the

Proceedings of the National Academy of Sciences found streams adjacent to gas wells are negatively impacted by runoff and sedimentation (Total Suspended Solids), harming benthic life, fish and wildlife and causing streams to be eroded and destabilized.[xiv]

According to a peer reviewed paper assessing stream vulnerability to unconventional oil and gas development, approximately 79% of assessed U.S. river and stream miles have degraded environmental conditions with significantly altered biological communities.[xv] Common stream stressors that degrade water quality are excess nitrogen and phosphorous, metals, sediment, and other contaminants from agriculture, urbanization, and wastewater.[xvi] Development for energy sources such as mining has had large impacts on stream quality over the years. Today, unconventional oil and gas extraction (UOG) from shale has the potential to alter streams through land development, spills, water withdrawals, and wastewater production.[xvii] The report states that adding these impacts to the existing stressors will have an unknown level of impact. The study developed indices to describe watershed sensitivity and exposure to disturbances and compared various shale plays. Catchments in the Barnett and Marcellus-Utica were naturally sensitive from more erosive soils and steeper catchment slopes.[xviii] These catchments also encompassed areas with greater UOG densities and urbanization.[xix] These findings document that development of shale gas in the Delaware River Basin can be expected to have negative impacts due to the natural conditions of the watershed and that as intensity of development increases, so do the adverse impacts.

Wetlands are located throughout the portions of the Basin underlain by gas-bearing shales. Forested wetlands are characteristic of these regions. However, DRBC has not developed detailed maps of regulated wetlands in the Basin. (Schmid)

> "There are no detailed maps of regulated wetlands in the Basin. Existing National Wetland Inventory maps show the general location of wetlands recognizable from aerial photographs, but omit many forested wetlands, which are characteristic in the Special Protection watersheds of the Basin, and which offer special habitat values over and above other kinds of wetlands in this biome (Schmid& Co., Inc. 2014)."[xx]

Wetlands are sensitive to development activities and are documented to have been degraded by oil and gas development. There is substantial potential for destruction and loss of wetlands if fracking were to occur in the Basin. (Schmid)

> "Wetlands are among the most threatened ecosystems on the planet. They are degraded and converted to human uses more rapidly than any other ecosystem, and the status of freshwater species is deteriorating faster than any other species. Since wetlands are essentially characterized by hydrologic conditions, changes in water volumes and timing of flows are major threats, as are discharges of various pollutants."[xxi]

A report on frack well sites documents the harmful impacts to wetlands and wetland species. "Brackish (salty) wastewater released at a wellsite can pollute streams and wetlands, rendering them unsuitable for many salt-sensitive freshwater organisms including frogs, salamanders, fishes, and many freshwater plants."[xxii] Plants are also adversely affected. "Brackish wastewater spilled or leaked onto soil would render the habitat unsuitable for many common and rare woodland plants including some trees, as well as many soil invertebrates."[xxiii]

A report from New Jersey Department of Environmental Protection concludes that less than half the wetlands mitigated over time were successful; only 48% concurred with their design specifications on average, leaving most sites without the mitigation goals accomplished.[xxiv] A report from the New Hampshire Office of Energy and Planning warns that there is a lack of scientific evidence that documents the success or failure of mitigating adverse impacts through wetlands creation or expansion; contracted wetlands are not necessarily successfully providing environmental benefit.[xxv] In other words, mitigation is a leap of faith not founded on scientific evidence.

The U.S. Council on Environmental Quality states that impacts should be avoided altogether by not taking a certain action or parts of a certain action and includes as options to minimize, reduce, rectify and compensate for adverse impacts of development.[xxvi] Once a natural system such as a wetland is damaged or destroyed, it is very difficult to restore that resource's full function or to replace those lost ecosystem functions with another. The far better policy is to prevent the damage rather than try to repair or replace after the intact natural system is diminished.

Examining the trend in shale gas development today, the size of well pads is expanding as horizontal well bores extend further (up to 4 miles in Pennsylvania's Marcellus Shale) and the geometry of drilling adjusts to allow more horizontal well bores to each vertical bore.[xxvii] Supersized well pads or "mega-pads" are the trend, starting in 2016 and becoming more common in 2017. DRBC's Supplementary Information states that the average total disturbance for a single well pad is 7.7 acres including access roads and gathering lines.

This estimated area to be disturbed for a fracking well site is now out of date. Companies such as EQT – the largest natural gas producer in the nation with offices in Pittsburgh - Range Resources and industry investor reports are touting the new "supersize" wells as the wave of the future, maximizing the investment of up to a half billion dollars on well pads with up to 20 wells. Some pads in the southwestern Pennsylvania area have up to 37 wells permitted.[xxviii] In the Permian Basin in Texas, one pad has 64 wells.[xxix]

The size of the well pad today is trending to be at least 10 acres in the Marcellus and Utica shale regions for these supersize wells, without considering the associated disturbances for access, pipelines, water basins, and other industrial activities required for well development. This translates into more impervious surface, more runoff, and more intense use of each site. It also means that industrial scale operations to develop the wells on a mega-pad will last longer, at least 3 years rather than the previously typical one year time frame.[xxx]

This means prolonged impacts on land and streams while wells are being constructed. This also provides more time for pollution events, spills, leaks and stormwater impact to occur, exposing the environment, waterways and the public to more risk for longer periods of time. And it prolongs the period of time that humans and wildlife are impacted by local air, noise, and light pollution, traffic impacts and other disturbances. For instance, the number of truck trips to transport water into a frack well site and to transport the waste out of the property also increases; typically 1400 truck trips are required to deliver the average 4.5 million gallons of water to frack a well. However, since water use has now more than doubled, the local truck traffic and the air emissions that are released by the diesel trucks can also be expected to increase by at least double.

Fracking Fluids, Injection, and Gas Production Impacts

The next phase of gas development involves the storage, handling, and use of chemicals and additives for extraction and stimulation of gas, the drilling and fracking of the gas well, and the release of gas from the geologic formation. The impacts of the production of flowback and produced fluids will be addressed in this comment under Section 440.5.

The two primary pathways for pollution to reach waters of the Basin from fracking and drilling operations are across the ground surface and through groundwater. (Tom Myers, "Technical Memorandum: Review of Proposed Natural Gas Regulations as Proposed by the Delaware River Basin Commission", March 12, 2018)

> "There are two primary pathways for contaminants to reach waters of the Delaware River Basin –across the ground surface and through groundwater. The primary source of contaminants on the ground surface is spills from operations or transportation."[xxxi]

Spills or leaks

The potential for contamination of ground and surface water from spills at a gas well site is substantial and presents a significant threat. Studies show that spills and leaks are among the most likely means of contamination from gas and oil wells. (Myers) Examination of data from four states, including Pennsylvania, found the occurrence of one spill per every 3.2 wells. (Myers)

> "Contamination can reach surface water near a gas well by flowing across the ground surface through small drainages to streams downhill from the source. The potential for spills or leaks to follow such a path is clear, but there is little specific research. Lefebvre (2017) found that spills or other surface releases represent the most probable mechanism leading to groundwater contamination. Most research concerning spills of fluids associated with O&G development focuses on well pad spills. For example, EPA's review of fracking-related spills was limited to spills near the pad (EPA 2015). In a substantial review paper concerning the impact of shale gas on regional water quality (Vidic et al. 2013), the authors cited just one report from grey literature (Considine et al. 2012) regarding spills and one journal article from the early 1980s regarding spills transporting through shallow groundwater (Harrison 1983). A more recent article (Maloney et al 2017) summarized details of the threats of spills at the well site harming nearby streams.
>
> Considering O&G development in four states, Pennsylvania, Colorado, New Mexico, and North Dakota, Maloney et al (2017) reviewed data from 6622 spills that occurred for 21,300 unconventional wells, a ratio of one spill for every 3.2 wells."[xxxii]

Of the four states examined in Maloney et al (2017) Pennsylvania had the closest proximity of wells to streams. (Myers) This means a more rapid delivery of pollutants to surface water and more difficult management of pollution incidents. Over the four states, 5.3% of the reported spills in Pennsylvania were within 100 feet of a surface waterway. (Myers) Since Pennsylvania regulations only require a 100 foot separation from the edge of a well pad to a stream, compliance with those regulations will not prevent contamination from spills. These statistics show that to prevent gas well spills from causing pollution, prohibiting fracking is the best course.

> "The proximity to streams was smallest in Pennsylvania, with an average distance of 268 meters (Id.). This could be due to the higher density of streams in a humid-regions state like Pennsylvania as compared to the other states. Over the four states, 7% of spills were within 100 feet of a stream, and 5.3% of the spills in Pennsylvania were within this distance. Maloney et al (2017) reported that the required setback in Pennsylvania is 100 feet, so decisionmakers should not rely on compliance with regulations to protect streams. The statistics regarding spills shows that DRBC is correct to ban fracking within the DRB to protect streams within the basin."[xxxiii]

Groundwater contamination occurs when pollutants are spilled onto the ground surface and are infiltrated to shallow groundwater. This contamination can then easily be transported to surface water. (Myers) The likelihood of water contamination from fracking is great due to the vulnerable nature of the headwaters regions of the basin, supporting the prohibition of fracking as the most effective means of preventing the spread of contamination from spills. (Myers)

> "A groundwater flow pathway unique to headwaters regions within the DRB is shallow transport from spills or leaks of surface storage. The distance from any point on a

> drainage basin to a first-order stream is short, on the order of a few hundred to perhaps a thousand feet. Shallow aquifers especially on ridges are thin (Taylor 1984) and the water table follows the topography. Thus, spills would move as interflow from the source to streams relatively quickly, on the order of days."[xxxiv]

Spills or leaks at fracking well sites contain very dangerous chemicals and hazardous substances. For instance, hydrocarbons, petroleum distillates, and diesel range organic chemicals (DRO) have been found in soils and shallow groundwater near spill locations at well sites. (Myers) These are very difficult to clean up and remain 25 times longer in the clay-rich soils found in the Basin, making prevention rather than mitigation the preferred approach to water resource protection. (Myers) Radioactive materials are also more likely to be found at spill locations at fracking sites; radioactive properties are also extremely long-lived (the half-life of radium 226 is 1600 years).

> "Spills of fracking fluids include hydrocarbons and petroleum distillates which linger in the soils and are difficult to clean up (Maloney et al 2017), regardless of whether the spill is at the pad or during transportation. Ripendra (2016) found contamination by wastewater disposal and accidental leaks and spills of wastewater and chemicals used during drilling and the hydraulic fracturing process to be two of the four primary threats to water quality posed by fracking, with the other two being well integrity related.
>
> Drollette et al (2015) found in the Marcellus region an elevated concentration of diesel range organic chemicals linked to hydraulic fracturing fluid within shallow

groundwater. They associated it with spills, primarily at the well sites, by correlating DRO concentration with distance from wells. They did not test for distance from other types of spills, presumably because the location of those spills is not available in the data base. In addition to showing potential for long-term contamination near well sites, these results suggest there would be long term DRO contamination near all spill sites. The contamination from spills into clay-rich soils is likely to linger as much as 25 times longer than for gravely soils (Cai and Li 2017). The contamination is also likely to contain higher concentrations of various radioactive substance (Lauer and Vengosh 2016)."[xxxv]

Complicating the problem of spills at fracking sites is that much is not known. This is due to lack of routine monitoring that could catch unreported releases or the accumulation of smaller spills, inadequate reporting and enforcement systems, and the use of hazardous materials that are unidentified or are protected by trade secret laws. "Little information is available on the potential impacts of some fracking chemicals on streams, wetlands, or upland soils. Because some of these chemicals are known to be endocrine disruptors or carcinogens, these substances would undoubtedly cause harm to many stream, wetland, and forest wildlife species."[xxxvi]

The Fracking Process

Contamination of groundwater aquifers by fracking occurs underground and involves at least three different substances – natural gas, formation brine, and fracking fluid. The contaminants can follow natural fractures and faults in the subsurface rock formations or can travel from a poorly constructed gas well and/or through abandoned wells. (Myers)

> "The most complex transport pathways for contaminants from fracking to reach Watershed lands occur underground, between the point of fracking and shallow groundwater or surface water. At least three different substances released by fracking can reach shallow groundwater or surface in the DRB – natural gas (shallow biogenic and deep thermogenic gas), formation brine, and fracking fluid. All would be part of produced water as defined by the proposed regulations if they transported up the well bore to shallow groundwater or surface water. These contaminants can follow pathways through natural faults and fractures, through abandoned wells or poorly constructed gas well, or a combination of both."[xxxvii]

Natural gas is a mixture of carbon-chain gases, with methane (CH4) being the dominant. (Myers) There are many studies that have documented increased concentrations of thermogenic (from deep geologic formations) CH4 within one kilometer of fracked wells. (Myers) Valley locations along faults have also collected CH4 and fractures caused by faulting is considered to provide pathways to the surface. (Myers)

A peer reviewed study by Tom Myers explained several ways that shallow groundwater can become concentrated with CH4 including: microbial methane production; natural migration over time; vibrations from drilling activities that drive natural gas towards shallow groundwater; leakage from target or intermediate-depth formations through a poorly cemented well annulus; leakage from target formations through faulty well casings;

migration of gas from deep formations along natural faults, joints, or fractures; migration of deep formation gas through faults or fractures caused by drilling or fracking; migration of deep or intermediate gas through abandoned or orphaned wells. Earthquakes may also cause vibrations that cause gas to be released and earthquakes may also be associated with increased fracking. Gas migration into groundwater can affect water wells. (Myers)

> "Darrah et al. (2014) listed the following scenarios that can lead to higher methane concentrations in shallow groundwater:
>
> > (i) in situ microbial methane production;
> >
> > (ii) natural in situ presence or tectonically driven migration over geological time of gas-rich brine from an underlying source formation or gas-bearing formation of intermediate depth (e.g., Lock Haven/Catskill Fm. Or Strawn Fm.);
> >
> > (iii) exsolution of hydrocarbon gas already present in shallow aquifers following scenario 1 or 2, driven by vibrations or water level fluctuations from drilling activities;
> >
> > (iv) leakage from the target or intermediate-depth formations through a poorly cemented well annulus;
> >
> > (v) leakage from the target formation through faulty well casings (e.g., poorly joined or corroded casings);
> >
> > (vi) migration of hydrocarbon gas from the target or overlying formations along natural deformation features (e.g., faults, joints, or fractures) or those initiated by

drilling (e.g., faults or fractures created, reopened, or intersected by drilling or hydraulic fracturing activities);

(vii) migration of target or intermediate-depth gases through abandoned or legacy wells”[xxxviii]

Also documented by studies using tracers during fracking, gas can move quickly from the well into the surrounding environment and can move between rock layers under the ground. (Myers) This means that the release of CH4 is difficult to control and can be difficult to mitigate.

“Gas tracers released during fracking were found at production wells 750 feet away from the source within days (Hammock et al 2014). They also found evidence of gas migration to a sandstone formation 3000 feet above the Marcellus shale (Id., Figure 33). A model study based on conditions found at the southwest Pennsylvania site used in Hammock et al. estimated that gas can flow from a well bore leak through a sandstone rock matrix to a well 170 m away in times ranging from 89 days to 17 years depending on conditions (Zhang et al 2014). Darrah et al. (2014) found several gas wells within one kilometer of fracked wells that experienced large increases in gas concentration between annual sampling events which suggests that gas transport of up to a kilometer occurred in a time period of less than a year.

Additional evidence of gas movement along faults through the earth’s crust to shallow groundwater may be seen through studies concerning CO_2 sequestration. Shipton et al.

(2004) found that fluids (liquid and gas) can move vertically through low permeability faults, including those otherwise considered to be sealed with calcite."[xxxix]

The movement of gas through various faults and pathways is also extremely variable and hard to predict. (Myers) But the evidence of the ability of gas released by drilling and fracking from deep formations to reach shallow groundwater and water wells, springs and streams is scientifically affirmed. (Myers) The effects of CH_4 concentrations in streams and on aquatic life can be devastating.

"It is common to ignore the presence of methane in streams. Methane degases from surface water, but without sufficient aeration, the methane decreases the dissolved oxygen in the surface water which would have severe aquatic effects. Essentially, methane discharges to streams increase the dissolved methane content of the stream thereby decreasing the dissolved oxygen content for areas near the methane source. This can lead to dead zones just as anything else that depletes oxygen."[xl]

The forces that cause the release are many and complex, are not usually understood or required to be analyzed prior to drilling and fracking a well and are not uncommon. To avoid CH_4 contamination, prevention is the most effective approach.

Formation brine, under natural forces, moves from deep rock formations to shallow groundwater through natural faults and fractures. (Myers) Reports point out that these same pathways are available for fracking fluids to shallow groundwater. Studies have proven that fracking fluid has reached drinking water wells and that transport has occurred between the gases well and shallow groundwater. The flow of deep brine to the surface and between shale layers is well documented in scientific literature over the years. (Myers)

> "Formation brine naturally flows through faults and fractures from the Marcellus (Warner et al. 2012) or other deep Appalachian basins to shallow groundwater (Llewellyn 2014) based on geochemical and isotopic evidence. Both papers warn that these connections could allow more rapid brine flow or portend the flow of fracking fluid to shallow groundwater due to increased pressure or enhanced connections due to fracking. At least three published studies have documented fracking fluid reaching drinking water wells (Llewelyn et al 2015, DiGiulio et al. 2011; EPA 1987) and litigation settlements have prevented disclosure of the facts in similar circumstances. Llewelyn et al (2015) documented transport between a fault plane/well intersection 1600 feet BGS and a shallow aquifer.
>
> Model studies for years have simulated the potential for deep brine to circulate to the surface naturally (Deming and Nunn 1991; Person and Baumgartner 1995) or in conjunction with deep waste or CO2 injection (Birkholzer and Zhou 2009)). The role of fractures to allow flow through shale layers has also been known for years, with Bredehoeft et al. (1983) finding that at a field scale, the vertical conductivity of shale is up to three orders of magnitude greater than the conductivity estimated from a column in a laboratory."[xli]

Marcellus Shale has been modeled to show that deep brine and fracking fluids can be transported from the Marcellus to shallow aquifers over a period of ten years to more than a thousand years. (Myers) Numerous modeling studies show that these fluids can move from deep formations (where fracking occurs) to drinking water and surface waters. Two studies that countered these findings have serious flaws that have been exposed. (Myers)

> "Myers (2012) found that transport from the Marcellus to shallow aquifers could occur over a period from 10 to more than a thousand years, depending on the conductivity assumed to result from fracking -- his model had the horizontal gas well intersecting a vertical fault connecting the shale to the near-surface. Gassiat et al. (2013) modeled a high permeability, continuous, 10-m wide fault zone from the shale to the shallow groundwater with fracking simulated as a change in permeability over a 2-km long, 150-m thick zone. Kissinger et al. (2013) simulated a continuous 30-m thick vertical fault with a head drop of up to 60 m to drive a plume of fracking fluid into the lower aquifer. After 30 years under this scenario, simulated fracking fluid had reached the shallow aquifer. Lateral migration of contaminants occurred at rates up to 25 m/y (Lange et al. 2013). Chesnauw et al. (2013) modeled flow along a fracture pathway between a target shale zone and surface aquifer in a two-dimensional framework, 3000-m long by 3000-m deep and 1 m thick. The modeling studies utilized generic stratigraphic and topographic cross-sections with idealized formation properties due to a lack of specific aquifer data. Also, they considered flow through a fault, but likely underestimated the potential for preferential flow through small but highly permeable fractures even within a preferential flow zone. Taherdangkoo et al (2017) found that upward fluid migration to a shallow aquifer depended on the characteristics of the fault, but argued the

probability remained small; they did not consider out-of-formation fractures intersecting the fault or a natural upward gradient in the fault zone due to common basin topographic circulation (Deming and Nunn 1991). Wilson et al (2017) used model simulations to show that fracking fluid could reach shallow aquifers through fault zones from a target shale greater than 2000 meters bgs. Travel time was quicker for increased induced fracture extent (out of formation fractures), absence of deep high hydraulic conductivity strata, and low fault hydraulic conductivity. The authors found that high conductivity horizontal formations intersecting the fault and high conductivity faults allowed fluids to leak off thereby reducing the mass reaching shallow groundwater."[xlii]

Brine from the Marcellus Shale uses pathways that are opened or expanded by fracking, allowing the free water that is contained in fracture zones to travel upwards. The fact that brine dominated the flowback after the initial flowback carried the nearest fluids – the fracking fluids – up the well bore, proves that there is free water in the deep formations and it is agitated, released, and transported by fracking. (Myers) The highly contaminated properties of this brine, including TDS, various salts, hydrocarbons, heavy metals, and naturally occurring radioactive materials (NORM) poses tremendous threat to the quality of groundwater, drinking water wells, and surface water in the Delaware River Basin. (Myers)

"Fracking provides a pathway for Marcellus brine, the free water, to flow to the gas well, probably becoming dominant after the fracking fluid remaining most closely near the well goes back up the well as flowback.

Haluszczak et al (2012) showed that brine dominated the flowback, based on the rapid increase in concentrations of various constituents, including TDS, Cl, Br, Na, Ca, Sr, Ba, and Ra, in the flowback to levels several times that of seawater. Flowback was not fracking fluid that had dissolved rock minerals from the shale as claimed by Engelder et al. Kohl et al. (2014) used strontium isotope ratios found in flowback to isolate the source formation; the strontium signatures would not be as representative of the source formation if its presence was due only to high velocity dissolution during fracking. Rowan et al. (in press, abstract, emphasis added) conclude that the "δ18O values and relationships between Na, Cl, and Br, provide evidence that the water produced after compositional stabilization is **natural formation water**, whose salinity originated primarily from evaporatively concentrated paleoseawater"."[xliii]

Because this movement of contaminants cannot be controlled underground, there is effectively no way to avoid the contamination it causes. The only way to avoid this substantial risk of pollution is to prevent it by prohibiting fracking within the Watershed.

"The proposed regulations properly prohibit fracking within the Delaware watershed. This section has described how fracking has been shown to cause pollution or how it is likely to do so in the future, both through the actual process of fracking and from well bore leaks. The potential for contaminants to reach groundwater through these pathways is a good reason for banning the process within the watershed. DRBC is correct in doing so."[xliv]

Scientific reports examine the competence of the cement that is used to seal the gas well bores that access gas and the steel that is used to encase the produced gas in the well bore. One report investigated many industry and technical reports on these issues and provides ample evidence of the substandard well construction and plugging and abandonment regulations that are in place. Well casings, cementing, and cement plugs are not regulated to protect aquifers and will lead to pollution, either in the short term or as they degrade. "Because hydraulic fracturing opens joints well beyond the borehole, plugging and abandonment practices may do little to protect the environment after chemical additives are repeatedly injected into bedrock formations under high pressure. Also, presently used cement mixtures and other materials do not achieve zonal isolation in each well, allowing for gas migration and the escape and comingling of fresh and contaminated subsurface waters."[xlv] The report concludes that the implications of short term cement failure on long term aquifer water quality protection are extremely significant. As stated in the report[xlvi]:

> "Aquifer protection requires the use of downhole methods and materials that, like aquifers, will stand the test of time and harsh physical conditions. Current state-of-the-art cement materials used in well completion and plugging and abandonment operations do not have a documented long-term history of durability. Cement mixtures or alternate sealant materials must be capable of maintaining the long-term hydrologic integrity of freshwater aquifers separate from deep underlying geologic formations that contain saline water enriched with natural gas, radioactive elements, and hydrofracture-related chemicals. Inherent in permitting and the regulation of gas wells is the concept that

groundwater quality will be maintained and will be available as a potable water source in perpetuity.

Freshwater aquifers have taken millions of years to form. As geologic layer after geologic layer was deposited, buried, and eventually lithified over time, many became physically isolated from overlying strata. Some of the deeper bedrock horizons contain old, brine-rich, connate waters that are present in the pores of the bedrock. This saline water was either trapped in bedrock pores when the rock units were formed or became highly saline later in time through mineralization due to stagnant flow conditions (Fetter, 1994). Under natural conditions, this pore water is not encompassed by the hydrologic cycle. Gas drilling activities provide a mechanism whereby deep formation waters now have an avenue to commingle with overlying freshwater aquifers if failure of zonal isolation materials occurs."

"The oil and gas industry has long recognized the need to maintain the long-term integrity of boreholes that breach bedrock formations that have naturally and effectively isolated freshwater aquifers from deep connate waters for millions of years. Research continues in efforts designed to lead to better practice and better cement formulations, including some self-sealing mixtures that are newly developed but have not been tested for years in the harsh downhole environment."

"Cement shrinkage, debonding, and failure can result from a variety of causes including too high a water content, water expulsion, shrinkage after setting and during hardening, radial cracking, tensile failure, compressional failure, traction, cement dehydration, osmotic dewatering in the presence of high salt content formation brines, corrosive gases, high formation pressures and temperatures, changes in temperature and pressure, sustained casing pressure (SCP), poor cement blends, pressure testing, gas and water channeling, gas migration through setting cement, influx via mud channels, internal and external microannulus development, cement shattering, and cement plastic deformation (e.g., Dusseault et al. 2000; Heathman and Beck 2006; Brufatto et al. 2003; Kellingray 2007; Lecolier et al. 2006; Newhall 2006; Mainguy et al. 2007; Teodoriu et al. 2010; Ladva et al. 2005; Moroni et al. 2007; Ravi et al. 2002; Gray et al. 2007; Reddy et al. 2007; Darbe et al. 2009; Bellabarba et al. 2008; Daneshy, 2005; Crook and Heathman 1998; Boukhelifa et al. 2005; Tahmourpour et al. 2008).

Problems with the integrity of well cement are well known in oil and gas fields. For example, twenty-five to thirty percent of wells in one shelf study area were estimated to have annular pressure problems (SCP) in five to six years, reaching 60 percent in 27 years (Kellingray 2007). Fractured shales of the Appalachian Basin may present problems when cementing wells (Newhall 2006)."

"Assorted researchers are evaluating the service-life of reinforced concrete structures susceptible to chloride corrosion (e.g., Trejo and Pillai 2003). Similarly, Shiu (2011), of Walker Restoration Consultants, states that reinforced concrete structures generally have a service life of 30 to 40 years. Their work may help assess the maximum potential service life of concrete under various conditions. Research to date indicates that the life of concrete in both above ground and downhole conditions, under the best of circumstances, may be less than 100 years. Even if this preliminary assessment is in error by an order of magnitude and the life of concrete is 1,000 years, this time frame for the design life of concrete very quickly results in jeopardizing the useful life of Delaware River Basin aquifers in far less than 1,000,000 years – in only 0.1 percent of the conservatively estimated life of aquifers." [xlvii]

Considering groundwater flow, time, and the corrosive downhole environment created by gas extraction processes, including the lack of durability of the cement sealant and steel well casings, aquifers and surface waters are not sufficiently isolated from the gas, toxic fluids and deep geology pollutants that are distributed by drilling and fracking.[xlviii] Aquifers could be impacted quickly, such as when there is a faulty cement seal or casing during construction, or over time. But it is certain that the life of the cement and/or steel (up to 100 years under good conditions) is less than the life of the aquifer - so even if there is no evidence in the near term, the eventual pollution is likely occur in less than a century.[xlix] It is not a matter of "if" these wells will fail, but a matter of "when".[l] And when that does occur, water sources are ruined for the generations to come. This is not an acceptable legacy for DRBC and this unavoidable problem supports a ban on fracking.

Fracking is responsible for a plethora of environmental and public health problems where it is occurring, including in the Marcellus and Utica Shales in Pennsylvania. The harms are documented in a growing body of scientific literature and in data being produced by agencies and reporting mechanisms such as FracTracker (https://www.fractracker.org/map/us/pennsylvania/) SkyTruth (https://www.skytruth.org/) and industry sites such as FracFocus.

SkyTruth uses technology to identify and monitor threats to the natural environment.[li] As part of that work, SkyTruth collects violations of permits for oil and gas development for subscribers. Attached as **Attachment 3** is an excel document that contains all the violation SkyTruth collected from PADEP's website (http://www.dep.pa.gov/Pages/default.aspx) since May 2012, a total of 2765 reported violations. These may not include all of the violations since the information varies depending on time of inspection and issuance of violation, follow-up actions, and other details, according to SkyTruth staff.[lii]

Arguably the most comprehensive collection of scientific literature on fracking and its impacts is the Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking, 5th Edition.[liii] The Fifth Edition of this authoritative report started in 2014 examining the impacts of fracking on the environment and public health was published March 13. DRN has submitted the entire Compendium through the DRBC's web portal as comment on the Draft Regulations in a separate submission from this Comment.

The health professionals who reported and analyzed over 1,200 peer reviewed research articles for the Compendium concluded in the report: The "…findings to date from scientific, medical, and journalistic investigations combine to demonstrate that fracking poses significant threats to air, water, health, public safety, climate stability, seismic stability, community cohesion, and long-term economic vitality. Emerging data from a rapidly expanding body of evidence continue to reveal a plethora of recurring problems and harms that cannot be sufficiently averted through regulatory frameworks. There is no evidence that fracking can operate without threatening public health directly or without imperiling climate stability upon which public health depends."[liv]

Another related report is a literature review that examines literature compiled on fracking impacts for an earlier edition of the Compendium. The report concludes that the body of scientific evidence demonstrating the negative environmental and human health effects from unconventional natural gas development (UNGD) is very strong. The authors of a 2016 study evaluated peer-reviewed literature published between January 1, 2009 and December 31, 2015 as they related to the potential impacts of UNGD on public health, water quality, and air quality. The boundaries of the assessment included scientific literature on hydraulic fracturing and the associated operations and ancillary infrastructure required to develop and distribute unconventional natural gas.[lv] The results indicated that at least 685 papers have been published in peer-reviewed scientific journals that are relevant to assessing the impacts of UNGD.[lvi]

A portion of these papers covering each category (public health, water quality, and air quality) was selected by the authors to review. Of the 31 studies selected for public health, 26 (84%) contained findings that indicate public health hazards, elevated risks, or adverse public health outcomes from UNGD.[lvii] Of the 58 studies related to water quality, 40 (69%) had findings that indicated potential, positive association, or actual incidence of water contamination from UNGD.[lviii] Finally, of the 46 studies associated with air quality, 40

(87%) had findings that indicated that UNGD increased air pollutant emissions and/or atmospheric concentrations.[lix] This study demonstrates that the weight of the findings in the scientific community indicates hazards and elevated risks to human health as well as possible adverse health outcomes associated with UNGD.

Another important source of data about the impacts of gas development is the website of the Pennsylvania Department of Environmental Protection (PADEP). PADEP has determined that there are 307 cases of private water well contamination caused by oil and gas operations in the Commonwealth, as of 3.23.18.[lx] This number does not include ongoing investigations or cases that were settled and are now subject to a non-disclosure agreement. The number also represents "cases", as many as 16 water wells and, in the case of Dimock, PA, nine square miles of aquifer were contaminated but the contamination was counted as one "case". There are also cases that were not found to meet PADEP's requirements to be determined as definitely caused by oil and gas operations that are still unresolved by well owners. It is important to also recognize that PADEP uses data collected pursuant to oil and gas regulations which have limited zones of influence around the gas well that can be considered, limited periods of time in which contamination can be considered, and a limited number of contaminants for which sampling is done. For instance, methane migration into water wells caused by fracking is not being counted by PADEP as a pollution incident[lxi] and yet it can render a water well unusable and has health and safety impacts for the residents.

For instance, if contamination occurs after the period of time that a water well in proximity to a gas well is required to be monitored, the contamination may not be considered as legitimate. Further, because the sampling of water wells within the zone of presumption is compared to current background water quality, pollution events can be masked by prior contamination of an aquifer, leaving the well owner without the proof needed to receive a positive letter of determination from PADEP. It also means that because background concentrations are used as the standard to which groundwater must be cleaned under Pennsylvania's Act 2, aquifers where fracking contamination has occurred but had not been discovered will be condemned to a downward spiral of water quality as the "new normal" becomes the contaminated condition.

Therefore, the 307 cases – in itself representing an unacceptable loss of residents' well water quality and clean drinking water - that have been "positively determined" by PADEP are more than likely an under-representation of the total number of private water wells that have been contaminated by oil and gas operations in Pennsylvania. Since the number of "positive determinations" continues to rise as new cases are resolved, it is clear that private water wells and the aquifers of Pennsylvania are not protected from degradation by gas and oil development and fracking, regardless of the adopted regulations.

The Delaware River Basin would be exposed to this same risk. Over 4,400 water complaints related to oil and gas have been filed by the public with PADEP. Between 2004 and 11.2016, PADEP lists a total of 9,443 public complaints about environmental problems in shale gas drilling areas.[lxii] As fracking has progressed in Pennsylvania, instead of practices improving and the adoption of new regulations by PADEP reducing gas and oil operation-related complaints, the ratio of complaints has increased.[lxiii]

Finally, the U.S. Environmental Protection Agency's (EPA) Hydraulic Fracturing study issued in 2016 after seven years of research provides scientific evidence that fracking activities can impact and have impacted drinking water resources.[lxiv] EPA also has published an analysis of oil and gas industry spills.[lxv] The false claim that fracking has not contaminated water supplies cannot be made with a straight face; EPA and other reports (see "Compendium" and other references in these comments) have proven it has and that water pollution incidents can be expected to continue.

It is also important to recognize the shortcomings of some analyses, especially if the results are being mischaracterized. Some members of the public have been describing a report issued by the Susquehanna River Basin Commission (SRBC) as concluding that there are no adverse impacts from fracking to the water resources of the Susquehanna River Basin. In fact, the U.S. Geologic Survey and Northeast-Midwest Institute conducted a review of the SRBC report and concluded that the existing water quality data in the Susquehanna River Basin are inadequate to assess whether the increase of shale gas development activity in the Susquehanna River Basin is causing adverse changes in water quality.

The report states that the rapid growth of high-volume hydraulic fracturing (HVHF) in the Susquehanna River Basin has raised concerns about the potential for degraded surface-water quality and potential impacts on drinking water aquifers throughout the basin. USGS and the Northeast-Midwest Institute outlined the key elements necessary to assess the impacts of shale gas development in the Susquehanna Basin. First, it is necessary to collect sufficient water-quality monitoring data. The cumulative effects of shale gas development are more subtle to detect and water-quality monitoring is the only path to identifying low level and long-term changes. Without water-quality data, the long-term cumulative effects of shale gas development on water quality will be unknown.[lxvi] The report concludes that existing surface-water quality data in the Susquehanna River Basin are insufficient to detect water-quality change related to shale gas development.[lxvii] The key steps to generating the needed data include increased monitoring at a subset of priority monitoring sites that includes increased sampling frequency, sampling for additional priority parameters and streamflow, and commitment to long-term monitoring.[lxviii]

The report explains that surface water monitoring sites should be located in each of the four ecoregions with active or planned shale gas development, because stream chemistry in each ecoregion is unique and will respond differently to disturbances or changes in land use.[lxix] Monitoring sites must be located in watersheds with fracking wells and in reference watersheds in each ecoregion (areas with no fracking well development). Monitoring sites in both types of watersheds allow for the detection of water-quality changes that can be compared to identify whether these changes are resulting from natural gas development.

The report states that water-quality and streamflow data at these monitoring sites must be available with sufficient sampling frequency and duration to evaluate trends in concentration over time.[lxx] It also states that data on shale gas development, geology, climate, and other changes in land use throughout the monitored watershed must be available to correlate water-quality change with shale gas development activity. Without this information, the relationship between shale gas development and water quality cannot be evaluated.[lxxi]

The report further states that networks of groundwater sampling sites are also needed with each sampling site located within 1 mile of a fracking well. Water quality data collected before and after shale gas development are necessary in order to detect groundwater quality change. Information on the shale gas development, geology, other changes in land use, and climate near those sampling sites must be available to compare water-quality change with shale gas development activity.[lxxii] Next, a suite of water quality parameters is needed to determine if contamination from the cumulative impact of shale gas development activities has occurred in the Susquehanna River Basin. The suites of priority parameters for surface water and groundwater should be based on the specific hydrology, geology, past and current land use, and other environmental concerns expressed in the Susquehanna River Basin.[lxxiii]

The report says that monthly sampling frequency is needed to detect changes in water quality year-round and to minimize the time needed to detect statistically significant water-quality change at each monitoring site. A minimum of eight surface-water monitoring sites are needed: one monitoring site in a watershed with fracking wells and one reference watershed monitoring site is needed in each of the four ecoregions with active or predicted shale gas development.[lxxiv]

According to the report, the magnitude of water quality change that could occur from contamination related to shale gas development is unknown, but it would take 3-6 years of monthly monitoring to detect a 20% change in median specific conductance or total barium in the Susquehanna River Basin.[lxxv] Only 4 of 22 surface-water monitoring sites in the Susquehanna River Basin with enough existing data for a water-quality trend analysis for barium or specific conductance are located in watersheds with active fracking wells, and few of the 26 recommended surface-water monitoring parameters are available for those sites.[1lxxvi] Only one of those monitoring sites is in a watershed with a fracking well density greater than 0.5 wells per square mile.[lxxvii] The existing surface-water data in the Susquehanna data set are not sufficient to detect whether the cumulative effects of shale gas development are resulting in water-quality change.[lxxviii]

The report states that there is no systematic, large-scale, long-term monitoring effort underway to assess the effects of shale gas development on groundwater quality in the Susquehanna River Basin. The groundwater sampling sites with existing data are rarely located within 1 mile of a fracking well, but even when they are in the right locations the sites lack data for most of the priority groundwater parameters.[lxxix] In addition, the available groundwater data lack the sampling frequency needed for a water-quality trend analysis and lack the number and location of sampling sites needed for a spatial water-quality network analysis.[lxxx] Targeted, robust monitoring networks for both surface water and groundwater are critical for identifying whether the increase of shale gas development activity in the Susquehanna River Basin is causing adverse changes in water quality. The report thus concludes that the existing water quality data in the Susquehanna River Basin are inadequate to serve this purpose.

The findings of the USGS/Northeast-Midwest Institute analysis of the SRBC report were also reported in the USEPA's 2016 Hydraulic Fracturing Study.[lxxxi]

Air Pollution and Greenhouse Gas Emissions from Fracking

In the both development and production phases, natural gas has significant negative air quality and greenhouse gas impacts. While DRBC is responsible for protecting the water resources of the basin, it is known that air emissions effect water and ecological systems. When contaminants disperse to the air they eventually settle downwards, affecting water, soil, vegetation, species, and surfaces. The impact can be substantial, depending on the concentrations and dispersal pattern of the pollution. Many factors influence the effects of air emissions, including weather, climate, atmosphere and anthropomorphic influences.

Scientific reports have confirmed that air quality is impacted by natural gas operations. Air monitoring is not uniform or required in most instances, leaving large data gaps. However, studies have been done of air near gas activities and unhealthy conditions and increases in related illnesses have been discovered.

For example, Colborn et al. conducted an exploratory study in western Colorado where residences are in close proximity to natural gas wells and development.[lxxxii] The study was designed to explore the presence of volatile organic compounds (VOCs), many of which are associated with the production of natural gas, in this rural natural gas production area for one year. The sampling period spanned the timeframe before, during, and after development of a natural gas well pad. Development included drilling, hydraulic fracturing, and production operations. Baseline and weekly air samples were collected between July, 2010, and October, 2011, from a fixed sampling station near a well pad on which 16 vertical (directional) gas wells had been drilled, hydraulically fractured, and put into production during the course of the study.[lxxxiii]

Among the VOCs, four chemicals were detected in every sample: ethane, methane, toluene, and propane. Chemicals with the highest mean values across the sampling period were, in order of mean value: methane, methylene chloride, ethane, methanol, ethanol, acetone, and propane.[lxxxiv] Regarding the carbonyls, acetaldehyde and formaldehyde were detected in every sample. The highest values were for formaldehyde and crotonaldehyde.[lxxxv] Naphthalene was the only polycyclic aromatic hydrocarbon (PAH) detected in every sample and it was also found at the highest concentration among the PAHs detected.[lxxxvi] The most chemical detections occurred during the first four months of drilling, at a time when only one fracturing event occurred. Notably, the highest percentage of detections occurred during the initial drilling phase, prior to hydraulic fracturing on the well pad, and did not increase during hydraulic fracturing.[lxxxvii]

The study found that methylene chloride, a toxic solvent not reported in products used in drilling or hydraulic fracturing, was detected 73% of the time.[lxxxviii] This also stood out due to the extremely high concentrations in some of the samples, including one reading of 1730 ppbv, and three other readings more than 563 ppbv during the period of well development. In contrast, after activity on the pad came to an end and the wells went into production, the highest level of methylene chloride detected was 10.6 ppb.[lxxxix] Residents and gas field workers have reported that methylene chloride is stored on well pads for cleaning purposes.[xc] A literature search of the health effects of non-methane hydrocarbons revealed that many had multiple health effects, including 30 that affect the endocrine system, which is susceptible to chemical impacts at very low concentrations, significantly less than government safety standards.[xci]

The study also found that selected PAHs were at concentrations greater than those at which prenatally exposed children in urban studies had lower developmental and IQ scores.[xcii] While natural gas development and production continues to spread across the land it is moving closer to schools, homes, and places of business. The authors warned that at the same time more and more raw gas will be released into the atmosphere on a steady, daily basis. The report recommended that in order to determine how to reduce human exposure for both those who work on the well pads and those living nearby, systematic air quality monitoring of natural gas operations must become a regular part of permitting requirements.

This report covers many of the air impacts that accompany gas development and fracking. It shows that the various stages of drilling and fracking have impacts, that there are many toxic contaminants that are released by the drilling and fracking process and that many of them have significant adverse health effects upon exposure. The information contained in this report supports a complete prohibition of fracking and drilling and a prohibition of related activities. There are many other scientific reports and articles that are included in the "Compendium", submitted by DRN to the public record for DRBC's comment period on the Draft Regulations and discussed earlier in this Comment. Also, reports from the Southwest Pennsylvania Environmental Health Project[xciii] document air emission-related health problems in the vicinity of shale gas operations and facilities. Some of the data and reports from that Project are included in the Compendium.

In addition to problems associated with harmful air emissions from fracking and gas operations, odors are also a problem related to the storage, management, and treatment of fracturing fluids and in flowback produced by fracking. Odors are not just a nuisance, they can be a serious human health issue and can greatly affect the quality of life near a well site. Hydrogen sulfide is an example of an odorous gas that is nauseating (the "rotten egg smell") and is highly toxic. (Glenn C. Miller, Ph.D., "Review of the Draft Delaware River Basin Commission's Regulations on Hydraulic Fracturing in Shale and Other Formations", March 20, 2018) It can cause illness and even death. There are other toxic odors as well released by fracking operations. (Miller)

> "Odors are a particular problem for management/storage/treatment of HF waters, and a variety of chemicals are present in hydrocarbon formations that can present a serious odor problem, which can be both a serious human health issue and can affect the quality of life of persons living near these sites. A very common, but toxic, constituent is hydrogen sulfide, characterized by a rotten egg smell. Other organic sulfides can also be present, including a variety of alkyl sulfides. Odors are very difficult to regulate, due to the vagaries associated with odor detection, acclimation, and differential effects on different persons. The severity of an odor is in the nose of the beholder. Odors are particularly bothersome to persons living downwind, and storage of HF waters in the Basin can very likely lead to complaints, which should be taken seriously."[xciv]

Radon is another dangerous gas that can be released in toxic amounts by fracking, due to the radioactivity of Marcellus Shale.[xcv] Radon is a radioactive decay product of radium and is a known carcinogen.[xcvi] Dr. Marvin Resnikoff states, “We support section 440.3 which prohibits fracking within the Delaware River basin. This is important, not only for the potential release of drilling fluids and contaminated water into aquifers but also for minimizing the potential release of the radioactive inert gas radon”.[xcvii]

According to a report that examined the potential impacts from fracking on the Delaware River Watershed, the development of shale gas wells could as much as double nitrogen oxides (NOx) emissions, compared to current air conditions in the Marcellus Shale counties of the basin.[xcviii] The release of the NOx is not expected to be short term, during fracking or construction like some of the air pollution associated with fracking operations.[xcix] But the gathering lines require compressor stations to move the gas from the well to market pipelines and those compressor stations are permanent necessity as long as the gas well is producing. So the air quality degradation and unhealthy condition created by the NOx is long-lived and unavoidable throughout the life of the producing gas well.[c] NOx and VOCs are precursors to ozone, or smog, which is known to cause respiratory illness.[ci] Other air pollutants are released by fracking and during all stages of gas development, including sulfur oxides, particulate matter, and volatile organic compounds such as formaldehyde, benzene, toluene, ethylbenzene, and xylene.[cii]

In the same study that examined the potential impacts from fracking on the Delaware River Watershed, health impacts from air emissions and other pollution from fracking was examined.[ciii] The report mapped the likely location of well pads in the Delaware River Watershed's Marcellus Shale region and estimated that 45,000 people live within 1 mile of a projected well pad, virtually the entire population of the location where fracking is most likely to occur.[civ] The study reported that scientific literature documents that some health risk factors are related to the distance from a well pad to a person's home.[cv] 60% of the health of Wayne County's population could be affected by close proximity to a well pad.[cvi] The study examined the pollutants that people would be exposed to, based on scientific studies (CNA, Table 12).[cvii] These findings make very clear that the effects of gas development and fracking on the air and the health of the people of the region are inescapable due to the proximity of projected well pad locations to the population. It is unacceptable to sacrifice the air quality and health of the people of the Marcellus Shale region in the Delaware River Basin so that shale gas can be developed. The only protective option is to prohibit fracking and gas development completely.

Methane pollution and greenhouse gas releases from natural gas development significantly contribute to air degradation from natural gas, whether during stimulation and production or during transport when pipeline leakage is a mounting problem. Methane is an ozone precursor.[cviii]

Natural gas is primarily methane, a greenhouse gas 86 times more efficient at warming the atmosphere than carbon over a 20 year time frame[cix] and its effects persist for hundreds of years[cx]. The well documented vented and fugitive losses from natural gas systems contribute to atmospheric warming; current technology and practices have not controlled these releases. The emissions from shale gas development are so great that it is projected that their release from the build out of Pennsylvania's Marcellus shale will prevent the achievement of global warming goals in the state, accelerating climate change.[cxi]

Climate change impacts on the Basin's water resources include changes in precipitation and runoff that increase flooding and drought, impairment of habitats and water quality (including salt water intrusion to Delaware River Estuary water supplies, the drinking water source for millions of people) and sea level rise[cxii].

Again looking at the study referenced above that examined the potential impacts from fracking on the Delaware River Watershed, the amount of leakage from natural gas development in the Watershed was estimated to be approximately at least an additional 0.5 to 2.2% per year, which would be added to the current releases from the Marcellus Shale play in Pennsylvania and West Virginia.[cxiii] Considering the potency of methane as a greenhouse gas, this burden adds to the growing problem of atmospheric warming from methane, fueling the advance of climate change for the planet. This is an adverse impact of fracking should be considered by DRBC because of the environmental and water-related problems that are caused by climate change and global warming, as discussed above.

The adverse water resource and health impacts caused by methane being released to the atmosphere are another of the impacts of fracking that cannot be eliminated; the leaked and vented gas is part of the fracking process and, even with attempts to develop performance standards to reduce or control leaks and venting, the effort has been ineffectual. As stated in a review of the Center for Sustainable Shale Development Standards, Dr. Robert

Howarth rejects what was touted as a new “gold standard” from industry practices that could reduce methane emissions substantially as full of loopholes and too vague to be effective.[cxiv]

In fact, the sources of methane emissions from components that make up fracking operations in the Marcellus Shale region are largely unavoidable, extremely difficult and/or expensive to control in terms of methane emissions, including: gathering lines; compressors for gathering lines; the use of under-balanced drilling and the presence of “faults” such as those found where mining has occurred (such as would be found in the anthracite coal mining areas of the western portion of the Delaware River Upper Basin); and the venting of gas, including “non-pipeline quality” or “low flammability” gas, venting during completion of a well, venting from exploratory wells that are not equipped to flare and on-site “de minimis” venting.[cxv]

Methane is a very difficult gas to control and it is so potent that its effects are outpacing the global effort to control the warming of the earth’s atmosphere. Studies are showing that methane emissions are rising, even as carbon emissions are just beginning to slow. As stated is a news article about a new study that reveals the huge negative impacts of methane: "What’s true for carbon dioxide is not at all true for methane, the second most important greenhouse gas. Atmospheric concentrations of this gas — which causes much sharper short-term warming, but whose effects fade far more quickly than carbon dioxide — are spiking, a team of scientists reports in an analysis published Sunday in the journal Environmental Research Letters."[cxvi]

As Dr. Robert Howarth of Cornell University eloquently explains, “We need to reduce carbon dioxide. We’ve already put 90% of the carbon dioxide we can into the atmosphere and keep the earth well below 2 degrees Celsius, so we can’t afford to put much more carbon dioxide up there. But no matter what we do for carbon dioxide over the coming years and decades, the planet will continue to warm to 1.5 degrees [Celsius] in 12 years and to 2 degrees [Celsius] in 35 years unless we cut methane emissions. The planet responds much much faster to methane than to carbon dioxide. There was a lot of talk at COP21 that yes, we need to start looking at these short-lived climate pollutants. We need to focus attention on them. We need to do it internationally within the next 2 or 3 years. So, we need to cut methane. Where is methane coming from? The major source in the United States is the natural gas industry. There’s no question about that. And there’s good evidence that shale gas development has accelerated that and perhaps doubled the methane emissions for the natural gas industry because of that. So this completely undercuts the idea that natural gas is a bridge fuel. It cannot be a bridge fuel for it to meet the COP21 targets.”[cxvii] The fact is, methane is a major part of the global warming problem and it is essential that action be taken wherever possible to prevent its release.

Methane emissions are so large they can now be seen from outer space.[cxviii] These findings support the prevention of methane releases to the atmosphere by the complete prohibition of fracking in the Delaware River Watershed.

Comments in opposition to the export of water and water resources out of the basin for fracking at Section 440.4

DRN opposes the Draft Regulations at Section 440.4 that would allow the diversion, transfer or exportation of surface water, groundwater, treated wastewater or mine drainage water from the Delaware River Basin to support fracking outside the basin. DRN requests that this Section 440.4 as written be removed from the draft regulations. Despite a statement by the DRBC that this practice is "discouraged", the regulations lay a road map for drilling companies showing how to successfully receive DRBC approval. Due to trends in industrial practices over recent years and the proximity of high-producing gas wells in adjacent Susquehanna County and other portions of the Susquehanna River Basin, it is more than likely that drillers would take advantage of the opportunity to withdraw water from the Delaware River Watershed for fracking.

The management, protection, and conservation of water resources is DRBC's *raison d'être*. One of the few regions to be governed by a Compact based on watershed boundaries, predating our federal environmental laws and bureaucracies, DRBC is in a unique and powerful position to make watershed-based decisions from which the Basin states have richly benefited since 1961. Indeed, little is being done regarding proper management and protection of water nationally or on a global scale, evidenced by the high water consumption and out of date planning that dominates the world's approach to water.

Examining the demand for water worldwide, a report published in August in *Nature* concludes that we are overexploiting our aquifers, estimating that the global groundwater footprint is about 3.5 times the actual size of aquifers where almost one quarter of the world's population lives (1.7 billion people).[cxix] An article in the Harvard Business School's Working Knowledge points out that by 2050, the Earth's population will likely exceed 9 billion people, many expected to live in cities yet in terms of urban planning, "Water is often planned last and gets short shrift," said John Briscoe, a professor at the Harvard School of Engineering and Applied Sciences, who participated in a panel a session dedicated to water. "Water is absolutely the poor cousin of the utilities."[cxx]

Water used for fracking, particularly in deep geologic formations, is a depletive use and is defined as depletive by DRBC. This depletion is fundamentally different than evaporative losses for agriculture, electricity generation, and recreational uses like golf courses, which essentially recycle the water used into the atmosphere where it returns as precipitation. In fracking, the water used is not only removed from its source, but is locked away in the rock formations where it was injected. In the Marcellus Shale, approximately 90% or more of the water stays below the ground and the remainder (10% or less) travels back up the well bore during the fracking process as "produced water". That produced water has been transformed from its natural quality to a polluted state that essentially renders it useless as a water source, and becomes wastewater that is required to be disposed of under Clean Water Act regulations. The majority of the water injected for fracking is locked away from the earth's natural hydrologic cycle, a total loss that simply doesn't return to the atmosphere, except perhaps over geologic time frames, in a highly polluted condition.

The ecological and socio-economic implications of this true depletive loss have not been studied or quantified, but considering the finite nature of potable water and our expanding consumption rate, this must be recognized by DRBC as a key element in assessing fracking's water footprint and how it impacts the Basin's water "balance sheet". Very little data exists to quantify groundwater in many aquifers[cxxi], even within the relatively well-studied Delaware River Basin, so that accurate water footprint accounting and its implications for meeting existing and future water demands while maintaining water quality standards just isn't available. This should be a huge caution sign for DRBC that supports a total prohibition on this depletive use.

The amount of water used to frack a shale gas well in Pennsylvania has more than doubled since 2011. In 2017, the average amount of water used was 11.4 million gallons per Marcellus Shale well in Pennsylvania. (FracTracker Alliance, "Potential Impacts of Unconventional Oil and Gas on the Delaware River Basin", March 20, 2018)

> "Water usage for Marcellus wells in Pennsylvania have increased from an average of 4.3 million gallons in 2011 to 11.4 million gallons in 2017, while water use in the deeper Utica formation has increased from 5.8 million to 13.5 million gallons per well over the same time frame. The reason for this increase is twofold. First, drillers are using increasingly longer bore holes in the Appalachian basin, the lateral portion of which is starting to exceed 4 miles in some cases. The resulting effect is more surface area to stimulate (which inherently uses more water). And second, operators in the Appalachian basin are using significantly more water per lateral foot than in years past."[cxxii]

The lengthening of horizontal well bores due to advances in drilling technology has created a trend in the drilling industry that has dramatically changed the water footprint of fracking in the Marcellus and Utica Shales. The DRBC estimate in its Supplementary Information of an average 4.3 million gallons per well per fracturing event based on SRBC data from 2008 and 2013 and a median 4.18 million gallons reported by EPA for Pennsylvania between 2011 and 2013, are now out of date. DRBC states that EPA also reported that in at least 10% of the cases, 6.6 million gallons was used per well in Pennsylvania. DRBC states that the longer well bores that began in 2016 increased the average water use per fracturing event to approximately 5.1 to 6.5 million gallons. The current data shows an even greater average use per Marcellus well in Pennsylvania than DRBC's estimates – 11.4 million gallons of water on average per fracked Marcellus shale well. (FracTracker) This is a sea change in terms of potential water resource impacts.

News articles are reporting large well pads with wells that have longer and more well bores in western Pennsylvania's Marcellus Shale region, with horizontal bores traveling up to four miles and curving away from the vertical well bore at shallower depths and less radical curvatures to allow for more horizontal bores that won't interfere with each other, multiplying the capacity of each well.[cxxiii] Industry reports consider the longer well bores and supersized pads to be a better investment and the direction that shale gas well development is going.[cxxiv]

The amount of water used today to frack a shale well in the Appalachian basin also has been calculated to use significantly more water per lateral foot. (FracTracker) This phenomenon is being reported in industry filings but the reasons have not been analyzed publicly. This is another important change, however, that could increase the amount of water used for fracking shale gas wells and should be considered as a driver for demand. Overall, the potential impact of water depletion to meet this demand has at least doubled and the trend is for the demand to continue to increase per well drilled, making the impacts greater.

Another factor that influences the amount of water needed by drillers to develop shale gas wells is the induced expansion of the market for gas due to the buildout of infrastructure such as pipelines and end uses that include the export of gas and gas liquids and the consumption of natural gas at new gas-fired electric generating stations and petrochemical processing facilities.

The U.S. Energy Information Administration reported in March 2018 that the nation's liquefied natural gas (LNG) exports quadrupled in 2017. "The increase in LNG exports over the past two years is the result of the continuing expansion of U.S. LNG export capacity. Two LNG projects—Sabine Pass in Louisiana and Cove Point in Maryland—have come online since 2016, increasing U.S. LNG export capacity to 3.6 Bcf/d. Four more projects are scheduled to come online in the next two years: Elba Island LNG in Georgia and Cameron LNG in Louisiana in 2018, then Freeport LNG and Corpus Christi LNG in Texas in 2019. Once completed, U.S. LNG export capacity is expected to reach 9.6 Bcf/d by the end of 2019. As export capacity continues to increase, the United States is projected to become the third-largest LNG exporter in the world by 2020, surpassing Malaysia and remaining behind only Australia and Qatar."[cxxv]

This illustrates the expansion of the LNG market which is spurring new fracked gas well starts in Pennsylvania as well as other states. The proximity of Pennsylvania to the Cove Point LNG export facility in Maryland (in the Chesapeake Bay) will increase close-by demand for more gas. Also, demand for gas to be processed and marketed as natural gas liquids (NGL) at export facilities will grow as well. An example is the expanding Sunoco Logistics export terminal in Marcus Hook, Pennsylvania south of Philadelphia on the Delaware River; a second Market East pipeline is under construction to bring more natural gas liquids from the Mark West processing facility in southwestern Pennsylvania to the Delaware River terminal for export. There is also an active application to build a new NGL export facility in Greenwich Township, Gloucester County, New Jersey on the Delaware River, across from Philadelphia. PADEP has permitted 49 new natural gas-fired power plants in the Commonwealth in recent years which will also increase demand for fracked gas wells. DRN received documentation of the number of permitted natural gas power plants from PADEP in late 2017 through a Right to Know Law request and the excel sheet provided by PADEP in response is linked in the Endnotes.[cxxvi]

The number of shale gas wells drilled in 2017 increased by 35 over the year prior in Pennsylvania and, as delivery systems and markets grow, the price of gas will go up, making it more profitable to drill new wells. (Fractracker)

> "In all, we estimate that the industry used 51.4 billion gallons of water to stimulate 7,721 Unconventional wells in Pennsylvania in the seven-year period from 2011 through 2017."[cxxvii]

All of this activity means an increased demand for water for fracking in Pennsylvania. Looking at 2017 alone, 6 billion gallons of fresh water was used in Pennsylvania to frack wells. (FracTracker). That is approximately 16.5 million gallons of water per day, a depletive use. If the amount were to remain steady (rather than increase per well as the trend expects) the fracking industry will be looking for fresh water sources to fill their need and can be expected to look to the Delaware River Basin, especially for the areas in proximity to high-producing wells such as those located near the Delaware River Watershed in northeast Pennsylvania. The amount of water demand for fracking from nearby wells could easily dwarf the current depletive water use of fresh water in the Upper Delaware River Basin.

> "In an industry expecting to drill roughly 45,000 more wells just in the Interior Marcellus Formation of PA through 2045,24 the pressure to find new water sources and waste disposal sites will be ongoing in the coming decades, including within the Delaware River Basin. This will require over half a trillion gallons of water to stimulate, assuming that the per-well water consumption does not continue to increase beyond 2017 figures."[cxxviii]

> "Currently, none of the Pennsylvania O&G related surface or ground water withdrawal sites are in the Delaware River Basin, although with such an increasing demand for fresh water, drilling operators would likely make extensive use of hydrological resources there."[cxxix]

Water withdrawals from surface and groundwater have substantial impacts on water resources, ecosystems, and stream habitats. Human activities that effect these resources have severely altered the natural environment and continue to do so. 30-35% of all freshwater fish species are believed by scientists to be already extinct, with 93% of those reductions occurring in the last 50 years. This shows an accelerating trend towards extinction. Freshwater mussels is one of the most imperiled animal groups in North America. The dwarf wedgemussel, a federally endangered species, has established populations in the Upper Delaware River Watershed (Piotr Parasiewicz, PhD, A.Prof., "Ecological review of the DRBC Draft 18 CFR Parts 401 and 440 Proposed Amendments to the Administrative Manual and Special Regulations Regarding Natural Gas Development Activities," February 2018)

> "The dramatic impact of human-induced alterations on freshwater flora and fauna is widely reported (Gleick et al., 2001; UNEP, 1999). Running water ecosystems belong to the most severely human-impacted habitats on Earth (Nilsson et al., 2005; Malmqvist and Rundle, 2002). Of more than 3,500 species currently threatened with extinction worldwide, one-quarter are fish and amphibians.
>
> In freshwaters, the projected decline in species diversity is about five times greater than in terrestrial ecosystems (Pimm et al., 1995). This rate is similar to that of great prehistoric extinctions (Malmqvist and Rundle, 2002).
>
> It has been suggested that some 30-35% of all freshwater fish species are already extinct or in serious decline worldwide (Stiassny, 1999). Ninety-three percent of these

reductions occurred during the last 50 years, indicating extinction of freshwater fishes is a serious and accelerating global trend (Harrison and Stiassny, 1999).

The freshwater mussel is one of the most imperiled animal groups in North America with only 25% of the existing species having stable populations (Williams et al., 1995). Freshwater mussels fulfill many crucial ecosystem services such as the filtering of large amounts of water, which removes pollutants from the water. Hence, healthy assemblages of mussels are necessary to maintain high water quality standards."[cxxx]

Urbanization is playing a large part in the destruction of natural flow patterns in streams and habitat loss. Excessive water withdrawals and deforestation that alter hydrograph runoff patterns that increase peak flows and decrease base flows of streams are a large part of the changes accompanying urbanization that are causing species extinction and destabilization. (Parasiewicz)

"Historical and ongoing urbanization of our landscape intensifies floods and droughts, causing damage to human property and stressing the fauna. Excessive water withdrawals due to human and industrial demands dry up rivers with increasing frequency.

The process of urbanization alters seasonal hydrographs by increasing peak flows and decreasing base flows (e.g., Bedient and Huber, 1988; Dunne & Black, 1970; Parasiewicz and Goettel, 2003; Petersen, 2001). In the Northeastern United States, this hydrological pattern appears to be a regional phenomenon and a lasting legacy of historic deforestation. Even in areas such as the Catskill Mountains that superficially

> appear to have recovered from the historical impacts of earlier timber harvests, similar effects can still be observed (Parasiewicz et al., 2010)."[cxxxi]

Reduced base flows that result from these changes warm up the water in a river or stream more quickly. Groundwater withdrawals translate into less cold water being expressed to the surface and to waterways. Summer temperatures in excess of 89 degrees F are now being recorded in "long stretches of coldwater streams." (Parasiewicz) These impacts harm species and also degrade water quality. Scientists are warning that, coupled with climate change impacts that are causing higher summer temperatures, longer warm seasons, lower river flows, and more frequent and more severe flooding, the risk of further degradation and extinctions are so great that water withdrawal management must be a priority. (Parasiewicz) A species such as the dwarf wedgemussel, which is sedentary, is particularly vulnerable to habitat changes that can result from water withdrawals at sensitive times or rapid fluctuations in flow. (Parasiewicz)

> "The water in these reduced flows tends to warm up more quickly in rivers that have been widened by previous floods and historical logging operations. Shallow ponds, created by thousands of small dams, serve as natural solar collectors. Additionally, less cold water is entering the rivers from base flow because of increased ground water withdrawals. We are frequently now measuring summer water temperatures in excess of 80°F in long stretches of "coldwater" streams (e.g. Ballestero et al., 2007, Parasiewicz et al., 2007).

The change in our global climate further contributes to this impact by causing higher summer air temperatures, a longer summer season, and lower minimum river flows together with more frequent and severe flooding (Faloon and Betts, 2006).

Consequently, the habitat conditions are quite unstable and high water temperatures have caused fish die offs and potentially reduced mussel populations in the past. As documented by an investigation of dwarf wedgemussel habitat, the existing populations are limited to a few locations that maintain hydraulic stability. The sedentary organisms like freshwater mussels are particularly vulnerable to the habitat reduction due to the lack of water than can be caused by water withdrawals or rapid fluctuations."[cxxxii]

Water withdrawal management, however, is not a simple matter that can be addressed effectively by setting minimum flow levels based on the Q7-10 (the flow which occurs for a period of seven consecutive days one time in 10 years – considered "drought flow") or simply managing the scheduled releases from reservoirs and dams. (Parasiewicz) Scientists have discovered that the hydrologic pattern of a flowing water body are critical and if disrupted can be detrimental to aquatic life. (Parasiewicz) Preserving the natural or ecological flow regime of a waterway is of utmost importance in terms of stream health, habitats, water quality and species and must be the basis of decisionmaking regarding water withdrawals if these are to be adequately protected.

"Silk et al. (2000) eloquently suggests that "The natural ecosystem of any river is the product of millions of years of adaptation and evolution, which have created a myriad

> of variables and subtleties more complex than we can imagine." Due to this complexity and continuing conflicts of interest among competing water uses, a very precise planning and evaluation of potential development impacts is required.
>
> Water allocation issues are not new, and many techniques have been developed in recent decades to address these problems (Stalnaker, 1995; Dunbar et al., 1998). Only recently we learned to recognize that not only is the quality and quantity of water released below a hydro-power or irrigation dam important, but also that modifications of hydrological patterns can have detrimental effects on aquatic life (Richter et al 1997)."[cxxxiii]

In the Delaware River Basin, the Upper Delaware's Catskills and Pocono Mountains are generally rural with steep areas that have shallow soils overlaying bedrock. (Parasiewicz) Severe erosion can occur when there are high flows in a stream, eroding stream banks and widening the stream to unnatural widths. The adverse changes in stream morphology are exacerbated when woody debris is removed or high flows scour debris away. (Parasiewicz)

> "The Catskill Mountains' and Poconos watersheds are generally rural, topographically steep areas with shallow, permeable soils overlaying restrictive bedrock or fragipans. Heightened flow peaks cause severe erosion, leading to the down-cutting and over-widening of river corridors (Parasiewicz et al., 2010). The notable lack of woody debris structure documented in the Stony Clove Creek study in the Catskill Mountains (Parasiewicz et al., 2003) was partially a consequence of increased flow peaks removing log jams before they can stabilize, but also due to frequent "cleanups" of woody debris as a flood protection and beautification measure."[cxxxiv]

Shallower, wider and straightened streams add to the factors that heat up waterways. Anchor ice also tends to form in winter in shallower streams, sticking to the bottom and damaging aquatic fauna and forcing fish to move, increasing mortality. This becomes a downward spiral for the life of a stream when reduced base flow and groundwater levels caused by excessive and poorly timed water withdrawals disrupt critical natural flow patterns. (Parasiewicz)

> "These changes, in combination with reduced stream flows and groundwater levels, increase summer water temperatures and can cause creation of anchor ice in the winter. Anchor ice is an ice forming at the bottom of the river that can create considerable damage to the aquatic fauna by forcing fish movements and increasing their mortality. In addition, many river corridors, especially those in urbanized areas, have been physically modified (e.g., straightened, widened, dredged or impounded), altering the character of the corridor (e.g. from braided to straightened) and leading to further modifications in the hydrological regime (Hewlett and Hibbert, 1967)."[cxxxv]

One of the results of the hydrologic pattern changes, the disruption of the natural flow regime, is the loss of species that were adapted to the unique habitat conditions that allowed them to live in a location. More generalized species move in that can adapt to the changed conditions, as documented in northeastern rivers. (Parasiewicz)

> "The most apparent consequences of such changes in hydrological patterns are a reduction in fish densities and modification of the fish community structure from specialized riverine species towards more generalized species. This phenomenon has

been documented in several recent studies in the Northeast Region (e.g. Parasiewicz and Goettel, 2003; Armstrong et al., 2001)."[cxxxvi]

DRBC does not explain how the measures it expects to "discourage" water withdrawals will be carried out. The lack of detail about how biocriteria will be assessed and used to protect flows and species is not disclosed in the draft regulations but must be in order for the public to understand and comment on the draft regulations. (Schmid)

"DRBC has not explained how it intends to implement the requirements of its *Water Code* and *Water Quality Regulations* when authorizing stream water withdrawal for HVHF uses. In particular, it does not indicate how it will assure compliance with its adopted biocriteria. Those biocriteria appear not to be addressed by other agencies. DRBC has offered no detailed regulations or technical guidance specifying how such assessments will be made and reported in order to fill the current regulatory gap."[cxxxvii]

DRBC proposes to allow out-of-basin water withdrawals for fracking, despite its "discouragement" of out of basin transfers and its recognition and regulation of such withdrawals as depletive. DRBC implies that its low-flow and pass-by flow policies for water withdrawal dockets will sufficiently protect the Watershed's streams and rivers. This is not so. DRBC regulates withdrawals from streams with the use of a "pass-by flow" that limits the amount of water that can be withdrawn to protect streams from being overdrawn. However, a pass-by flow that is based on using the Q7-10 (the flow which occurs for a period of seven consecutive days one time in 10 years – considered "drought flow") is not adequate to protect waterways and the life that depends on them[cxxxviii] and can be expected to cause direct harm to the habitats and water quality of the stream.[cxxxix]

Using the Q7-10 allows the stream's flow to be artificially "flattened" because the natural flow regime and seasonality will be disrupted and potentially eliminated. An ecological flow analysis of the waterway is required to measure the natural variation of the waterway's flows in terms of volume, rate, temperature, stream stricture, and quality. This analysis should be completed before any withdrawal of surface water in order to provide an ecologically-based flow regime that will give needed protection to the habitats, species and water quality of that particular stream. Once a comprehensive assessment is complete, reliable models can be used to forecast changes should withdrawals for any purpose be contemplated. (Parasiewicz) Ecologically-based flow requirements, stream channel restoration projects and mitigation projects, will then be able to be designed to retain the habitats needed by the River's species. (Parasiewicz) This is essential to protect habitats and to ensure water quality that will support the river's uses and values.

> "Before contemplating any option associated with potential water withdrawals of any kind it would be necessary to conduct a comprehensive assessment of habitats and species in tributaries and main stem and to develop watershed models to forecast potential cumulative impacts. Such models need to inform the decision not only with regard to the possibility of water withdrawals, but also about necessary mitigation and compensation measures such as by-pass flows or channel improvements. Such documentation and models do not exist yet."[cxl]

Water withdrawals from surface waterways also have the potential to deplete downstream groundwater resources if set based on pass-by flows that do not take seasonality into account, including local benefits of high flows such as springtime flows or heavy precipitation events. Such a withdrawal may downstream cause some additional discharge from the aquifer to make up the loss of stream flow. This additional base flow will be contributed by shallow groundwater downstream of the withdrawal site, impacting aquifers. This presents the potential for loss of groundwater reserves that will discharge to the stressed waterway to attempt to maintain base flow that was lost to the withdrawal.[cxli]

The Delaware River is an exceptionally healthy river that supports the federally endangered dwarf wedgemussel and several other freshwater mussels, and many migratory fish that travel to the upper reaches of the river, including the American eel and American shad. (Parasiewicz) These are iconic species for the Delaware that define its nature and distinguish it as unique and of national importance, enabled by the river's free flowing main stem, the longest free-flowing river east of the Mississippi. The river is enjoyed by millions due to the nearby New York and Philadelphia metropolitan regions that can drive there on a tank of gas. Fly fishing in the coldwater creeks and streams are famous and beloved for generations. (Parasiewicz)

The river has been recognized by Congress as a Wild and Scenic River, among the early rivers to receive this merit, due to its outstanding natural features and scenic and recreational values. The National Park Service protects the Upper Delaware and the

Delaware Water Gap National Recreation Area, one of the most frequently visited in the nation.

But the Upper Delaware's streams still show the imprint of human activity in the long-lasting effects of historic deforestation and heavy industrial practices from the last centuries on its creeks and streams that are shallow, wide, and flashy, exhibiting dramatically altered hydrologic patterns due loss of natural flow regimes. (Parasiewicz) The export of water from the Upper Delaware for drinking water in New York City has indelible impacts. (Parasiewicz)

> "However, the legacy of deforestation and an industrial past is still visible in its over-widened, shallow river channels and flashy hydrology with rapidly changing flows from very low to very high. The watershed is also under pressure for hydropower use and as a drinking water supply for New York City (Parasiewicz et al., 2010)."[cxlii]

Water withdrawals of freshwater totaled about 4,130 Mgal/d in 2010, with New York City withdrawing an average 574 million gallons per day.[cxliii] Up to 17 million people receive their drinking water from the Delaware River, varying between 15 and 17 million on any given day depending in large effect on how much is exported to New York City through the reservoir and aqueduct system.

Pumping of aquifers to remove water for depletive/consumptive use can diminish surface water supplies by reducing natural shallow groundwater flows to streams and reservoirs. It also has the potential to disrupt the flow of groundwater that feeds existing water supply wells on which millions within the Basin rely for drinking water and other local uses. It can also diminish and/or disrupt available groundwater that supports forests and other vegetation, including agriculture, harming existing uses. Natural resources such as wetlands, seeps, and springs, are also diminished or seasonally depleted by depletive water withdrawals.

Managing the Delaware River flows downstream of the major reservoirs on its tributaries is a complex and difficult task. The Supreme Court Decree that prescribes the division of water among the four states, the minimum flow targets that must be maintained in the main stem river, and the Court's mandate to repel the salt line in the tidal river to protect drinking water intakes in Philadelphia and southern New Jersey as well as the flow regimes that are required to protect fish and aquatic life in the Upper Delaware, all present challenges that sometimes lead to unstable water temperatures and fish die-offs as well as threatening the river's dwarf wedgemussel populations. (Parasiewicz)

> "The flows in the river are strongly influenced by releases from upstream reservoirs: Cannonsville on the West Branch, Pepacton on the East Branch, Wallenpaupack on the Lackawaxen River, Mongaup on the Mongaup River and Neversink on the Neversink River. A Supreme Court decree was needed to manage the downstream salt wedge in Philadelphia by mandating the minimum flow releases. Due to complex management objectives, the current flows in the river can be erratic and unpredictable.
>
> Consequently, the habitat conditions are quite unstable and high water temperatures have caused fish die offs and potentially reduced mussel populations in the past. As

> documented by an investigation of dwarf wedgemussel habitat, the existing populations are limited to a few locations that maintain hydraulic stability."[cxliv]

The Flexible Flow Management Plan, a major agreement between the Decree Parties, is an ongoing plan that has recently been renewed after intense negotiations; it is a crucial endeavor that requires further work to develop adaptive management strategies to protect life in the streams and Upper River. (Parasiewicz)

> "In consequence of a multiyear collaborative efforts the next Flexible Flow Management Plan including measures to protect federally endangered species such as the dwarf wedgemussel has been recently extended for another 5 years. It is a complex effort and intensive endeavor aiming towards managing numerous users and protecting the river ecology. During this time the DRBC and involved parties committed to continue investigations of the consequences of plan introduction searching for adaptive management options."[cxlv]

All water withdrawal decisions must be informed by the Flexible Flow Management Plan and the methods that are developed to manage the river's flows to protect the Watershed's habitat and species. The depletive removal of water from the river jeopardizes the competence of the plan and the protections it is supposed to provide. (Parasiewicz)

> "HVHF requires high volumes of water (between 4 to 11 million gallons per fracturing event on one well only). Such withdrawals could easily destabilize the carefully crafted web of Flexible Flow Management Plan and other protective regulations."[cxlvi]

The proposal to allow water to be exported from the Basin for fracking does not sufficiently take into account the water scarcity that DRBC describes in times of drought and low rainfall. Well pads outside of the Basin will likely be encouraged in close proximity to the Delaware River Watershed boundary to take advantage of the availability of water, especially when new sources are sought for fracking in regions already being heavily tapped. (Parasiewicz)

Managing the water flows and protecting the outstanding values and living systems that make up the Delaware River is complex and DRBC is just now beginning to take up the development of adaptive strategies and ecological flow consideration in its Flexible Flow Management Plan work and the research that the Regulated Flow Advisory Committee and Subcommittee on Ecological Flows (SEF) will be doing. The fluctuations of weather and the added stresses of climate change such as increased frequency and intensity of storms and the environmental degradation that results, demand more comprehensive and ecologically-based management strategies. It is counterproductive to allow water exports that will impact flows, groundwater reserves, and stream stability by permitting further depletive uses. This fracking-related activity must be avoided to achieve success in the endeavor to both protect and manage the river and its ecosystems. (Parasiewicz)

> "A thorough review of existing information made it clear that complete prohibition of shale gas extraction is an appropriate decision for protection of public health and resources in the Delaware River Basin. This prohibition, however should also include water exportation from and wastewater imports to the Watershed. Offering permitting

options will encourage development of extraction wells in near proximity of the Delaware Watershed imposing the public and wildlife to associated risks. Particularly the substantial uncertainty with long term effects of the pollutants in produced water and our ability of stopping them from entering into the waters of the area calls for very strict regulation without permitting options."[cxlvii]

"However, the Commission is willing to consider permitting *water exports* for utilization in hydraulic fracturing. Although the Commission requires also alternative analysis, in face of the ample evidence of water scarcity in the Delaware River Watershed this consideration seems to be inconsistent with declared policy of discouraging the exports."[cxlviii]

"The Upper Delaware River Watershed is a precious resource with a multitude of outstanding characteristics and users. The maintenance of the watershed's ecological integrity requires careful and wise management. Such management is under development and measures that prevent degradation of aquatic fauna under climate change scenarios are not in place yet.

At this point adding more complexity and additional risks before such a program is in place is counterproductive, as obviously more time and resources are necessary to complete ongoing scientific efforts and take control over current issues in a way that will allow the protection and enhancement of ecological integrity.

Therefore, I recommend that Natural Gas Development should be fully banned without encouraging HVHF activities, especially in the proximity of the Delaware River

Watershed. This includes complete prohibition on water exports and wastewater imports for the purpose of natural gas mining as an unnecessary risk to the wellbeing and health of millions of citizens and the Delaware River Watershed's water resources and natural ecosystems, including the species that live there."[cxlix]

DRN recommends that a change be made to the text of Section 440.3 (b) to include all gas drilling and fracking regardless of whether it is High Volume Hydraulic Fracturing (HVHF), as defined at Section 440.2, or not. DRN bases this recommendation on the fact that "conventional" gas drilling, as defined by Pennsylvania Department of Environmental Protection, has substantial adverse impacts on water, the environment, and public health, where it is occurring today, as discussed in the review of scientific reports in this Comment. Furthermore, fracking and drilling that uses less than 300,000 gallons of water still has the potential for a substantial effect on the water resources of the Basin due to the toxic and radioactive properties of the fluids that are injected and the produced water or flowback that is generated by all drilling and fracking carried out to develop natural gas.

Comment Opposing Wastewater Transfer, Treatment, Storage, Disposal and Discharge of Produced Water and CWT Wastewater Produced by Fracking as Proposed at Section 440.5

DRN opposes the importation, transfer, treatment, storage, disposal, or discharge in the Basin of produced water and Centralized Waste Treatment (CWT) wastewater generated by fracking operations, as proposed at Section 440.5. DRN supports the complete prohibition of these proposed activities.

DRBC has recognized many of the problems posed by the wastewater produced by fracking in its Supplementary Information. However, the draft regulations do not provide protection and effective management of the water resources of the Delaware River Basin. The only option that will allow DRBC to meet its obligation to protect the water resources of the Basin is to prohibit these wastewaters and produced waters from being stored, processed, treated, disposed or discharged within the Basin.

There is ample evidence that supports a complete prohibition of the storage, processing, treating, disposal or discharge of produced water and CWT wastewater within the Basin.

The highly toxic nature of frack waste is widely recognized. According to the GAO, produced water is "generally of poor quality, with levels of contaminants varying widely".[cl] Fracking can yield poorer quality produced water than other extraction processes.[cli] A previous study from the U.S. Department of Energy concludes that produced water from gas drilling is 10 times more toxic than those from off shore oil drilling.[clii] Adding to pollution dangers posed by the reuse and recycling of frack fluids mixed with flowback or produced water, Marcellus Shale contains radionuclides including uranium-238, thorium-232, and their decay products. Radioactive concentrations in the Marcellus Shale formation are at concentrations 20 to 25 times background, making shale gas wastewater extremely radioactive.[cliii] The produced water from Marcellus Shale has higher levels of radionuclides than water from Barnett Shale wells, according to the GAO.[cliv] Sampling and data-gathering by New York State detected radiological parameters in Marcellus Shale flowback, including

Radium-226[clv], the longest lived isotope of radium with a half-life of 1600 years. Radium 226 can cause lymphoma, bone cancer and blood formation diseases such as leukemia and plastic anemia. Gross Alpha, Gross Beta, Total Alpha Radium and Radium-228 were also found.[clvi]

New York's DSGEIS contained a list of constituents in Marcellus Shale wastewater from Pennsylvania and West Virginia.[clvii] Many are hazardous, some have known harmful health impacts, and some are carcinogenic. New York tested flowback from these shale gas extraction operations in Pennsylvania and West Virginia and found 154 parameters.[clviii] DRBC proposes to require Treatability Studies for the treatment of frack wastewater at Centralized Wastewater Treatment Facilities that plan to discharge to the Watershed. These studies are supposed to show that the "Pollutants of Concern" are treated, using USEPA Tables from the agency's technical document on oil and gas waste discharges to define the "Pollutants of Concern".[clix] There are 78 pollutants listed but those are not all the toxic and/or hazardous pollutants contained in frack wastewater. For instance, Tables C -11, C-13, C-15, C-17, and C-19 don't include all the 154 parameters that New York discovered in their sampling. We know from DRBC and many other sources that over 1000 additives are in the fluids used to frack wells today,[clx] and many, according to U.S. EPA and other authorities, are carried into the frack wastewater produced by the well.

Wastewater produced by fracking contains many dangerous and toxic constituents and properties including: Total Dissolved Solids (TDS), Total Kjeldahl Nitrogen (TKN), Ammonia Nitrogen, Nitrate–N, Chloride, Bromide, Sodium, Sulfate, Oil and Grease, BTEX (benzene, toluene, ethylbenzene, xylene), VOC (volatile organic compounds), Naturally Occurring Radioactive Materials (NORM), Barium, and Strontium, according to a report by Natural Resources Defense Council.[clxi] Some are carcinogenic, some have known health effects, and some are toxic to aquatic life and plant life.

Yale University School of Public Health, in a study of chemicals used in fracking, found that of the 119 compounds with sufficient data to classify them in terms of carcinogenicity (only 20% of chemicals in use had sufficient data – a problem in itself), "44 percent of the water pollutants and 60 percent of air pollutants were either confirmed or possible carcinogens."[clxii] Fifty five unique compounds with carcinogenic potential could be released to both water or air and 20 chemicals had evidence of increased risk for leukemia or lymphoma specifically.[clxiii]

In its national study of fracking and drinking water, EPA identified 1,606 chemicals in fracking fluid or drilling wastewater including 1,084 identified in fracking fluid and 599 identified in wastewater, yet only 173 had toxicity values from sources that met EPA's standards for conducting risk assessments. "This missing information represents a significant data gap that makes it difficult to fully understand the severity of potential impacts on drinking water resources." However, EPA also reported that "health effects associated with chronic oral exposure to these chemicals include carcinogenicity, neurotoxicity, immune system effects, changes in body weight, changes in blood chemistry, liver and kidney toxicity, and reproductive and developmental toxicity."[clxiv] It is instructive to note that EPA did not mention that the agency's own failure to request health testing for new chemicals proposed for oil and gas drilling and regulated by EPA under the Toxic Substances Control Act contributed to the lack of information about chemical risks.[clxv]

EPA officials could not be certain about the accuracy of their list of chemicals found in fracking fluid and wastewater in part because the list did not include confidential chemicals used by drilling companies for hydraulic fracturing. Drilling companies have withheld fracking chemical identities from the public as confidential thousands of times.

Two Harvard researchers found that 92 percent of the well-by-well fracking chemical disclosures submitted to the non-governmental organization FracFocus between approximately March 2011 and April 2015 included at least one chemical identity withheld from the public as confidential business information (CBI).[clxvi] FracFocus is the nation's leading repository of fracking chemical disclosure information and currently contains disclosures from more than 127,000 wells.[clxvii] EPA commented that, "when chemicals are claimed as CBI, there is no public means of accessing information on these chemicals. Furthermore, many of the chemicals and chemical mixtures disclosed, or those detected in produced water, lack information on properties affecting their movement, persistence, and toxicity in the environment should they be spilled."[clxviii]

There may be constituents in flowback and produced waters from gas development that are not regulated under the Safe Drinking Water Act even though they have human health risks and ecosystem/environmental impacts. Some substances are chemicals that are unregulated and for which there is no maximum contaminant level (MCL) yet set by U.S. Environmental Protection Agency (EPA) or the State for drinking water quality. Many of these are known as “emerging contaminants” and have known harmful human health effects but standards are still in the process of being developed. These pose additional unacceptable risks because they may be released into the environment without detection or any requirement for monitoring, detection, or treatment. Some of these are endocrine disruptors (EDC) or pharmaceuticals that may occur in gas drilling wastewater.[clxix]

EDCs used in hydraulic fracturing fluids and found in flowback are of special concern due to the biological effects of these constituents at extremely low concentrations. Suspected EDC’s found in gas drilling wastewater include arsenic and selenium; hydraulic fracturing fluids may contain others such as 2BE, 2-Ethylhexanol, and Crystalline Silica. Scientists and health professionals are beginning to analyze these materials and measure their impacts on human health in a different way, testing these compounds at very low levels in the range of human exposures and at various endpoints.[clxx]

In an effort to protect human health from these very dangerous materials, scientists are concluding that there are no safe doses for endocrine disrupters; the fact that they have biological effects proves that EDC’s have biological activity – what the induced effects are is the question.[clxxi] As stated by Linda Birnbaum, Director, National Institutes of Health, “It is time to start the conversation between environmental health scientists, toxicologists, and risk assessors to determine how our understanding of low-dose responses influence the way risk assessments are performed for chemicals with endocrine-disrupting activities. Together, we can take appropriate actions to protect human and wildlife populations from these harmful chemicals and facilitate better regulatory decision making”.[clxxii]

There are other problems that make it impossible to accurately test for and remove toxic constituents of wastewater and produced water generated by fracking. According to a report that the Partnership for Policy Integrity published in 2016 based on a Freedom of Information Act (FOIA) request filed with EPA, between 2009 and 2014, EPA reviewed 105 new chemicals proposed for drilling and fracking for health and environmental risks under the New Chemicals program.[clxxiii] EPA had health concerns about 88 of the chemicals ranging from irritation to skin, eyes, and mucous membranes; lung effects; neurotoxicity; kidney toxicity; and developmental toxicity.[clxxiv]

Nevertheless, EPA allowed 98 of the 105 to go into commercial production, often without health testing data that could have more conclusively determined health risks; more than half of these chemicals went into commercial production and use.[clxxv]

Chemical manufacturers frequently withheld as trade secrets information about the chemicals' identities including Chemical Abstracts Service Numbers, chemical names, and trade names. This confidentiality makes it very difficult to know where these chemicals have been used but we do know they are used in Pennsylvania's Marcellus Shale wells.[clxxvi]

It is likely that drilling companies would use secret and potentially dangerous chemicals if drilling and fracking were allowed in the Basin. And it is likely if wastewater discharges are allowed, these secret chemicals will enter the Watershed's environment and contaminate its water.

The EPA has found that fracking wastewater can contain chemicals injected in fracking. Therefore, if fracking wastewater is allowed in the basin, it is likely that treatment facilities will be handling and discharging unknown and potentially toxic contaminants that not only are not identified in the permit or docket as requiring treatment but may not even be sampled for.

This opens a pathway of pollution that is extremely dangerous because the presence of the chemical and its concentration in effluent would be unknown, allowing it to slip past treatment and enter receiving waterways as well as potential air emissions or sludge residues. If the facilities don't know what they're trying to remove from the water, they are unlikely to remove it.

The end result will risk contamination of the Basins' water resources, including drinking water supplies. The only way to eliminate the outsized risk of exposing people, wildlife, and the environment to this contamination in drinking water and through other environmental pathways is to prohibit its storage, treatment, processing, disposal, and discharge in the Watershed. (Miller)

> "The range of hydraulic fracturing additives is very large, and difficult to assess from a risk perspective, since the list is almost certainly incomplete, specific information on the chemicals is lacking, and the specific rate of usage is not offered. Thus, not knowing the composition of the specific additives and the amounts provides effectively no basis for estimating the risk of these components on the biota of the receiving water. A mere laundry list of these components does not meet requirements for analysis of their potential impacts. The list is so long, and the data on each component so meager, that it falls far short of an analysis of risk. Additionally, many additives used are given

proprietary trade names, and while the regulators may have information on the constituents in those products, the public does not, and thus the public cannot legitimately understand the risk of these products. Additionally, treatment of those proprietary compounds, even in a CWT, is not understood and ultimate disposal in a surface water constitutes a risk that can be avoided entirely by requiring deep well disposal in a permitted facility outside of the Basin."[clxxvii]

DRBC's claim that they can address the pollutants in produced water and frack wastewater from Centralized Wastewater Treatment (CWT) Facilities by "treating" the EPA's Table of Pollutants of Concern and by requiring that water quality standards be met for contaminants that have them, is not supported by the facts. As discussed above, there are contaminants that pose significant hazards to human health and flora and fauna, including aquatic life, that are not included in EPA's Table; that do not have water quality standards established or other regulatory limits on exposure but have known adverse human health effects and/or ecological impacts; that do not have information developed that allows them to be used in a risk assessment; or that are kept unidentified as trade secrets by industrial operators. This is an untenable situation, much different than other wastewater that DRBC regulates, and it simply cannot be remedied by DRBC's efforts.

In attempting to address the treatment of produced water and CWT wastewater, DRBC has left important and some of the most dangerous issues unaddressed or vaguely addressed with opportunities for substantial and long term contamination to occur, even if the methods in the draft regulations were to be followed. "The flowback and produced water that flows back up the wells following hydraulic fracturing is heavily contaminated, primarily with the Marcellus formation contaminants. The produced brines that are released during gas production are complex and contain a variety of problematic contaminants and represent a serious chemical contamination potential." (Miller, p. 2)

> "The Commission clearly recognizes the problems with contaminants in HF waters, particularly in the non-tidal portions of the Delaware River. However, further efforts are required for understanding all of the contaminants in the flowback and produced water, their management and disposal. Four problematic components of the flowback water and produced brines include (1) the inorganic salts (including bromide), metals and metalloids, (2) the radioactive component (NORM), (3) the organic substances (from the hydrocarbon formation) and, (4) the chemical additives that increase the efficiency of gas recovery."[clxxviii]

The largest component in the formation water by mass is salts and other organic constitutes. (Miller) Disposal of the large volume of highly contaminated water is the biggest management problem. (Miller)

> "The associated EPA study (EPA, 2016) on management of HF water shows that produced waters containing the formation water are variable in chemical composition, but include not only simple salts (e.g. sodium, potassium, chloride, bromide, sulfate, fluoride etc.) but also a variety of metals with varying frequency (cadmium, mercury, cobalt, nickel) and metalloids (arsenic, selenium, boron). Some of the constituent concentrations are very high, particularly sodium chloride, which has a mean

concentration of on the order of 10% by weight. Some samples had over 30% by weight of simple salts plus other contaminants. The extreme contamination of these wastewaters, and the high variability of contaminant levels, make these waters complicated for treatment and potential reuse, as well as for tracking and disposal. If improperly managed and released to surface or groundwater, potentially severe contamination is likely. In particular, if this contaminated water intercepts domestic groundwater or surface water used as a drinking water source, the potential exists that these sources of water may need to be removed as a domestic source. While the proposed regulations effectively may not allow discharge of these waters into a surface stream that can be used as drinking water, that appears to not be the case for the more saline portions of the Basin.

While recognizing the problems with management of this water, the Commission fails to clearly state how this water will be either disposed in a manner that protects human health and the environment, or otherwise treated to remove the contaminants. While a range of alternatives potentially exist, effectively none of these is likely to be accomplished in even a centralized waste treatment facility, and simply eliminating these waters from the Basin is the prudent alternative."[clxxix]

One of the most difficult constituents to treat in Pennsylvania's fracking wastewater is bromide. (Miller) PADEP acknowledges that bromide is a key parameter of concern in the effluent because it can form brominated disinfection by-products (DBP's) in water supplies.[clxxx] These are a drinking water hazard because of the propensity for the brominated DBP's to form trihalomethanes and haloacetic acid, which can cause cancer.[clxxxi]

An example of how difficult it is to control bromides and the far-reaching effect high concentrations can have is the Monongahela River in Pennsylvania in 2010–2011. Bromide concentrations increased significantly, leading to increases in trihalomethane and haloacetic acids from mixing with drinking water supply disinfectants. This drinking water crisis affected the drinking water for millions of people in the Pittsburgh region; see "Bromide levels in Monongahela River rose in 2010, remain high" Pittsburgh Post-Gazette[clxxxii] and "Bromide pollution persists in Allegheny River in Western Pa.," Associated Press.[clxxxiii]

Despite "treatment" that is supposed to remove this dangerous constituent and the problems it causes in drinking water, it persists as a problem. The result is that carcinogens have entered people's drinking water and preventing this exposure is not consistently achieved by today's water treatment facilities. This problem is so risky and could expose so many people to carcinogenic substances that DRBC should prohibit fracking wastewater to enter the Basin. Miller states:

> "A particular constituent that has been problematic in Pennsylvania waters receiving partially treated hydraulic fracturing water is bromide. When water is taken in to be treated as a drinking water, normal disinfection processes (chlorine and chloramine) convert bromide ion to bromide radical, which reacts with naturally occurring organic matter to produce the probable carcinogenic brominated trihalomethanes (THM). Because of the higher molecular weight of the brominated trihalomethane, the drinking

water can violate drinking water for trihalomethanes (Chowdhury, et al., 2010; EPA, 2016) Use of ozone as a disinfectant can generate bromate, a known carcinogen (Fellet, 2014)."[clxxxiv]

A highly toxic component in frack wastewater with an extremely long life is radioactive material. Yet DRBC poses no means of addressing the disposal of naturally occurring radioactive materials (NORM). (Miller)

"The Commission also certainly recognizes the issues associated with management of NORM that comes to the surface either in the flowback or the production brines. However, similar to the salt problem discussed above, no indication on how treatment to remove these materials will be conducted.

Examples of NORM concentrations are presented from flowback in the EPA study (EPA, 2016).

The level of radioactivity as gross alpha is very high, from about 18,000 pCi /L to 123,000 pCi/L. The drinking water standard is 15 pCi/L (gross alpha).

What is to be done with these waters, and what is to be done with the residual NORM, if it is removed from the produced water and the flowback water? Dilution of the brines to a drinking standard of 15 pCi/L (gross alpha) will require 1000x to 10,000x dilutions, and is unlikely to be acceptable in nearly all jurisdictions, particularly when the components that are causing the radioactivity are not specified.

Ultimately, these radioactive materials will need to be removed offsite. Where will these radioactive materials be disposed, and will they be included with the very large tonnage of salts that results from an evaporation-crystallization treatment, or will they be separated into a metal/radioactive fraction by some (unknown?) chemical precipitation process? These issues are critical for an analysis of the potential impacts of management of these materials, and the lack of a thorough analysis presents a serious problem when assessing the risk of these substances. There is effectively no discussion of how these materials will be disposed, other than a general suggestion that they would be "treated" in a centralized treatment facility. In fact, there is no demonstrated economic and chemically efficient method for disposal of these wastes which is why most of this waste is transported to a deep well disposal site."[clxxxv]

It is well known and long understood that the Marcellus Shale formation is radioactive.[clxxxvi] USGS investigated and verified high concentrations of uranium in the Marcellus. (Marvin Resnikoff, "Memorandum, DRBC Draft Regulation Comments", Radioactive Waste Management Associates, February 19, 2018) The naturally occurring radioactive material (NORM) found in frack wastewater is unavoidable - it is released through the fracking process into the flowback that comes back to the surface through the well bore as a result of a fracking event. (Resnikoff)

One of the most commonly found in frack wastewater is Radium-226, which has a half-life of 1,600 years, so it will be present in the environment for thousands of years.[clxxxvii] It is also water soluble, meaning it easily travels with water.[clxxxviii] Radium 228 and other decay products of uranium are also found in the Marcellus and its waste products. (Resnikoff)

New York State sampled and verified the presence of Gross Alpha, Gross Beta, and Total Alpha Radium in addition to Radium 226 and 228.[clxxxix] A Duke University study of a stream in Pennsylvania below a frack wastewater plant found radium 226 levels in stream sediments at the point of discharge were ∼200 times greater (544−8759 Bq/kg) than upstream sediments and background sediments (22−44 Bq/kg) and above radioactive waste disposal threshold regulations.[cxc]

Interstitial or formation water (the brine in the shale formation) can be highly radioactive (as concentrated as 15,000 pCi/L), so each time the water is reused, the radium is concentrated. This will result in TENORM, or Technically Enhanced Naturally Occurring Radioactive Materials.[cxci] Frack wastewater containing TENORM is not properly regulated by the federal government or the states due to lack of requirements for monitoring/testing for TENORM at crucial junctures in the waste stream where it should be targeted for detection and removal. For instance, the concentrated residuals that are filtered from wastewater at treatment plants can occur at levels that are so dangerous they would need to be removed to a specially designed storage facility, such as those used for nuclear waste.

DRBC states in the proposed regulations that residuals from wastewater treatment should not be affected by the treatment process but radioactive properties inevitably pose a treatment challenge that will affect both the waste liquids and solids, including residuals; the radioactivity doesn't just disappear. (Resnikoff) In addition, the lack of testing at the well site and related lack of truck signage ("placarding") that accurately reflects the level of radioactivity of the wastewater that is transported[cxcii] adds great risk to the transport of the untreated, toxic produced water or flowback from wells outside of the Basin to the Delaware River Watershed for storage, treatment and disposal.

One of the most important distinguishing problems with produced water and CWT water produced by fracking is that it contains toxic concentrations of radioactive materials that cannot be destroyed. The result is that by attempting to set standards for its treatment in the Delaware River Basin, DRBC is not controlling its release or its effects on human health and the environment but is allowing it to enter the Watershed and its drinking water at concentrations DRBC has decided are acceptable. The radioactive materials can be released as flowback, as treated effluent from a CWT plant, in drill cuttings and other solids, in residues that result from processing or treatment, and as an inert gas, radon, which is the second highest cause of lung cancer in the United States. (Resnikoff)

This is far too great a risk for DRBC to take. This potent toxicity and long lived properties of radioactive materials alone is reason enough to prohibit frack wastewater from entering the Watershed's environment. In the SPW portions of the River, the release of radioactive elements are categorically inconsistent with the "no measureable change" requirement. (Resnikoff)

> "To review, the process of hydraulic fracturing consists of drilling a well down to the Marcellus shale formation 4000 to 8000 feet below ground and then extending the well horizontally in the shale formation for up to a mile. Casings are constructed and the wells are placed under hydraulic pressure. Explosives shatter the shale formation and proppants maintain open the shattered shale formation. When the hydraulic pressure is

released much of the contaminated water, consisting of drilling fluid and interstitial water along with rock cuttings (with the consistency of coarse sand) comes to the surface. This contaminated water is stored in an adjacent pond or in tank cars. After approximately two weeks' time, natural gas continues to come up with some of the remaining water. This salty water (brine) is highly radioactive and is separated from natural gas at the surface and placed into condensate tanks or trucks. This produced water or brine contains high concentrations of total dissolved solids (TDS). As shown in the table below, the TDS concentrations increase over time. The TDS concentrations can range up to 345,000 mg/L by day 90 after the well is placed into production. At the present time flowback and production water is transported to a centralized water treatment facility (CWT). After processing, the rock cuttings and sludge are disposed in sanitary landfills and processed water is released to the environment. Under the proposed regulations the rock cuttings, sludges and processed water can be transported to the Delaware River basin and may be released to accessible waterways. The proposed DRBC regulations do not prohibit disposal of rock cuttings into landfills within the basin.

It has been known for over 50 years that the Marcellus shale formation is radioactive. In the late 1970s the USGS investigated the Marcellus shale for high concentrations of uranium. So clearly what is radioactive below ground does not become non- radioactive above ground; this is not alchemy where the radioactivity simply disappears. This radioactivity, consisting of radium-226 and 228 and decay products, is a problem faced by the DRBC in establishing regulations. Because all this radioactivity must go somewhere, the DRBC is essentially establishing regulations that set the radioactive concentrations that can enter the environment within the Delaware River Watershed.

We support some sections of the proposed regulations. We support section 440.3 which prohibits fracking within the Delaware River basin. This is important, not only for the potential release of drilling fluids and contaminated water into aquifers but also for minimizing the potential release of the radioactive inert gas radon. We also support the policy of the commission, section 440.5, that there be no measurable change in existing water quality and that the release should not create a menace to public health and safety at the point of discharge. Based on this policy, it is inconsistent that the commission will allow produced water and wastewater from central waste treatment facilities, even under regulated conditions."[cxciii]

The removal of radioactive elements from flowback and produced water is difficult and poorly carried out by treatment facilities today. DRBC presents no method for doing this in the draft regulations. (Resnikoff) Also, DRBC's stated goal of meeting drinking water standards for the discharged effluent from CWTs is essentially not practically achievable; the safe drinking water standard for combined radium 226 and 228 is 5pCi/L. (Resnikoff) Concentrations as high as 25,000 pCi per liter can be contained in produced water generated by fracking in the Marcellus Shale. (Resnikoff)

"Centralized waste treatment facilities are not a panacea. Studies by the Pennsylvania Department of Radiation Protection show that concentrations of dissolved radium that enter a CWT are approximately equal to concentrations that leave a CWT[1] (Though there are methods for removing radium from water - methods have been used extensively in uranium mills), the process is more expensive than simply releasing this contamination to the environment or into a deep well. Even if CWT's were effective, what would be the final disposal solution for sludges and solids that were created? Essentially the radium dissolved in water would be converted to a solid that can be filtered. And what would be the final disposal solution for the rock cuttings? The radioactive content of the rock cuttings ranges from 30 pCi per gram to 204 pCi per gram (the radioactive concentration of rock cuttings that were sent to the Allied landfill in Niagara County New York)[2]. Released to waterways, Duke University scientists have measured radium concentrations and stream sediments at the point of discharge 200 times greater than upstream and background sediments and above radioactive waste disposal threshold regulations. So we are mystified by what the commission is going to find in these treatability studies required in section 440.5." [cxciv]

"The commission also states that effluent shall not exceed the more stringent of EPA or the host states primary drinking water standards. For combined radium 226 and 228, the drinking water standard is 5 pCi per liter. Produced water can contain concentrations up to 25,000 pCi per liter. It will be difficult to reach concentrations as low as 5 pCi/L."[cxcv]

[1] The DEP study showed that high Ra-226 effluent releases from CWT's were 26,000 pCi/L (DEP,ES-22) equal to the high Ra-226 concentrations into the CWT's and indicating that Ra-226 was not removed at the CWT's.

[2] NYSDEC, Division of Environmental Remediation, August 2012, re. Allied Landfill, Niagara County.

The release of produced water and CWT wastewater produced by fracking into the waters of the Delaware River Basin will release radioactive materials. Even if discharged at established drinking water standards, radioactive materials can build up over time in the environment, as is shown by scientific literature and reported data. Furthermore, since the Estuary and Bay portions of the Basin are not designated as drinking water supply, these radioactive materials can be discharged at any level set by DRBC in dockets. The public will be inevitably exposed to increased concentrations of radioactive elements over the current backgrounds. This could happen with one discharge to the air or water or it could happen as radioactivity accumulates in sediments or other environmental features in the Watershed. This exposure of the public to radioactive materials will result in an increased risk of cancer.[cxcvi] The only way to avoid this inevitable health risk is to prohibit produced water and wastewater from fracking to be stored, treated and/or discharged in the Watershed. Resnikoff states:

> "While I support the Delaware River Basin Commission's (DRBC) prohibition on high-volume hydraulic fracturing (fracking), I do not support the proposed regulations of Part 440 that allow the import of radioactive waste and solids from fracking into the basin. To be clear, the oil and gas industry has a problem in disposing of fracking water and rock cuttings. To frack a well, approximately 5 to more than 11 million gallons of water are required; in 2017 the average volume of water used to frack a Marcellus Shale well in Pennsylvania was 11.4 million gallons. That is primarily because of the longer well bores, increased now from 1 - 2 miles to 4 miles or more in some areas. Some of this

drilling fluid can be recycled. But there are not enough deep disposal wells to accommodate the demand for the volume of fracking water produced. As a result, the oil and gas industry has pressured the DRBC to accept this contaminated water. Under Parts 400 the DRBC has proposed regulations for the acceptance of water from fracking and placed conditions on that acceptance. Just to be clear the DRBC could simply ban the importation of fracking water and rock cuttings, but instead have established regulations that allow that to proceed. The following specific comments are in support of some of the regulations DRBC has proposed and opposes others.

We support the commission's policy of no measurable change in existing water quality. But we strongly oppose approving centralized water treatment facilities."[cxcvii]

Hydrocarbons are contained in flowback and produced water from fracking. But they are only part of the known components such as heterocyclic amines and sulfur containing compounds and the array of unknown compounds that are routinely produced. Without knowing all components, effective treatment can't be achieved. The safe option is to prohibit the discharge to surface waters of the wastewater produced by fracking.

"Hydrocarbons present in the flowback and produced water are characteristic of fuel hydrocarbons, and are represented by (a) compounds that, in some cases, are carcinogenic (e.g. benzene, benzo(a)pyrene), (b) common solvents (e.g. toluene, ethylbenzene), and (c) the primary fuel components of natural gas, particularly methane. But, these components are only part of the mix that is contained in fracking water. Other components include heterocyclic amines, sulfur (odor) containing compounds, and an array of unknown compounds that have not yet been identified from specific wells. The characterization of these constituents before and after treatment has not been completed. Without knowing what these chemicals are, and the toxicity of each of them, it is difficult to know how to treat them. The associated risk is primarily ecological, and, again, simply eliminating discharge of HF waters is the safe option."[cxcviii]

The draft regulations are written to allow discharges of produced water from fracking and CWT wastewater to be discharged under certain conditions. For the tidal zones of the Delaware River, there are several loopholes built into the regulations that will allow the standards that are mentioned for certain contaminants to be used as goals or guidelines and not as enforceable standards. Because the application of much of the protective measures do not apply in the Estuary where drinking water is not a protected use and because mixing zones are allowed in the Estuary and Bay, these regions of the River are open to degradation of water quality, increased concentration of toxics and emerging pollutants, and the destruction of aquatic life and species that are already at great risk due to other stresses and conditions ongoing in this part of the Basin.

This is true for contaminants that would be controlled based on Background Concentrations as well. DRBC proposes, in certain circumstances, to use the "background concentration" of a pollutant, or the measurement of the existing level of a pollutant in a waterway, as the amount that a discharger of effluent must not exceed. This could protect a part of the river where there is no or a very low concentration of a given contaminant but where there are already high concentrations of a pollutant, the waterway will, effectively, be doomed to maintaining that concentration of a pollutant if the effluent discharged simply meets the background; the waterway won't have a chance to become cleaner. In the Estuary parameters such as Total Dissolved Solids and some toxics already far exceed healthy conditions and are in need of improvement.

DRBC and the states, under federal EPA regulatory requirements such as the Clean Water Act, work regularly on plans to minimize pollution and billions of public and private funds have been spent to implement pollutant minimization plans and total maximum discharge limits (TMDL) to restore healthy water quality. The background concentration method undermines those efforts, both in current DRBC permitting practices and as proposed in the Draft Regulations. Fracking wastewater discharges that meet background concentrations in already contaminated waters, will spell doom for water quality and could harm aquatic life. The DRBC should completely prohibit the discharge of wastewater produced by fracking.

Another problem is that DRBC says they have not yet developed the analytical methods, method detection limits, and quantification limits that a discharger must use to define the background concentration of a pollutant so there is no certainty about its accuracy or reliability. This is another compelling reason not to move ahead with the draft regulation.

DRN opposes the Total Dissolved Solids (TDS) standard in the draft regulations. TDS is extremely high in frack wastewater and constitutes, by sheer mass, the largest pollutant. TDS contains potent salts that must be kept below strict levels to protect water quality and aquatic life. (Miller) In such huge amounts, TDS is very difficult to keep under control. (Miller) DRBC proposes a limit of 500 mg/l of TDS, or not to exceed background, for zones of the river as far south as River Mile 95, located roughly at the southern part of the Philadelphia region. However, 500 mg/l is not protective of aquatic life. 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.[cxcix] And in the Truckee River, the EPA found that juvenile Lahonton cutthroat trout were subject to higher mortality when exposed to thermal pollution stress combined with high total dissolved solids concentrations.[cc]

DRN opposes the standards and methods proposed in the Draft Regulations regarding TDS in the Estuary and Bay. In Zones 4 to 6,[cci] encompassing most of the Estuary south to the Bay and Ocean, DRBC is allowing a TDS standard of "not to exceed 1,000 mg/l" "or a concentration established by the Commission that is compatible with designated water uses and stream quality objectives". There is too much discretion given to the agency to establish the concentration and 1000 mg/l has been shown to not sufficiently protect aquatic life, as discussed above. It is not possible for DRN or the public to comment on a concentration that is unknown and proposed to be decided by DRBC on a case by case basis. Furthermore, DRBC has not committed to monitoring and reporting of numeric effluent limits; in the draft regulations, this essential oversight tool only "may" be required. These regulations should be withdrawn as incomplete as well as not protective of water quality and aquatic life.

The record of how DRBC currently calculates and sets TDS concentrations for dockets is instructive. This practice by DRBC is not reliable or protective, as shown by variances allowed by DRBC for TDS loadings from wastewater into these areas now. DRBC even has a form that a discharger fills out to explain why they can't meet TDS limits and why they need a mixing zone – it is that customary a practice. Examples of specific approvals for permits where DRBC has been lax in applying TDS limits are Global Advanced Metals Industrial Wastewater Treatment Facility, Schuylkill River, Perkiomen Creek, Swamp Creek, PA[ccii] (TDS of 15,000 mg/l) and JBS Souderton Industrial Wastewater Treatment Facility for a meat packing plant, Schuylkill River, Perkiomen Creek, Skippack Creek, PA[cciii] (TDS of 3,100mg/l).

Even when it is known that a discharger could not possibly meet required standards throughout the year due to high levels of pollution in the wastewater, DRBC currently bends the rules by allowing open lagoons to temporarily store wastewater that at certain times cannot be discharged due to conditions in the receiving waterway, such as low flows. So not only are the regulations not strict enough but DRBC already goes around the rules and allows TDS to contaminate the Estuary at damaging concentrations. To add new sources of these damaging salts is not acceptable and cannot be allowed. The only way to protect water quality, fish, other aquatic life and wildlife is to prohibit discharges of wastewater from fracking throughout the Basin.

DRBC allows broad discretion by allowing mixing zones and employing a non-standard such as "or a concentration established by the Commission that is compatible with designated water uses and stream quality objectives". (Miller) Considering that existing discharges already provide sources of contaminants that stress the quality of the Estuary, organic compounds and radioactive elements can provide unacceptable risks to species and the ecosystems of the Basin. (Miller) Miller states:

> "From my read of the proposed regulations, it appears that disposal of HF waste water will be effectively prohibited through even a centralized water treatment (CWT) facility in areas where the receiving water can potentially be a drinking water, and in the areas designated as Special Protection Waters. With a TDS limit of 500 mg/L limit, the salt load in these HF waters would effectively preclude any reasonable treatment (other than a membrane treatment) for discharge.
>
> However, on a closer reading this may not be the case for the tidal waters that have a higher TDS limit. The language in the 440.5(f) section contain words that allow a broad discretion on whether a facility can be sited in the saltier sections of the River, with discretionary terms such as "mixing zone" or "or a concentration established by the Commission that is compatible with designated water uses and stream quality objects". Existing discharges to the lower portion of the basin, from POTW and other industrial discharges already provide a source of contaminants that are of concern. While the Delaware River water quality has improved through dedicated efforts of the Commission, the lower stretch of the Delaware River Basin already receives discharges from other industries. While a pure sodium chloride discharge may not have a major negative impact on the biota of the Basin, the other constituents in HF water, including

organic compounds and the radioactivity can still provide an unacceptable risk to the ecological integrity of the Basin."[cciv]

In the Estuary drinking water is not a protected use, so safe drinking water standards don't apply, allowing less strict pollution controls. DRBC also allows "mixing zones" there, allowing pollution in wastewater that doesn't meet clean water standards to be mixed, or diluted by the waterway, before meeting a required standard. Allowing his practice with the highly toxic wastewater produced by fracking jeopardizes species that live there, including threatened and endangered species that are already under great stress and important forage fish.

This is harmful specifically for this region, affecting the Estuary resources of Pennsylvania, New Jersey and Delaware, threatening all life in these zones of the Estuary and Bay. And since the tides carry pollutants, including increased salinity, upstream and into tributaries, areas that do provide drinking water (including the State of Delaware's tributary drinking water intakes, and Philadelphia and south Jersey drinking water intakes serving millions of people) and upstream river zones that are tidally influenced will all be negatively impacted to some degree. Risking the viability of species and water quality is a chance too great to take; the discharge of wastewater from fracking should be prohibited altogether.

Whole Effluent Toxicity (WET) testing is relied upon in DRBC's draft regulations as a method that will assure that effluent is not toxic. But WET testing is not a panacea. It should only be the first stage in a risk assessment; WET testing identifies a hazard(s), not how much risk is associated with that hazard. WET testing used to assess the effect of all pollutants in a facility's effluent is not conclusive.[ccv] DRBC should not rely on WET testing to predict toxic effects. As discussed earlier in this comment, many of the chemicals, including some with known adverse human health effects, used in fracking fluids do not have enough known about them to allow them to meet the requirements of EPA to be tested through a risk assessment and some are kept confidential as Trade Secrets. WET testing faces similar limits when chemicals are not disclosed or when the chemical's properties are not fully understood or known. This is a flawed approach that cannot be trusted when applied to frack wastewater, providing another reason why frack wastewater must be prohibited to prevent water resource damage.

It is unclear how treatment would be accomplished because DRBC does not propose treatment options. Discharging CWT wastewater to the surface waters of the Basin without causing significant contamination that threatens the drinking water and the Watershed's water resources throughout the Basin and without causing measurable negative change in the nontidal River, is not a viable option. This is especially true considering economic cost and partial administration of such a program. (Miller) Miller states:

> "Permissible treatment of the flowback and the produced water is not well defined. It is unclear how the post-treatment residual salts and radioactivity will be managed. There does not appear to be any complete treatment of these waters that will allow discharge of the water in any surface water of the Delaware River Basin.

In my opinion, there are no treatment options that can remove the contaminants in a cost effective manner, and suggest that until such a process is developed, discharge of HF water should simply be banned within the basin to avoid the unreasonable risk of the contamination and loss of drinking water resources. This is particularly the case for drinking water sources, but also for lower basin waters, primarily associated with ecological risk. Some of the membrane processes (e.g. reverse osmosis, nanofiltration) may meet the standards in some cases for a portion of the water, although the reject water will still need to be disposed out of the basin and will contain higher concentrations of all of the contaminants. Effectively, there is no reasonable cost alternative to simply transporting the HF waters to regions where deep well disposal is permitted, which is the way those waters are being managed to date.

The methods for treatment of the water for discharge to a surface water are not considered, and how specific requirements for discharge could be met by various treatment processes (e.g. membrane, ion exchange or evaporative processes) are not mentioned. The residual contaminants removed by evaporative or membrane processes, and thus concentrated to form even more contaminated water, were not discussed, other than to indicate that the residual salts, or concentrated brine will require "further treatment or disposal". For flowback or brine containing 7% (70,000 mg/L) salts, upwards of 300 tons of salts will exist in every million gallons of water, plus the concentrated NORM as well as a portion of the hydrocarbons. The source of the alpha emitters also will need to be identified. If, as is suspected, polonium is present in the flowback water, it represents an additional management burden of the flowback and produced water.

The best option is simply to prohibit storage or treatment of HF water in the Delaware River Basin entirely."[ccvi]

No federal standards have been issued to guide DRBC on the design and regulation of the treatment of wastewater produced by fracking. DRBC attempts to fill that void but fails to do so. The wastewaters produced by fracking are complex and variable, to the extreme of each truckload produced at a frack site varying from other truckloads due to the uncontrollable nature of the fluids injected and released by the deep geologic formations. Chemicals are injected by drillers that are protected as Trade Secrets and, in Pennsylvania we know this has prevented the disclosure of the contents of these fluids, which are also found in the wastewater or produced water that fracking generates.

These complexities and unknowns make the wastewater unpredictable while also being highly toxic and dangerous to human health and the environment. This is fundamentally different than other types of wastewater for which DRBC now issues dockets. It is not reasonable to expect any agency to perform the vigilance needed to handle this waste. The means of control are prohibition, to "remove the option of disposal". (Miller)

"I have examined many of the chemical and toxicological issues, particularly related to potential treatment and discharge into the Delaware River Basin of waters associated with hydraulic fracturing, primarily produced and flowback (formation) water. This issue has confronted the Delaware River Basin Commission for several years now, and

> I appreciate the thought that has gone into these regulations. I feel strongly that, due to the chemical complexity of these highly contaminated waters, the best solution is to simply remove the option of disposal of any hydraulic fracture (HF) associated waters to any surface water in the Delaware Basin. The areas of the river designated by the Commission as Special Protection Waters (the nontidal river) cannot maintain adopted or proposed water quality standards nor meet the "No measurable change" requirement enforced by the Commission if the waters produced by hydraulic fracturing are discharged to the Basin's waterways, particularly if the HF waters are not treated to remove metals, salts and norm. The region below Philadelphia already receives a variety of discharges, and potentially adding a major load of a complicated array of contaminants from HF water should simply be prohibited."[ccvii]

The importation, treatment and discharge of produced water from fracking is contrary to the DRBC's stated goals of protection of water resources and the health of aquatic life and the public. The management challenges are not sufficiently met or assessed by the proposed regulations. (Parasiewicz) The methods of defining background concentrations for contaminants and the characterization of all contaminants in the wastewater stream are not developed or explained in the regulations. (Parasiewicz) Freshwater mussels such as the federally endangered dwarf wedgemussel are water filtering organisms that may be vulnerable to the toxic substances in CWT wastewater or produced water through long-term bioaccumulation but this is not addressed and must be. (Parasiewicz)

The cumulative impacts on species, habitats and water quality is not planned for but must be. The possible development of storage basins or tanks within the Watershed of highly toxic materials that cannot be sufficiently processed to meet discharge permit standards is not assessed or addressed in terms of management to avoid leaks, accidents, and spills of untreated produced water, concentrated residuals, or contaminated fluids and must be. (Parasiewicz)

It is documented in DRBC records that DRBC does already allow open lagoons and/or tanks within the Basin to temporarily hold materials too polluted to discharge into surface water due to conditions such as low flow; these dangerous materials that do not meet water quality standards for discharge are stored until they can be worked into the treatment system, risking accidental exposure to the environment and air emissions that could be harmful.

The obvious dangers of transport, accidental leaks and spills, and the inducement of development of HVHF in proximity to the Watershed by allowing the fracking-related activities of wastewater importation and water exportation, threatening additional impacts to the Basin, is not examined but must be. (Parasiewicz) Parasiewicz states:

> "Despite the requirement of alternatives analysis this proposition is also in contrast with the declaration of protection of public health and aquatic life, because:
>
> a. Many of the toxic substances occurring in the produced water of Marcellus Shale require special treatment with expensive technologies.
> b. Safe concentration of some of these substances (total dissolved solids, barium, bromide, radium and strontium) are not yet regulated and

treatability studies are still required even to characterize the pollutant loads in the produced water.

c. The long term bioaccumulation effects of these substances on biota is not well known. Water filtering organisms such as freshwater mussels may be particularly vulnerable to such toxic substances.

d. Similarly background concentrations that are required to be maintained according to the rule are yet to be determined.

e. Due to the fact that the produced water dissolves substances from target rock formation, it is conceivable that their concentration as well as their chemical composition may vary uncontrollably potentially exceeding the capacity of the treatment plant. Attempting to mitigate that would require toxic storage reservoirs with all associated and unacceptable risks of accidental breaching or leaching.

f. Transportation and handling of such substances is prone to accidental leaks, which are very difficult to control and account for.

g. It encourages the development of HVHF operations in the proximity of the Delaware Watershed with all the consequences described above."[ccviii]

Addressing what to do with all the waste produced by modern day fracking has been a formidable challenge. The trend in the increased volume of water used and, in turn, the increased volume of wastewater produced and discharged by fracking is making the challenge even more difficult. It has been consistently documented by agencies that unconventional wells (defined by geologic formation depth by PADEP; essentially these are shale gas wells that use HVHF) use more water than conventional wells (drilled into shallower depth rock formations as defined by PADEP), as illustrated by a comparison of waste generated in Pennsylvania. (FracTracker)

The number of conventional wells outnumber the unconventional wells by 3 to 1 in 2016-2017 but the cumulative volume of liquid waste produced by unconventional wells was more than 10 times than that of conventional wells. (FracTracker) Statistics from PADEP Oil and Gas Production Reports show the amounts in millions of barrels. (FracTracker Figure 4 and Tables 2 and 3) Solid waste in tons is also documented; 93% is disposed at landfills. (FracTracker, Table 4) Matt Kelso of FracTracker states:

> "Dealing with such large quantities of liquid waste has been problematic in Pennsylvania in recent years. Originally, much of this liquid O&G waste was treated in publicly owned treatment facilities, but due to rising contaminant levels in the rivers, the Pennsylvania DEP requested a voluntary cessation of the practice in April 2011, a move that was later made compulsory. However, other surface treatment facilities were not affected by this decision.
>
> Many other states rely heavily on oil and gas wastewater disposal wells to avoid surface treatment. This practice has created a number of problems as well, however, including aquifer contamination and induced seismic activity. In Pennsylvania, much of the geology has been deemed unsuitable for underground injection, although there are recent efforts to expand this program16 due to the immense volume of liquid waste now

being generated by the industry. In March 2018, the US Environmental Protection Agencies issued permits for two more of these disposal wells, including facilities in Allegheny and Elk counties. The industry does try to reuse some of this produced fluid, but there are limits to what they can do in that regard.

Solid waste disposal is also a concern for water quality, as there is the potential for toxic, radioactive contaminants such as Radium-226 to enter the water cycle via landfill leachate. Landfills in Pennsylvania have monthly radiation quotas, the limits of which were reached 87 times in 2015 due to oil and gas waste."[ccix]

The Delaware River Basin already receives some waste generated by unconventional oil and gas wells in Pennsylvania. These facilities are located in Reading, Berks County; Hatfield, Montgomery County; and Myerstown, Lebanon County. (FracTracker) While the definitions of liquid and solid wastes are blurred due to the nature of these wastes that can vary from liquids, to sludge material, to loose solids, to dry cake, and the descriptive terminology is not consistent in reporting, it is important to document that some produced wastewater or solid waste is being handled and processed within the Basin now. (FracTracker, Figure 5 and Table 5.)

The pressure to dispose of waste from the rest of Pennsylvania is already occurring within the Basin and can be expected to expand if the draft regulations are adopted, providing the road map drillers need to find much needed new locations for disposal of the enormous volumes of waste being generated by fracking in the Commonwealth. Matt Kelso of FracTracker states:

> "Although just a small fraction of the statewide O&G waste management picture, the waste accepted by facilities in the Delaware River Basin is significant, especially the more than 34,000 tons of drill cuttings disposed of at the Republic Environmental Systems facility. With waste haulers being willing to drive as far as Michigan to dispose of some Pennsylvania's waste, the economic pressure of finding closer destinations is likely considerable."[ccx]

The pressure to find locations for wastewater from fracking will grow as shale gas wells are drilled and fracked. The 45,000 wells that are forecasted to be drilled in the Interior Marcellus by 2045 will require even more water than prior projections expected due to the dramatic increase in the volume of water used per fracked well, as discussed earlier, and it will also translate into much larger volumes of wastewater (and solids) that must be disposed of. (FracTracker) "In an industry expecting to drill roughly 45,000 more wells just in the Interior Marcellus Formation of PA through 2045, the pressure to find new water sources and waste disposal sites will be ongoing in the coming decades, including within the Delaware River Basin. This will require over half a trillion gallons of water to stimulate, assuming that the per-well water consumption does not continue to increase beyond 2017 figures. If waste figures also hold steady, we will see 1.4 billion barrels (60 billion gallons) of toxic liquid waste and 28.5 million tons of solid waste that will need to be processed in the coming years."[ccxi] (FracTracker) Considering the advances in well boring technology and equipment, the volumes could reasonably be expected to increase to even greater levels. Matt Kelso of FracTracker states:

“The de facto moratorium on unconventional oil and gas development put in place by the Delaware River Basin Commission has afforded the region significant protections from serious impacts in recent years that the Susquehanna River Basin and Ohio River Basins have not been provided. Through 2017, the oil and gas industry in PA drilled 10,652 unconventional wells; caused 7,956 incidents receiving violations. In 2017 alone, the industry required over 6 billion gallons of fresh water in Pennsylvania and generated 53 million barrels (2.2 billion gallons) of liquid waste and 1.1 million tons (2.1 billion pounds) of solid waste, despite being a relatively light year in terms of the total number of wells drilled.

With its proposed ban as written, the Delaware River Basin Commission looks to protect the basin from the direct impacts of drilling, but if the ancillary industries of water withdrawals and waste disposal are permitted, such activities will have an adverse effect on the waters within the basin.

In an industry expecting to drill roughly 45,000 more wells just in the Interior Marcellus Formation of PA through 2045, the pressure to find new water sources and waste disposal sites will be ongoing in the coming decades, including within the Delaware River Basin. This will require over half a trillion gallons of water to stimulate, assuming that the per-well water consumption does not continue to increase beyond 2017 figures. If waste figures also hold steady, we will see 1.4 billion barrels (60 billion gallons) of toxic liquid waste and 28.5 million tons of solid waste that will need to be processed in the coming years. The actual figure is likely to be much more than that, however, as the current waste figures are based on the output of just 8,000 wells – if the industry drills 45,000 more, there will likely be times where there are tens of thousands of active unconventional wells generating immense volumes of waste simultaneously.

We expect substantial pressure will be placed on the basin to help shoulder the burdens of O&G water withdrawals and waste disposal in the coming decades. By ignoring these ancillary industries in its proposed ban of unconventional drilling, the Delaware River Basin Commission is taking a half-measure towards protecting the waters in its jurisdiction from substantial impacts in the years ahead."[ccxii]

Comment on Proposed Revision to Section 18 CFR 401.35(a) and (b) Classification of projects for review under Section 3.8 of the Compact

Section 401.35 (a) currently reads: "Except as the Commission may specially direct by notice to the project owner or sponsor, or as a state or federal agency may refer under paragraph (c) of this section, a project in any of the following classifications will be deemed not to have a substantial effect on the water resources of the basin and is not required to be submitted under Section 3.8 of the Compact:"

Section 18 CFR 401.35(a) (15)

DRN recommends changes to the proposed text at Section 18 CFR 401.35(a) (15) which reads: "Draining, filling, or otherwise altering marshes or wetlands when the area affected is less than 25 acres; provided; however, that areas less than 25 acres shall be subject to Commission review and action where neither state nor a federal level review and permit system is in effect".

DRN recommends: "All alterations to wetlands or marshes, including areas less than 25 acres, and regardless of whether a state or a federal level review and permit system is in effect, shall be subject to Commission review and action".

DRN considers DRBC to have more local and immediate information, data, and knowledge of wetlands that the state or federal agencies. Even though DRBC does not currently have detailed maps of all wetlands within the Basin, this research can be carried out more thoroughly under DRBC than under the more distant agencies that have less data and local knowledge on wetlands and marshes within the Basin. DRN considers DRBC to have the potential for more comprehensive and accurate assessment of proposed disturbances in wetlands and marshes within the Basin than state or federal agencies and therefore supports DRBC review of these activities.

DRN does not consider the 25 acre threshold for review that is currently in place and used as a threshold in the Draft Regulations to be scientifically-based. There is no justification that DRBC has produced to support the arbitrary threshold of 25 acres. DRN objects to 25 acres being used as a threshold for substantial impact.

Wetlands are located throughout the Delaware River Watershed and constitute a critical natural feature and a keystone ecosystem. Wetlands are sensitive to development activities and are documented to have been degraded by oil and gas development. Thorough and comprehensive oversight and review of all disturbance of wetlands and marshes is required to provide needed protection for the integrity of these ecosystems and the water resources of the Basin.

Miller states that “Wetlands are among the most threatened ecosystems on the planet. They are degraded and converted to human uses more rapidly than any other ecosystem, and the status of freshwater species is deteriorating faster than any other species. Since wetlands are essentially characterized by hydrologic conditions, changes in water volumes and timing of flows are major threats, as are discharges of various pollutants.”[ccxiii]

Section 18 CFR 401.35(a) (18)

DRN recommends a change in the text at Section 18 CFR 401.35(a) (18) which is proposed in the Draft Regulations as: “Except as provided at 18 CFR401.35(b) (18), the diversion or transfer of wastewater into the Delaware River basin (importation) whenever the design capacity is less than a daily average of 50,000 gallons”.

DRN recommends the text be changed to read: “Except as provided at 18 CFR401.35(b) (18), the diversion or transfer of wastewater into the Delaware River Basin (importation)”.

DRBC has more information about the potential impacts of wastewater, excluding wastewater produced by fracking which must be wholly prohibited, on the resources of the Basin and can potentially provide better oversight and review than the host state from where the wastewater is originating. For the myriad of reasons discussed in this Comment, the water resources of the basin are at risk of degradation by toxic discharges and should be under the jurisdiction of the DRBC no matter the volume of the wastewater.

Section 18 CFR 401.35(a) (19)

DRN recommends a change in the text at Section 18 CFR 401.35(a) (19) which is proposed in the Draft Regulations as: “To the extent allowed in the basin (see prohibition at 18 CFR440.3(b)), projects involving hydraulic fracturing, unless no state-level review and permit system is in effect;”.

DRN recommends Section 18 CFR 401.35(a) (19) be deleted and that NO hydraulic fracturing be allowed within the Basin, regardless of the state-level review and permit system that is in effect.

Considering the reasons provided in this Comment, DRN opposes all drilling and fracking for gas and oil within the Delaware River Basin.

Section 401.35 (b) currently reads: “All other projects which have or may have a substantial effect on the water resources of the basin shale be submitted to the Commission in accordance with these regulations for determination as to whether the project impairs or conflicts with the Comprehensive Plan. Among these are projects involving the following (except as provided in paragraph (a) of this section:”

Section 18 CFR 401.35(b) (14)

DRN recommends changes to Section 18 CFR 401.35(b) (14) that is proposed in Draft Regulations as: “Leachate treatment and disposal projects associated with landfills and solid waste disposal facilities in the basin”.

DRN recommends the text be changed to read: “Leachate treatment and disposal projects associated with landfills and solid waste disposal facilities in the basin, landfills and solid waste disposal facilities affecting the water resources of the basin”.

DRN agrees that leachate associated with landfills and solid waste facilities must be included in this Section because of the potential for substantial effect on the water resources of the Basin. DRN recommends the above text change based on the fact that toxic and radioactive waste generated by fracking is currently being imported to the basin, as discussed in this Comment, so it is a known threat but DRBC may not have any knowledge of this ongoing activity. DRBC cannot effectively carry out its responsibilities or implement its regulations that protect the water resources of the Basin unless it has information about the importation of wastes from fracking.

Landfills and solid waste disposal facilities are likely to continue to receive waste generated by fracking and drilling as gas development continues in the hydrocarbon bearing rock formations in the host sates and beyond. We know, as discussed in this Comment, that landfill radioactivity monitors have been set off hundreds of times by drilling and fracking waste; there is no change in the radioactive properties of waste generated by fracking that has changed or can reasonably be expected to change. Therefore, the threat of radioactive and toxic materials generated by fracking will remain, requiring DRBC to have review and regulatory authority over these activities. Based on the information contained in this Comment, DRN recommends that all fracking-related waste materials be prohibited from importation, storage, processing, treatment, disposal, and discharge within the Delaware River Basin.

II. INTERSTATE COMMERCE CLAUSE DOES NOT PREVENT A BAN ON IMPORTATION, STORAGE, PROCESSING, AND DISCHARGE OF OIL AND GAS WASTEWATER

The Interstate Commerce Clause of the United States Constitution **does not** prevent the Delaware River Basin Commission ("DRBC") from imposing a ban on the importation, storage, processing and discharge of oil and gas wastewater in the Basin. The ban would not prohibit transportation of wastewater through the Basin.

a. DRBC's Current and Proposed Oversight of Oil and Gas Wastewater

The DRBC has described its current oversight of oil and gas wastewater as follows:

> In some but not all cases, DRBC docket approvals for wastewater discharges include a condition expressly providing that the docket does not constitute an approval to import wastewater from ***hydraulic fracturing activities***, and stating that if the docket holder proposes to import and treat such wastewater, it must first apply for and obtain Commission approval for this activity. Such docket conditions do not constitute a moratorium.

DRBC, FAQ - Revised Draft Rules Addressing Hydraulic Fracturing Activities within the Delaware River Basin, at p.6 (emph. added). The DRBC has proposed new regulations that would "require Commission approval for the importation into the Basin and treatment and discharge within the Basin of wastewater from hydraulically fractured oil and gas wells." Id. at p.1.

The proposed rules would address more than simply fracking wastewater. The proposed rules deal with "produced water" and "CWT wastewater." "Produced water" is very broad:

> the water that flows out of an oil or gas well, typically including other fluids and pollutants and other substances from the

> hydrocarbon-bearing strata. Produced water may contain "flowback" fluids, fracturing fluids and any chemicals injected during the stimulation process, formation water, and constituents leached from geologic formations. For purposes of §§ 401.35(b)(18) and 440.5, the term "produced water" encompasses untreated produced water, diluted produced water, and produced water mixed with other wastes.

"CWT wastewater" is "any wastewater or effluent resulting from the treatment of produced water by a CWT [centralized waste treatment facility, as defined in the proposed regulations]."

Thus, the DRBC proposes to address more than fracking wastewater, potentially affecting all oil and gas wells. At the present time, according to available data, there are almost no oil and gas wells in New York or Pennsylvania in the Basin area – unconventional or conventional.

b. <u>Standards and Analysis</u>

<u>The Interstate Commerce Clause and the "Dormant Commerce Clause"</u>

Article I, sec. 8, cl. 3 of the United States Constitution is what is known as the Interstate Commerce Clause. It states, "[The Congress shall have Power] To regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes." Case law has developed over time to address what is known as the Dormant Commerce Clause ("DCC"), which is an implied reading of the Interstate Commerce Clause designed to prevent states from erecting barriers to or otherwise interfering with interstate commerce. "[T]he Commerce Clause is designed to eliminate protectionist restrictions on interstate trade which typically characterize international trade, such as embargoes, quotas, and tariffs." *Norfolk Southern Corp. v. Oberly*, 822 F.2d 388, 399 (3d Cir. 1987). Such state-versus-state provisions were common prior to the U.S. Constitution, during the period in which the Articles of Confederation governed. Id. A simple example of a protectionist restriction is a tariff that applies solely to out-of-state goods. "The Supreme Court has recognized a . . . Commerce Clause interest in federal uniformity in cases addressing state regulation of the means of interstate transportation." Id.

The DCC was central to a number of "flow control" challenges, in which states such as New Jersey had enacted bans on importation of out-of-state waste in order to preserve in-state landfill space for in-state waste. *See, e.g., Phila. v. N.J.*, 437 U.S. 617 (1978). Such preferential treatment for in-state waste was deemed discriminatory; however, the Court of Appeals left open the option that the state could have enacted other regulations to preserve landfill space that treated in-state and out-of-state waste alike. *Norfolk Southern Corp.*, 822 F.2d at 401.

In other cases, environmental regulations blocking the importation of certain out-of-state goods have been upheld where the state was able to specifically identify with scientific evidence reasons why importation of certain goods (i.e. live baitfish) posed a threat that the state could only truly address through a ban on the out-of-state goods. Maine v. Taylor, 477 U.S. 131 (1986).

The U.S. Court of Appeals for the Third Circuit has explained:

> In general terms, the Supreme Court has invalidated under the dormant Commerce Clause state laws falling into three categories: 1) laws that purposefully or arbitrarily discriminate against interstate commerce in favor of in-state interests . . . ; 2) laws that

> impose incidental burdens on interstate and foreign commerce that are clearly excessive in comparison to the putative local benefits . . . ; and 3) laws that undermine the federal need for uniformity among the states in particular areas, such as foreign trade and interstate transportation.

Norfolk Southern Corp., 822 F.2d at 398.

The DCC case law is often inconsistent. At times, the line between an improper regulation and a valid one is fuzzy, particularly when determining whether a law's discriminatory effects are such that it discriminates against out-of-state entities, or whether it merely incidentally burdens interstate commerce, and thus a lower standard of scrutiny would apply.

The Third Circuit summarized three categories of cases and thus varying levels of scrutiny to apply to challenges to state regulations that purportedly affect or impair interstate commerce.

> Three standards of review are applied in performing dormant Commerce Clause analysis: 1) state actions that purposefully or arbitrarily discriminate against interstate commerce or undermine uniformity in areas of particular federal importance are given heightened scrutiny; 2) legislation in areas of peculiarly strong state interest is subject to very deferential review; and 3) the remaining cases are governed by a balancing rule, under which state law is invalid only if the incidental burden on interstate commerce is clearly excessive in relation to the putative local benefits.

Id. at 398-99.

For Category 1 cases, "Discrimination against interstate commerce in favor of local business or investment is *per se* invalid, save in a narrow class of cases in which the municipality can demonstrate, under rigorous scrutiny, that it has no other means to advance a legitimate local interest." *C & A Carbone, Inc. v. Town of Clarkstown, NY*, 511 U.S. 383, 393 (1994)(citing *Maine v. Taylor*, 477 U.S. 131 (1986)).

Category 1-type cases are those like *Phila. v. N.J.* and *Maine v. Taylor*, in which there is a difference in treatment – whether facially or in effect – between in-state and out-of-state entities. The standard explained in Category 2 does not apply to "nondiscriminatory environmental statutes." *Norfolk Southern Corp.*, 822 F.2d at 398, 405.

Category 3 cases involve statutes that treat in-state and out-of-state entities alike, but still impose some burden on interstate commerce. For example, in *Norfolk Southern Corp.*, the Third Circuit upheld Delaware's ban on new industrial activity in the coastal zone. It found no difference in burden between in-state and out-of-state entities as far as being restricted from building in the coastal zone, and no burden that was excessive; this obviated the need to review the state's conclusion that industrial activity of the type proposed would endanger the coastal zone through pollution. *Norfolk Southern Corp.*, 822 F.2d at 406-07; *see also Huron Portland Cement, Inc. v. Detroit*, 362 U.S. 440 (1960). In contrast, the U.S. Supreme Court invalidated a state law pertaining to fruit packaging that would have required an in-state entity to invest a substantial amount of money to build an in-state packing facility, rather than continuing to ship its melons to another state for packing. *Pike v. Bruce Church, Inc.*, 397 U.S. 137 (1970). It found this burden to be excessive in comparison to the state interest, which was "to protect and enhance the reputation of growers within the State." Id. at 143.

The Dormant Commerce Clause Case Law Does Not Apply to the DRBC

The DCC does not apply to the DRBC because the DRBC is an interstate entity. Courts have repeatedly found that construction of an interstate compact is a question of federal law, not state law, and that compacts are to be construed in the same manner as contracts. *Tarrant Reg'l Water Dist. v. Hermann*, 569 U.S. 614, 628 (2013); *Texas v. New Mexico*, 482 U.S. 124, 128, (1987); *Cuyler v. Adams*, 449 U.S. 433, 438 (1981); *Petty v. Tenn.-Missouri Bridge Comm'n*, 359 U.S. 275, 278-79 (1959). The DRBC also has, as one of its members, the federal government, and Section 2.1 of the Compact specifically identifies the DRBC as "an agency and instrumentality of the governments of the respective signatory parties," including the federal government. Thus, the Dormant Commerce Clause should not apply at all because there is no state entity here – it is an interstate or federal agency exercising powers beyond the boundaries of any one state.

c. Even if the Dormant Commerce Clause Applies to DRBC Actions, It Only Applies When Those Actions Are Based on State Boundaries, not Basin Boundaries

Industry may attempt to argue that the Dormant Commerce Clause applies by pointing to Section 1.4 of the Compact, which states:

> Nothing in this compact shall be construed to relinquish the functions, powers or duties of the Congress of the United States with respect to the control of any navigable waters within the basin, ***nor shall any provision hereof be construed in derogation of any of the constitutional powers of the Congress to regulate commerce among the states*** and with foreign nations.

(emph. added); *see also* Section 15.1(s), (t). Thus, although the Compact itself is federal law, and the federal government is a member, there is also a provision stating that the Interstate Commerce Clause still has some impact on the DRBC. However, we have not yet found a case challenging an interstate agency's exercise of authority on the basis of the Dormant Commerce Clause to determine precisely what that impact would be. Practically, the federal government's interest in and authority over the free flow of interstate commerce is protected in part by its membership on the DRBC. *Cf. W.Va. ex rel. Dyer v. Sims*, 341 U.S. 22, 26-28 (1951) (discussing the Ohio River Valley Water Sanitation Compact and that the "national interest" was safeguarded both by Congressional consent under the Compact Clause, and by the federal government's membership in the compact agency); *see also Cuyler*, 449 U.S. at 438 (Congressional consent under the Compact Clause allows Congress to "maintain ultimate supervisory power over cooperative state action that might otherwise interfere with the full and free exercise of federal authority").

One way to read Section 1.4 is that it provides a backstop against a majority vote of the DRBC to engage in specific actions that would interfere with or impair interstate commerce across state lines in the same fashion that state regulation is not allowed to do. For instance, if the DRBC voted to prohibit the importation of waste into New Jersey from the Pennsylvania portion of the Basin, this would be very similar to the fact pattern in *Phila. v. N.J.*, 437 U.S. 617 (1978), and would likely be found improper. Given the contentious history of water allocation between DRBC signatory states, it is possible that preventing discrimination against particular states (commerce across state boundaries, rather than basin boundaries) is one reason for the provision – to provide one more check against abuse of authority to benefit or harm certain signatory states over others.

If that is the case, that concern does not arise in regard to a ban on the importation of fracking wastewater into the Basin because it would not result in discrimination on the basis of state borders. While it is true that Pennsylvania currently has the most shale gas activity, the proposed regulation does not distinguish between shale gas and other wells. Likewise, a proposed regulation applies to brines, which can come from any type of oil or gas well regardless of whether shale gas development is allowed in the state or not. The proposed regulations are, on their face, concerned with watershed boundaries, not state boundaries. Viewed in this light, it is clear that the proposed regulations would not discriminate on the basis of state boundaries. As a result, the Category 3 standards from *Pike v. Bruce Church, Inc.* would apply, and the analysis would revolve around whether the incidental burden on commerce across signatory state lines in the Basin is clearly excessive relative to the local benefits from the wastewater ban. *Norfolk Southern Corp.*, 822 F.2d at 398-99.

As will be discussed further below, there is significant scientific evidence to support the harms associated with improperly treated produced water and CWT wastewater, and the difficulty of achieving proper treatment that justify the prohibition on bringing these types of wastewater into the Basin, including across signatory state lines. As for the incidental burden, wastewater from oil and gas operations already has to be shipped long distances because facilities capable of handling the wastewater are limited in number. Thus, prohibiting wastewater from coming into the Basin and across signatory state lines does not carry with it the same weight if the wastewater were more easily treatable in closer distances. Also, the sparse history of oil and gas development in the Basin means a far less likely chance that anyone would even need to send wastewater into the Basin and across signatory state lines for storage, processing, treatment and discharge due to the lack of facilities.

Industry may go further to claim that the Compact language in Section 1.4 is designed to avoid in-Basin/out-of-Basin discrimination that impacts interstate commerce, as if the DRBC were itself a state, and the boundaries of the Basin were equivalent to state borders. This perspective would favor application of DCC case law to the DRBC in a way that recognizes DRBC as an interstate entity whose actions could be construed as impeding commerce flow across Basin borders. Even assuming, arguendo, that this view of Section 1.4 prevailed, it would not change the result, as explained further below.

d. Even if the Ban on Importation Based on Basin Boundaries Is Viewed as the Equivalent of a Ban that is Based on State Boundaries, It Would Still Survive Challenge

Below we apply the Category 1 and Category 3 standards to a potential DRBC oil and gas wastewater ban. For the purposes of this analysis, we assume a potential industry view that would equate "in-Basin" and "out-of-Basin" to "in-state" and "out-of-state" to apply the relevant case law.

<u>Category 1: Differential Treatment Between In-Basin and Out-of-Basin Entities/Blocking Commerce Flow at Basin Borders and Heightened Scrutiny</u>

When a regulation discriminates against interstate commerce (either on its face or through its effects), the burden is on the "State to demonstrate both that the statute 'serves a legitimate local purpose,' and that this purpose could not be served as well by available nondiscriminatory means." *Maine*, 477 U.S. at 138 (quoting *Hughes v. Okla.*, 441 U.S. 322, 336 (1979). It could theoretically be argued that a ban on importation of produced water and CWT wastewater into the Basin while placing no restrictions on in-Basin produced water and CWT wastewater would trigger this level of heightened scrutiny because it facially discriminates against out-of-Basin-generated produced water and CWT wastewater.

Assuming that there is no storage, processing, treatment, and discharge of in-basin-generated produced water or CWT wastewater, the DRBC could argue that there is no discriminatory treatment because no such in-Basin activities, posing the same threats, are occurring while the out-of-Basin entities are barred from doing so (and thus, there can be no discrimination between in-Basin and out-of-Basin occurring). *Norfolk Southern Corp.*, 822 F.2d at 401-02; *Exxon Corp. v. Md.*, 437 U.S. 117, 125 (1978).

Even if the ban were to trigger the highest level of scrutiny, a DRBC ban should survive heightened scrutiny. Although heightened scrutiny has invalidated many laws, the DRBC ban situation can be distinguished from *Phila. v. N.J.*, and analogized to *Maine v. Taylor*, a case in which the local law was upheld.

First, the ban serves a "legitimate local purpose" in protecting Basin waters and the uses that rely on those waters from the well-documented impacts of poorly-treated oil and gas wastewater. Science has strongly established the harms associated with inadequately-treated oil and gas wastewater in Pennsylvania streams and rivers. This includes streams whose sediments are now radioactive due to the discharges from certain centralized waste treatment facilities, and streams whose ecology was turned to that of a saltwater environment. Inadequately-treated oil and gas wastewater can negatively affect public drinking water supplies, in addition to harming aquatic life and changing the salinity of the aquatic environment. Protecting Basin water resources from the threat of produced water and CWT wastewater based on this science demonstrates that there is a legitimate local interest at play. In comparison, in Maine, state experts "testified that live baitfish imported into the State posed" threats of parasites and nonnative species to Maine's wild fish and aquatic ecology, which the Court found to meet the legitimate local interest requirement. 477 U.S. at 140-41.

Second, even if one concluded that there was discrimination, protecting Basin waters and the uses they support would not be "served as well by available nondiscriminatory means." *Maine*, 477 U.S. at 138. Although the DRBC proposed regulations seem to suggest that the DRBC thinks such means exist, the science says otherwise. For example, full disclosure of all potential pollutants requiring treatment in produced water and CWT wastewater is impossible when fracking has been employed because the industry uses undisclosed "trade secret" constituents that will be present in the wastewater. This hampers proper treatment of the wastewater, exposing Basin waters, users, and the aquatic ecology to significant uncertainties and risks. *Cf. Maine*, 477 U.S. at 148 ("Maine has a legitimate interest in guarding against imperfectly understood environmental risks, despite the possibility that they may ultimately prove to be negligible").[3]

[3] *See also id.* quoting the District Court's opinion in 585 F.Supp. 393, 397 (D.Mn. 1984) ("[T]he constitutional principles underlying the commerce clause cannot be read as requiring the State of Maine to sit idly by and wait until potentially irreversible environmental damage has occurred or until the scientific

If industry were to argue that there should be an allowance of some oil and gas wastewater (e.g. wastewater with fracking fluids in it versus others), there is no easy way to distinguish different types of oil and gas wastewater from one another except via sampling every load and determining if it should be allowed into the Basin. *Cf. Maine*, 477 U.S. at 141-42 (state experts testified to "no satisfactory way to inspect shipments of live baitfish for parasites or commingled species," that it would be a "physical impossibility," and that "no scientifically accepted procedures" for certifying a shipment as parasite-free "were [not] available for baitfish."). That is a high administrative burden that the DRBC need not take on to protect the waters of the Basin from a known threat. *Cf. id.* at 147 (state not required to "develop new and unproven means of protection at uncertain cost").[4]

Category 3: Nondiscriminatory Environmental Standards and a Balancing Test

For Category 3 cases, "the extent of the burden that will be tolerated will . . . depend on the nature of the local interest involved, and on whether it could be promoted as well with a lesser impact on interstate activities." *Pike v. Bruce Church, Inc.*, 397 U.S. 137, 142 (1970). Because a ban can pass the stricter standard set forth above, it can pass the balancing test as well. The same evidence described above would be useful to defend the ban under this standard.

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community agrees on what disease organisms are or are not dangerous before it acts to avoid such consequences.")

[4] In practice, a significant amount of wastewater goes to places capable of deep injection, such as Ohio, thus, wastewater generators and transporters already have a substantial burden to bear as far as transport in comparison to what the DRBC would be doing.

e. Applying the Standards to a Potential Ban If In-Basin Produced Water and CWT Wastewater Storage, Processing, Treatment, and Discharge Exists

This analysis assumes that there is no produced water or CWT wastewater being generated, processed, treated, stored, and discharged in the Basin currently. A stronger approach that would account for any such in-Basin activities that might exist or that might begin in the future would be for the DRBC to ban processing, storage, treatment and discharge of produced water and CWT wastewater *regardless of origin*, whether in-Basin or out-of-Basin. Such an approach would avoid the pitfall inherent in New Jersey's trash importation ban, which "impose[d] on out-of-state commercial interests the full burden of conserving the State's remaining landfill space." 437 U.S. at 628.

To further strengthen this approach, we recommend that the DRBC include in the definition of "produced water" the liquid fraction of otherwise-solid waste, such as drill cuttings. For instance, some loads of drill cuttings that arrive at waste facilities are highly saturated with oils and other fluids. That liquid fraction can separate out and remain in the bottom of the waste container, requiring the receiving facility to do something with that waste fluid. That waste fluid may contain brine-type material, radioactive materials, drilling mud, or other chemical constituents that need proper treatment. Other facilities may bring in wastewater, separate out the solids in the wastewater for disposal in a landfill, and return the wastewater to the operator. The DRBC's current regulations do not account for this liquid waste or these types of scenarios, even though these activities pose threats to the health of

Basin waterways that are similar to the threats posed by the other oil and gas wastewater the DRBC is proposing to regulate.

If the DRBC took the approach of banning activities regardless of the wastewater's origin, the mere fact that the majority of oil and gas wastewater would come from outside of the Basin would likely not change the fact that both in-Basin and out-of-Basin entities were subject to the same standards. 822 F.2d at 402; *Exxon Corp. v. Md.*, 437 U.S. 117, 125 (1978).[5] Such an across-the-board ban would support the conclusion that the ban is based on environmental protection, in contrast to economic protectionism. *Cf. id.* at 403-04. A ban that treated in-Basin and out-of-Basin entities alike would be subject to the Category 3 standard, under which "state law is invalid only if the incidental burden on interstate commerce is clearly excessive in relation to the putative local benefits." *Id.* at 398-399. As already noted, the available science and knowledge of how difficult oil and gas wastewater is to treat – regardless of fracking fluid presence or not – would support the immense local benefits to keeping such wastewater out of Basin water resources. Also, it is common for oil and gas wastewater to be transported long distances to facilities for treatment. This differs from *Pike v. Bruce Church, Inc.*, in which the local benefits of melon packaging were far

[5] Although the DRBC could take the route of including a grandfather clause for facilities currently accepting to-be-prohibited waste streams, which would not affect the Commerce Clause analysis, the need for such a clause is not apparent because any facilities currently accepting waste do not appear to be solely dependent on oil and gas waste fluids and wastewater for their business. *Norfolk Southern Corp.*, 822 F.2d at 404. Thus, banning certain waste streams would not result in the facility shutting down, lowering the risk of a regulatory takings claim that might otherwise warrant a grandfathering clause.

less than the burden on a company to invest thousands of dollars to build an in-state packaging plant.

Conclusion

Delaware Riverkeeper Network supports DRBC's proposal for the prohibition of high volume hydraulic fracturing (HVHF) in hydrocarbon bearing rock formations within the Delaware River Basin ("the Basin"). DRN opposes the diversion, transfer or exportation of water from sources within the Basin of surface water, groundwater, treated wastewater or mine drainage water for utilization in hydraulic fracturing ("fracking") of hydrocarbon carbon bearing rock formations outside the Basin as proposed at Section 440.4. DRN opposes the importation, transfer, treatment, storage, disposal, or discharge in the Basin of produced water and Centralized Waste Treatment (CWT) wastewater generated by fracking operations, as proposed at Section 440.5. DRN requests the DRBC remove all reference to the allowance of water exports from the Basin for fracking and the import and storage, processing, disposal and discharge of CWT wastewater and produced water from fracking in the Basin, as described at Sections 440.4 and 440.5. DRN also requests that Section 440.3(b) is expanded to include prohibition of the activities related to fracking, specifically including the export of water and water resources out of the Basin for fracking elsewhere and the prohibition of the importation, transfer, treatment, storage, disposal, or discharge in the Basin of produced water and Centralized Waste Treatment (CWT) wastewater generated by fracking operations.

Respectfully submitted this 30th day of March 2018,

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Attachments:

Attachment 1: Expert reports

1. Tom Myers, "Technical Memorandum: Review of Proposed Natural Gas Regulations as Proposed by the Delaware River Basin Commission", March 12, 2018

2. Glenn C. Miller, Ph.D., "Review of the Draft Delaware River Basin Commission's Regulations on Hydraulic Fracturing in Shale and Other Formations", March 20, 2018

3. FracTracker Alliance, “Potential Impacts of Unconventional Oil and Gas on the Delaware River Basin”, March 20, 2018

4. Schmid & Company, Inc., “Comments on Proposed Regulations of the Delaware River Basin Commission Concerning High Volume Hydraulic Fracturing to Produce Oil and Gas, 3.18.2018

5. Piotr Parasiewicz, PhD, A.Prof., “Ecological review of the DRBC Draft 18 CFR Parts 401 and 440 Proposed Amendments to the Administrative Manual and Special Regulations Regarding Natural Gas Development Activities,” February 2018

6. Marvin Resnikoff, “Memorandum, DRBC Draft Regulation Comments”, Radioactive Waste Management Associates, February 19, 2018

<u>Attachment 2: Curriculum Vitae for Experts</u>

1. Kunz (Schmid and Co.)
2. Schmid
3. Parasiewicz
4. Resnikoff
5. Kelso (FracTracker)
6. Myers
7. Miller

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