

**Recommendations to Improve the  
December 9, 2010  
Delaware River Basin Commission (DRBC)  
Proposed Natural Gas Development Regulations**

Report to:  
**Delaware Riverkeeper Network**

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## Executive Summary

This report responds to the Delaware Riverkeeper Network's (DRN) request to provide expert review and opinion on the December 9, 2010 Delaware River Basin Commission (DRBC) Proposed Natural Gas Development Regulations. This report includes specific recommendations for improving DRBC's Proposed Natural Gas Development Regulations (DRBC's Proposed Regulations). These recommendations are aimed at preventing pollution and avoiding degradation of the Delaware River Watershed. They include the use of best technology and best management practices for natural gas exploration, drilling, and development.

Report recommendations were prepared by Susan Harvey, the owner of Harvey Consulting, LLC, (HCLLC) a consulting firm providing oil and gas, environmental, and regulatory compliance advice and training to clients. Ms. Harvey has 23 years of experience as a petroleum and environmental engineer. Ms. Harvey has planned, engineered, executed, and managed both on and offshore exploration and production operations, and has been involved in the drilling, completion, stimulation, testing, and oversight of hundreds of wells in her career. Ms. Harvey has completed numerous environmental assessments of oil and gas projects, examining pollution abatement design and execution. Ms. Harvey also has experience with oil spill prevention and response planning and execution. Ms. Harvey has worked in engineering and supervisory positions at both Arco and BP, including holding the position of Prudhoe Bay Engineering Manager and Exploration Manager.

During 2009 and 2010, HCLLC prepared four reports on shale gas development in Pennsylvania and New York. These reports contain extensive recommendations for improving exploration and production regulations.

1. Recommendations for Pennsylvania's Proposed Changes to Oil and Gas Well Construction Regulations, report prepared for Earthjustice and Sierra Club, 2010.
2. New York State (NYS) Casing Regulation Recommendations, report prepared for Natural Resources Defense Council, 2009.
3. Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas & Solution Mining Regulatory Program Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs, Review of DSGEIS and Identification of Best Technology and Best Practice Recommendations, report prepared for Natural Resources Defense Council, 2009.
4. Delaware River Basin Commission (DRBC) Consolidated Administrative Hearing on Grandfathered Exploration Wells, report prepared for Delaware Riverkeeper Network and Damascus Citizens for Sustainability, Inc., 2010.

Many of the recommendations made by HCLLC in the report titled Recommendations for Pennsylvania's Proposed Changes to Oil and Gas Well Construction Regulations have been incorporated into the latest draft of changes to Chapter 78 of Pennsylvania law. However, proposed changes to Chapter 78 have yet to be codified. HCLLC's recommendations are still under consideration by New York State (NYS). At this time, the extent of NYS's regulatory improvements is unknown.

Both Pennsylvania and New York state oil and gas regulations are presently in flux. The simultaneous development of state regulations and DRBC regulations could result in regulatory gaps. It is recommended that DRBC wait to develop its own regulations until after Pennsylvania and NYS codify a complete set of revised regulations. Waiting until a firm regulatory baseline is established will enable DRBC to identify the areas where more stringent standards are needed to protect the unique and sensitive

nature of the Delaware River Watershed. Alternatively, DRBC's Proposed Regulations should be expanded, before being finalized for adoption, to address known deficiencies in existing host state regulations.

DRBC's Proposed Regulations are a very important step forward for protection the unique and sensitive Delaware River Watershed. While DRBC's Proposed Regulations address a number of important issues, there is significant room for DRBC to strengthen and expand its rules.

This report provides recommendations for strengthening and expanding DRBC's Proposed Regulations. A summary of the report's recommendations is listed below:

**Recommendation Summary:**

1. Expand regulations to cover the potential impacts from liquid hydrocarbons and natural gas. Regulations should address the risk of contamination to the environment if oil is spilled while being processed or transported, or if a well blowout occurs.
2. Expand regulations to include both exploration and production impacts.
3. Expand regulations to address the full spectrum of hydrocarbon development impacts within Delaware River Watershed, including the siting and construction of processing facilities, pipelines, and compressor stations. Regulations should also address the potential need for additional power generation and waste handling facilities to support new development.
4. Require seismic exploration best practices including: reducing the number of trees and amount of vegetation that needs to be removed to access the survey area; reducing the weight of seismic equipment and selecting low impact tires to minimize surface damage; conducting careful pre-survey assessments of environmentally sensitive resources and areas of public and private concern; and limiting operations to the least sensitive seasons and the lowest impact times of the year.
5. DRBC should wait for the promulgation of new host state regulations before finalizing its own regulations, so that it knows what additional protections are needed for the Delaware River Watershed. Alternatively, DRBC's Proposed Regulations should be expanded before being finalized for adoption to address known deficiencies in existing host state regulations.
6. DRBC should be required to justify its heavy reliance on host state regulations. DRBC should provide a detailed analysis showing how PA and NYS regulations are protective of the Delaware River Watershed, or where gaps exist that need to be filled by new regulations.
7. DRBC should not only evaluate whether a host state regulation exists, but also whether it is effectively implemented and enforced in practice.
8. DRBC should demonstrate that there are adequate host state permitting, inspection, and enforcement resources to administer exploration and production activity in the Delaware River Basin; or DRBC should create additional regulations and provide additional resources to meet this need. There is ample information to show that host state regulations are not currently adequate.

9. DRBC should provide a table showing the number of state inspection and enforcement personnel that will be assigned to the oversee Delaware River Watershed exploration and production activities. DRBC should also provide information on the amount of state funding for this work.
10. More stringent review and approval requirements should be established for seismic exploration and exploration drilling operations.
11. Lower review thresholds should be set for Natural Gas Development Plan (NGDP) review.
12. Well density limits should be set to protect the Delaware River Watershed.
13. DRBC regulations should require operators to co-locate multiple wells on a single drillsite to minimize surface impacts and reduce the environmental footprint.
14. Establish pollution prevention standards to protect subsurface water.
15. Set chemical use limits to prevent the introduction of harmful chemicals into the environment, in combination with long-term monitoring programs that track the fate and effect of subsurface chemical transport.
16. Require an applicant to provide a list of chemicals, including the amount and concentration of each chemical, for approval prior to use in any part of the exploration and production process.
17. DRBC should provide scientific justification for the proposed 2,000' groundwater and surface water monitoring radius.
18. Require gas composition testing to ensure that there is sufficient information to identify the source of gas found in water. The composition and isotopic characteristics of the gas, and any associated fluids, should be analyzed. The collected information should be stored in a publicly accessible database.
19. Require operators to submit Water Management Plans for DRBC review and approval.
20. Require operators to achieve a zero (or as near to zero as possible) solid and liquid waste discharge goal in the Delaware River Basin Special Use Area. The use of closed loop tank systems, instead of reserve pits and impoundments, is best practice.
21. Prohibit the use of drilling mud reserve pits and onsite drilling waste burial. PA and NYS allow the use of reserve pits, onsite waste burial, and road spreading (in some cases); therefore, DRBC needs to specify in regulations that these practices will not be allowed in the Delaware River Basin.
22. Eliminate waste disposal waivers at Section 7.5(h)(1)(iv)(A)(5) and 7.1(e)(4) that allow waste to be discharged into the Delaware River Basin.
23. Include drill cutting and drill fluid waste handling requirements for all drill cuttings and fluids from the entire well, not just select intervals.
24. Include special handling, treatment, and disposal requirements for drilling waste and equipment that contains Naturally Occurring Radioactive Material (NORM), mercury, cadmium, and/or other heavy metals.

25. Include PPC plan requirements to ensure that hydrocarbon and chemicals spills are prevented or responded to effectively, and require DRBC review and approval.
26. Require more stringent cement integrity evaluation than what exists in NYSDEC and PADEP regulations, including the use of Cement Bond Log (CBL) or Cement Evaluation Tool (CET).
27. Require a well blowout response plan, a contract retainer with an emergency well control expert, and memorandums of understanding with nearby operators for mutual response aid.
28. Require identification of and access to well capping equipment and a drilling rig capable of drilling a relief well in a timely manner.
29. Require plans to protect environmentally sensitive areas from oil, fuel, and chemical spills.
30. Include air pollution control requirements in regulations to ensure that air pollutants do not adversely impact water resources.
31. DRBC's regulations should provide DRBC with the authority to apply site-specific mitigation measures that exceed minimum standards.
32. Require that equipment be designed to prevent corrosion and erosion. Require monitoring, repair, and replacement programs.
33. Require that operators use the lowest emission energy sources for exploration and production activities.
34. Require that best technology and best practices be used to model, design, implement, collect data for, and monitor fracture treatments, and that the data be made publicly available.
35. DRBC's regulations should identify the type, volume, and concentrations of fracture treatment additives that are protective of human health and the environment. DRBC's regulations should require the use of non-toxic materials to the greatest extent possible and should include a list of prohibited additives.
36. Require that fracture fluid flowback be routed to onsite treatment systems designed and permitted to meet specific water quality standards for fracture fluid recycling and/or collected in closed tanks for transportation to offsite treatment systems.
37. Require secondary containment and/or the use of double-wall tanks and the employment of best management practices for chemicals stored on a well pad.
38. Include a process whereby new technology and procedures used by industry and approved by government officials are subject to rigorous technical review or risk assessment.
39. DRBC should provide a scientific justification for the setback distance it has selected, or DRBC should consider adopting larger setback requirements to protect the unique resources of the Delaware River Watershed.
40. Setback requirements should be codified at appropriate distances by DRBC and no waivers should be granted.

41. DRBC's regulations should include a map identifying areas within the Delaware River Watershed that warrant increased setbacks, seasonal operation constraints, and surface use prohibitions.
42. Financial assurance requirements should be increased to address worst-case risk exposure.
43. A risk assessment of hydrocarbon exploration and development in the Delaware River Watershed should be completed. The risk assessment should include worst-case scenario impact models. The risk assessment should be used to set a higher financial assurance requirement.
44. Technical review and approval criteria must be set for DRBC's Executive Director to determine that a reduction in the financial assurance amount is appropriate.
45. Financial assurance releases should not be granted within just two years of project termination, because subsurface pollutant transport may take many years.
46. Financial assurance requirements should be expanded to address the risks from oil wells and hydrocarbon liquid development (oil and condensate).
47. All members of the public who are or may be directly affected by exploration and production operations should be notified. The notification threshold should be increased beyond 2,000', and should be defined by parameters that take into account the radii of visual, noise, blowout trajectory, and groundwater impacts.
48. Improve public access to data and findings on inspection, compliance and enforcement issues. Public notification should not be limited to the fact that a project is occurring; it should also include notifications of violations and enforcement actions.
49. Waivers to regulations should not be granted without public review. Waivers should require a higher level of justification than currently proposed.
50. DRBC either needs to ensure there are sufficient host state personnel and resources to enforce reported violations and conduct routine inspections, or DRBC needs to obtain the authority and resources to pursue violations of host state regulations.
51. Revise the definitions in DRBC's Proposed Regulations to address the recommendations in Section 11 of this report.

## 1. DRBC Regulation Scope

### 1.1 Include Liquid Hydrocarbon Impacts

DRBC's Proposed Regulations should cover the exploration and production of all types of hydrocarbons (oil, condensate, and gas). DRBC's Proposed Regulations (Section 7.1) cover natural gas exploration and production, but do not address the potential for liquid hydrocarbon exploration and production. The impacts from liquid hydrocarbon exploration and production can be significant for a watershed. Liquid hydrocarbon exploration and production can contaminate the environment if oil is spilled while being processed or transported, or if a well blowout occurs.

Natural gas reservoirs may also produce condensate, or natural gas may be found in solution in an oil reservoir. Additionally, oil reservoirs may be penetrated by wells exploring for gas. Unless a sufficient number of exploration and appraisal wells have been drilled in the Delaware River Basin to verify the absence of liquid hydrocarbons, DRBC's regulations should not be limited to natural gas. To date, DRBC has not provided a technical justification for ruling out the possibility of encountering liquid hydrocarbons while drilling for shale gas. Typically, state and federal regulations collectively address oil and gas exploration and development.

### 1.2 Expand Rules to Cover all Exploration and Development Impacts

DRBC's Proposed Regulations establish rules for natural gas drilling projects at a high review threshold (3,200 acres or 5 well pads). This means that single exploration wells or operators that drill wells and develop facilities smaller than 3,200 acres or 5 well pads will receive little scrutiny.

The scope of the proposed "Natural Gas Development Regulations" should be expanded to address the impacts of *all* hydrocarbon *exploration and production*, and the name of the regulations should be changed correspondingly. Currently, all oil exploration and production operations are excluded, and most natural gas exploration operations are excluded. Developments under 3,200 acres or 5 pads are also excluded.

### 1.3 Address Full Spectrum of Hydrocarbon Development Impacts

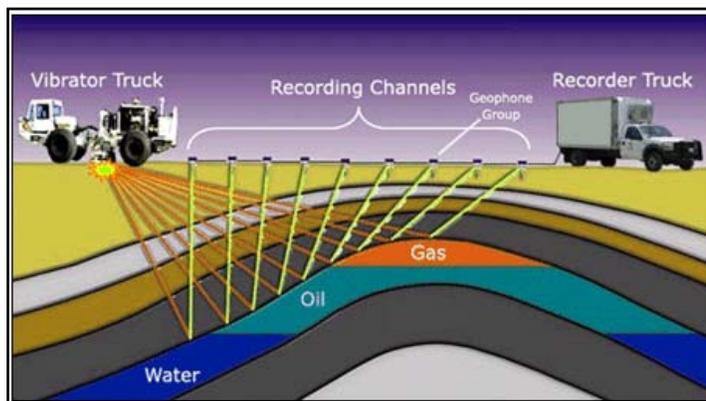
DRBC's Proposed Regulations do not address the full spectrum of impacts from hydrocarbon development within the Delaware River Watershed. The proposed regulations at Section 7.3 (a) target water use, waste disposal issues, and drillsite location issues, related to natural gas drilling and completion operations. However, DRBC's regulations do not address the siting and construction of gas (or liquid hydrocarbon) processing facilities, pipelines, and compressor stations. Nor do they take into account the potential need for additional power generation and waste handling facilities to support hydrocarbon development.

Furthermore, under DRBC's Proposed Regulations at Section 7.5, Natural Gas Development Plans (NGDP) are not reviewed until 3,200 acres or 5 well pads are affected. This means dozens of wells can be drilled by an operator without DRBC scrutiny. Even when a NGDP review is triggered, the scope of the review is limited to water use and waste handling. It does not address other impacts to the watershed that can occur.

## 1.4 Require Seismic Data Collection Best Practices

DRBC should establish regulatory requirements for seismic data collection, because seismic data collection methods can affect water resources. DRBC's Proposed Regulations are silent on seismic exploration impacts.

Exploration for oil and natural gas typically begins with a geologic examination of the surface structure of the earth, to identify areas where petroleum or gas deposits might exist. Then, once a geologist has identified an area of potential interest based on surface geologic maps, seismic data collection is typically obtained to identify possible subsurface hydrocarbon traps and structures. Seismic exploration equipment is used to send seismic waves into the earth. Seismic waves are generated by a surface positioned source and are measured by a surface positioned receiver. The rate that seismic energy is transmitted and received through the earth crust provides information on the subsurface geology, because seismic waves reflect at different speeds and intensities off various rock strata and geologic structures. Collecting seismic data in this manner is called a Reflection Seismic Survey.<sup>1</sup>



A reflection seismic survey involves generating hundreds to tens of thousands of seismic source events, or shots, at various locations in the survey area. The seismic energy generated by each shot is detected and recorded by sensitive receivers ("geophones" on land and "hydrophones" underwater) at a variety of distances from the source location. Geophones and hydrophones are connected by long cables to relay the collected information back to a centralized computer.<sup>2</sup>



On land seismic operations involve the generation of seismic vibrations by explosive or mechanical sources. One type of energy source for seismic exploration is an explosive charge. Small holes ("shot-holes"), typically 4 inches in diameter, are drilled into the earth surface 10'-60' deep depending on surface terrain,<sup>3</sup> although some drill holes have been drilled to 200'.<sup>4</sup> The photo to the left shows an example of a shot-hole drill unit.

The hole must be drilled into a hard layer of soil that is sufficiently dense to carry the seismic wave.<sup>5</sup> Explosive charges (typically 5-50 pounds each)<sup>6</sup> are lowered into the hole and detonated to create a shock wave (vibration). Some states have limits on the

<sup>1</sup> U.S. Geologic Survey, Seismic Data Acquisition.

<sup>2</sup> For every source event, each geophone generates a seismogram or trace, which is a time series representing the earth movement at the receiver location. A record of all traces for each shot is transmitted to a computer for storage and conversion into a seamless cross-sectional representation of the subsurface for subsequent study and interpretation by a trained geophysicist.

<sup>3</sup> Westlund, D., Thurber, M.W., Best Environmental Practices for Seismic Exploration in Tropical Rainforest, Society of Petroleum Engineers International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, SPE 10HSE 126844-PP, April 2010.

<sup>4</sup> US Fish and Wildlife Service, 612 FW 2, Oil and Gas, Policy Manual.

<sup>5</sup> The Pembina Institute, Seismic Exploration, [www.pembina.org](http://www.pembina.org).

size of charges that can be deployed near environmentally sensitive areas, human habitation, and roadways.

Historically, explosives were used on the ground, resulting in large craters and extensive surface damage. Explosive charges are no longer deployed at the surface. Instead, a shot-hole must be drilled and the explosive lowered into the shot-hole at a sufficient depth to prevent surface craters. Shot-holes are filled with cuttings, bentonite, and rocks to minimize surface impacts.

Mechanical vibrators are an alternative to the use of explosives, and are more commonly used. Mechanical vibrators provide more consistent source strength, repeatability, and are more reliable in the case of repeat data acquisition programs or for time-lapse studies.

Mechanical vibrators can include: a pad that thumps the surface of the earth (“thumper trucks”), driven by gravity or compressed air; a truck that generates vibrations (“Vibroseis™ Truck”); and compressed air guns.<sup>7</sup> The photo to the right shows a Vibroseis Truck. The Vibroseis method involves a truck equipped with vibrator pads that are lowered to the ground and triggered. Depending on the subsurface target depth and the purpose of the seismic survey, two or more seismic Vibroseis Trucks (vibrating in sync) can be needed.



The use of thumper trucks is not considered best practice because it involves dropping a steel slab that weighs about three tons to the ground to create a seismic vibration. Thumper trucks are large, requiring extensive tree and vegetation removal, and leave land scars.

In areas where seismic data is collected in water, the energy source is usually compressed air from an airgun submerged underwater. Explosives typically are not used underwater because they can cause adverse impacts to aquatic life.

Significant surface impacts can be caused by tree and vegetation removal to create straight “cutlines” for seismic equipment (as shown in the photo to the left). Lines need to be cut to run mechanical vibration equipment or set explosives. Other seismic lines are cleared to set geophones to measure seismic reflection. The width of each cutline depends on the seismic survey method used, but can be 20’-50’ wide, where large seismic equipment units are required. Best practice is to make the width of the cutlines as small as possible by using hand carried equipment. Recently, companies have been able to reduce cutline width to 6’-10’ in certain circumstances.



<sup>6</sup> US Fish and Wildlife Service, 612 FW 2, Oil and Gas, Policy Manual.

<sup>7</sup> Petroleum Engineering Handbook, Reservoir Engineering and Petrophysics, Volume V(A), Society of Petroleum Engineers, 2007.

The spacing between each cutline is dependent on the type of seismic equipment used and the depth of examination into the earth. Typically, the spacing ranges from 300' to 3,000'.<sup>8</sup>

Depending on existing development, infrastructure, and access in areas planned for on shore seismic exploration, seismic operators sometimes need to build access roads, set up temporary camps, and establish helicopter landings to bring in personnel and equipment. In areas where there are existing roads, housing, and airports, surface disturbance can be minimized.

Seismic operations are very labor intensive and require large amounts of equipment, personnel, and support systems. Depending on the size of the area under study, and the type of equipment selected, seismic operations can require dozens to hundreds of personnel. In addition to seismic exploration equipment, there is a need for housing, catering, waste management systems, water supplies, medical facilities, equipment maintenance and repair shops, and other logistical support functions.



While there are a number of responsible seismic data collection operators that continuously improve and implement low impact procedures, historically some on shore seismic operations have resulted in impacts to the environment by:

- Creating new, wide, straight seismic cutlines, as shown in the photo above. Seismic cutlines involve cutting trees and creating surface disturbance to flora, fauna, soils, and watercourses. In some cases, wide roads and clearings are needed for seismic equipment, helicopter landings, and work camps, and are created by using bulldozers, hydroaxes, and large construction equipment;
- Causing temporary or permanent fragmentation and loss of habitat and ecological populations;
- Disrupting mating, nesting, spawning, and migration routes;
- Removing vegetation that results in increased erosion and changes in surface hydrology;
- Siting camps, helipads, equipment storage, and cutlines based on logistical convenience and lowest cost, without consideration for sensitive biological areas, historic and cultural resources, and local community impacts and concerns;
- Creating new and long-term use travel corridors for predators;
- Creating new access routes into the forest for all-terrain vehicles, snowmobiles, and off-road trucks, which then results in increased hunting and poaching in areas where these activities would otherwise be prohibited or limited;
- Generating noise and light disturbances near animal and human populations;
- Introducing non-indigenous species via seismic and construction equipment;
- Damaging fish and wildlife habitat by surface disturbance and stream crossings;

<sup>8</sup> The Pembina Institute, Seismic Exploration, [www.pembina.org](http://www.pembina.org).

- Contaminating soils and surface and subsurface water resources due to spills;
- Creating pollution through poor solid waste, human waste, and wastewater management practices; and
- Adversely impacting visual aesthetics (“visual scarring”) due to the wide cutlines required to transport seismic survey equipment.

Best practices for seismic exploration include: selecting the right seismic survey equipment, conducting work during certain seasons to minimize impacts, and doing extensive pre-planning. New techniques and technology have been developed to reduce seismic exploration impacts. Modern seismic processing techniques now allow for data acquisition to occur around natural obstacles, such as trees and shrubs. These techniques eliminate the need for 100% clear cutting of straight line-of-sight seismic lines.<sup>9</sup>

In general, seismic exploration impacts can be minimized by: reducing the number of trees and amount vegetation that needs to be removed to access a survey area; reducing the weight of seismic equipment and selecting low impact tires; and conducting careful pre-survey assessments of environmentally sensitive resources and areas of public and private concern. Pre-survey assessments should be translated into a seismic data collection plan that includes setbacks from areas of concern. Additionally, operations should be conducted during the least sensitive seasons and the lowest impact times of the year.<sup>10</sup>

#### **Recommendation Summary:**

1. Expand regulations to cover the potential impacts from liquid hydrocarbons. Regulations should address the risk of contamination to the environment if oil is spilled while being processed or transported, or if a well blowout occurs.
2. Expand regulations to include both exploration and production impacts.
3. Expand regulations to address the full spectrum of hydrocarbon development impacts within the Delaware River Watershed, including the siting and construction of processing facilities, pipelines, and compressor stations. Regulations should also address the potential need for additional power generation and waste handling facilities to support new development.
4. Require seismic exploration best practices including: reducing the amount of trees and vegetation that needs to be removed to access the survey area; reducing the weight of seismic equipment and selecting low impact tires to minimize surface damage; conducting careful pre-survey assessments of environmentally sensitive resources and areas of public and private concern; and limiting operations to the least sensitive seasons and the lowest impact times of the year.

<sup>9</sup> Ikelle, L. T. and Amunden, L, Introduction to Petroleum Seismology, Society of Exploration Geophysicists, 2005.

<sup>10</sup> Further regulatory recommendations for minimizing onshore seismic exploration impacts can be found in HCLLC’s Report, Onshore Seismic Exploration Best Practices & Model Permit Requirements, Report to Sierra Club and Natural Resources Defense Council, January 2011.

## 2. Reliance on Incomplete, Draft Host State Regulations

### 2.1 Wait for Final Host State Regulations or Expand DRBC Regulations to Address Known Deficiencies

DRBC's Proposed Regulations at Section 7.1(i) conclude that host state regulations (i.e., New York and Pennsylvania) are sufficient to protect the Delaware River Watershed, except regarding water use and waste management. DRBC concludes that its regulations should be limited to water use and waste management related to natural gas development, because host state regulations address all other impacts of gas well construction and operation.

DRBC does not provide sufficient justification to support its position that host state regulations for natural gas well development, construction, and operation are adequate to protect the Delaware River Watershed. For example, DRBC's Proposed Regulations do not address the potential for water pollution resulting from: chemical spills, fuel spills, well blowouts, hydrocarbon processing activities, pipeline development activities, improper well construction, and improper well operation. DRBC has not provided evidence to show that these risks are being adequately addressed by host states.

DRBC's Proposed Regulations at Section 7.1(i) rely heavily on the assumption that host state regulations have been improved to protect human health, the environment, and water resources. However, host state shale gas regulatory improvements are not complete, and do not at present adequately address a significant number of risks associated with natural gas development.

DRBC's Proposed Regulations at Section 7.1(i) state:

*“Pursuant to their respective sovereign authorities, the Basin states of New York and Pennsylvania have enacted statutes and promulgated regulations governing the gas industry. These state laws impose requirements on, among other things, natural gas well construction and operation to protect human health and the environment, including water resources.”*

*“...the Commission will utilize and employ existing offices and rely upon agencies of the State of New York and the Commonwealth of Pennsylvania in their respective states in lieu of separately administering natural gas and exploratory well construction and operation standards.”*

Pennsylvania (PA) and New York state (NYS) well construction and operation regulations are known to be outdated, incomplete, and not reflective of best technology and best practices for oil and gas exploration and production operations. Both PA and NYS are in the process of revising their regulations.

The Pennsylvania Department of Environmental Protection (PADEP) may complete revisions to Chapter 78 (PADEP's Oil and Gas Well Regulations) in 2011. While PADEP's proposed revisions to Chapter 78 regulations have the potential to be a substantial improvement, they are not yet codified. Even if they were codified, some gaps remain. Chief among these gaps is the absence of an approval process for well construction design to ensure the protection of water resources before a well is drilled and completed.<sup>11</sup>

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<sup>11</sup> Further information on this topic can be found in the 2010 HCLLC report on Recommendations for Pennsylvania's Proposed Changes to Oil and Gas Well Construction Regulations, as well as the 2010 HCLLC report on the Delaware River Basin Commission (DRBC) Consolidated Administrative Hearing on Grandfathered Exploration Wells. These reports contain regulatory improvement recommendations.

NYS is still in the process of completing an environmental review for new shale gas development. It has not yet determined whether it will develop updated regulations or rely on the permitting process to control exploration and production activity. It is not clear when the environmental review will be completed. However, it is unlikely that it will be completed before the end of 2011. If NYS proceeds to adopt updated regulations, the earliest these regulations will likely be implemented is late 2012. NYS agencies and industry experts agree that current NYS shale gas development regulations need substantial improvements; the extent of improvements will not be known until the environmental review is complete.<sup>12</sup>

Neither NYS nor PA regulations require well casing and cementing plans to be submitted, reviewed, and approved as part of a well permit application. Therefore, host states do not have an opportunity to intervene in and stop poor practices before work commences. Current regulations only require the submission of an after-the-fact well completion report that documents problems encountered while drilling. Well design flaws or improperly designed and executed hydraulic fracture jobs can be difficult, and in some cases impossible, to remedy after the fact. This problem will not be resolved in the proposed PADEP Part 78 revisions. It is unknown how NYS will handle this issue in its regulatory revision process. The lack of review by host states of drilling and completion applications should be of concern to DRBC.

Absent a state review of well plans, DRBC has no assurance that wells drilled in the Delaware River Watershed will be constructed and completed to a standard protective of the watershed. DRBC will not be able to ensure that an effective drinking water barrier is in place before high-volume fracture treatments are performed. Therefore, DRBC should supplement host state regulations with a requirement that well casing and cementing plans be submitted, reviewed, and approved by DRBC.

DRBC should not only evaluate whether a PA or NYS regulation exists; it should also examine whether it is implemented and enforced in practice. There are some host state regulations on the books that as currently administered by the state do not adequately protect the Delaware River Basin. For example, Preparedness, Prevention and Contingency Plans (PPCs) are required by some host states to provide additional watershed protection; however, in practice, they do not adequately identify environmentally sensitive areas and do not include sufficient tactics and strategies to protect those areas. Furthermore, PA and NYS contingency plans do not require a well control plan, a written well control barrier policy, a well blowout response plan, or contracts with well control experts. The administration of PA and NYS contingency plans stands in sharp contrast to practices in other state and federal agencies, which do require response plans to deal with a worst-case blowout scenario.<sup>13</sup>

DRBC should wait for the promulgation of new host state regulations before finalizing its own regulations, so that it knows what additional protections are needed for the Delaware River Watershed. Alternatively, DRBC's Proposed Regulations should be expanded to address known deficiencies in existing host state regulations.

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<sup>12</sup> Further information on this topic can be found in the 2009 HCLLC report on New York State (NYS) Casing Regulation Recommendations, as well as the 2009 HCLLC report on the Draft Supplemental Generic Environmental Impact Statement On the Oil, Gas & Solution Mining Regulatory Program Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs, Review of DSGEIS and Identification of Best Technology and Best Practice Recommendations.

<sup>13</sup> The 2010 HCLLC Report on the Delaware River Basin Commission (DRBC) Consolidated Administrative Hearing on Grandfathered Exploration Wells contains more information and background on host state regulatory gaps that leave the Delaware River Watershed at risk.

## **2.2 Justification Needed to Support DRBC's Position That Host State Well Construction and Operation Regulations are Sufficient**

DRBC has not justified its decision to rely solely on host state well construction and operation regulations. DRBC should be required to justify its heavy reliance on state standards, and its decision not to adopt any new well construction and operation regulations.

DRBC should provide a detailed analysis showing how PA and NYS regulations are protective of the Delaware River Watershed, or identify where gaps exist that need to be filled with new regulations. This analysis could be provided in the form of a table that lists each well construction and operation standard necessary to protect the Delaware River Watershed, along with an explanation of how each standard is, or is not, currently addressed by state regulation. The table should clearly identify regulatory gaps and indicate whether it is anticipated that host states will adopt new regulations to close those gaps. The date those new regulations are expected to be in place should be included in the table. DRBC should use this analysis to determine whether additional DRBC regulations are needed to address shortfalls in state standards.

If DRBC waits for PA and NYS to upgrade their regulations before implementing its own regulations, DRBC should complete an analysis of the final, codified versions of host state regulations. This analysis should ensure that host state regulations protect the Delaware River Basin. This analysis should be provided for public review.

If DRBC does not wait for PA and NYS standards to be upgraded, it must improve its regulations to address the shortfalls in the current state regulations.

## **2.3 Reliance on PADEP and NYSDEC Inspection and Enforcement**

DRBC's Proposed Regulations assume that host states have sufficient resources to adequately administer exploration and production activity in the Delaware River Basin; however, there is no information provided to support this assumption. New hydrocarbon exploration and production operations in the Delaware River Watershed will put an additional strain on already taxed host state permitting, inspection, compliance, and enforcement staff.

DRBC should examine whether host states will realistically have sufficient resources to manage this new activity, or whether DRBC needs to expand its regulations and staffing to address projected gaps and shortfalls. To demonstrate the adequacy of host state resources, DRBC should provide information on the number of state inspection and enforcement personnel who will be assigned to oversee Delaware River Watershed exploration and production activities. DRBC should also provide information on the amount of state funding for this work.

### **Recommendation Summary:**

- 5.** DRBC should wait for the promulgation of new host state regulations before finalizing its own regulations, so that it knows what additional protections are needed for the Delaware River Watershed. Alternatively, DRBC's Proposed Regulations should be expanded to address known deficiencies in existing host state regulations.
- 6.** DRBC should be required to justify its heavy reliance on host state regulations. DRBC should provide a detailed analysis showing how PA and NYS regulations are protective of the Delaware River Watershed, or where gaps exist that need to be filled by new regulations.

7. DRBC should not only evaluate whether a host state regulation exists, but also whether it is implemented and enforced in practice.
8. DRBC should demonstrate that there are adequate host state permitting, inspection, and enforcement resources to administer exploration and production activity in the Delaware River Basin; or DRBC should create additional regulations and provide additional resources to meet this need. There is ample information to show that host state regulations are not currently adequate.
9. DRBC should provide a table showing the amount of state inspection and enforcement personnel that will be assigned to the oversee Delaware River Watershed exploration and production activities. DRBC should also provide information on the amount of state funding for this work.

### 3. Review Thresholds

#### 3.1 No Review Threshold for Exploration

DRBC's Proposed Regulations do not contain any requirements for seismic exploration and include very few limitations on exploratory drilling operations. DRBC's regulations only propose significant review requirements when natural gas operations meet a 3,200 acre or 5 well pad threshold. DRBC should set more stringent review and approval requirements for seismic exploration and exploration drilling operations.

#### 3.2 Review Threshold for Production Operations are Too High

DRBC's Proposed Regulations exempt large numbers of exploration and production wells from DRBC review. For example, if gas wells are drilled on an 80 acre spacing, and a 3,200 acre NGDP review threshold is allowed, 40 wells can be drilled before triggering the review threshold. Or, if multiple high-angle wells are drilled from a single well pad (e.g. 4-6 wells per pad), then the 5 pad review threshold could result in 20-30 wells before triggering the review threshold; higher well density pads with 10-12 wells per pad could result in 50-60 wells before triggering the review threshold.

DRBC has not provided scientific or technical information to show why hydrocarbon exploration and production operations smaller than 3,200 acres or 5 well pads will not impact the Delaware River Watershed.

Gas reservoirs are often produced on 160-640 acre spacing; however, some areas of the Marcellus and Barnett shales are being drilled much tighter (40-80 acre spacing, and potentially as low as 20 acre spacing).

The Pennsylvania Oil and Gas Conservation Law does not apply to formations that do not penetrate the Onondaga horizon or to formations that are less than 3,800', where the Onondaga horizon is 3800' or less from the surface. Since the Marcellus Shale is shallower than the Onondaga horizon,<sup>14</sup> as shown in the diagram to the right, the Pennsylvania Oil and Gas Conservation Law does not apply to the Marcellus Shale. Since the Pennsylvania Oil and Gas Conservation Law does not apply to the Marcellus Shale,

<sup>14</sup> Milici, R. and Swezey, C, Assessment of Appalachian Basin Oil and Gas Resources: Devonian Shale–Middle and Upper Paleozoic Total Petroleum System, Open-File Report Series 2006-1237, United States Geological Survey, 2006.

Marcellus Shale development is not subject to Section 4 of the law, which deals with prohibition of waste,<sup>15</sup> inefficient spacing of wells,<sup>16</sup> and unitization requirements.<sup>17</sup> This means that host state laws and regulations do not provide adequate protection against the potential for very high well densities in the Delaware River Watershed.

In NYS, the statewide gas well spacing rules<sup>18</sup> were extended to the Marcellus Shale, meaning that gas shale wells are typically drilled on 40-160 acre spacing. However, an operator can apply for a spacing exemption to drill in-fill wells on a tighter well spacing, meaning the well density in the Delaware River Basin could be between 20-160 acres.

DRBC’s own experts explain the potential for large scale impacts to the Delaware River Watershed:

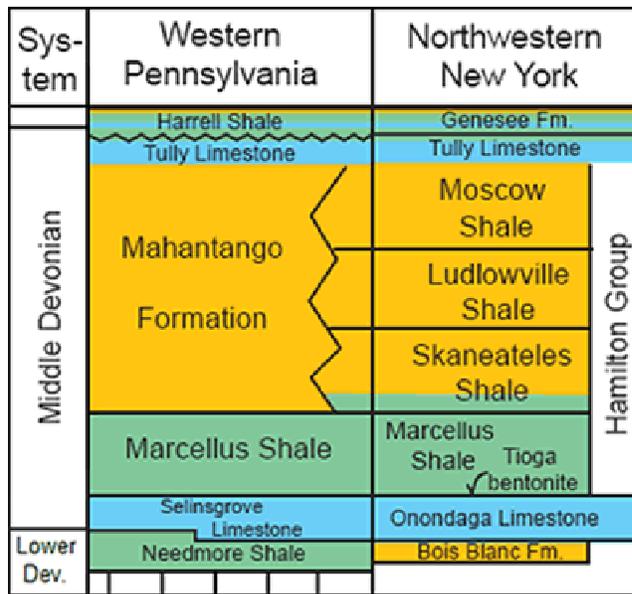
*“The Marcellus Shale formation in northeastern Pennsylvania and southern New York underlies about 5,000 square miles or one-third of the 13,500 square-mile Delaware River Basin.” . . . “Over 15 million people (approximately five percent of the nation’s population) rely on the waters of the Delaware Basin for drinking, agricultural, energy and industrial use, but the watershed drains only four-tenths of one percent of the total continental U.S. land area.*

*The 5,000 square-mile area common to the Marcellus Shale and the Delaware River Basin includes a 73.4-mile stretch of the Upper Delaware Scenic and Recreational River, which snakes gracefully through the rural countryside of green rolling hills (Figure 2). Within this same area, the Marcellus Shale includes some of the most promising sections in terms of the thickness of organic-rich shale.”<sup>19</sup>*

It is estimated that a total of 16,000-64,000 wells could be drilled in the Delaware River Basin. This estimate was developed using the planning assumption put forth by DRBC’s expert O’Dell.<sup>20</sup>

O’Dell assumed for planning purposes that:

- 80% of the 5,000 square mile Marcellus Shale formation underlying the Delaware River Basin will be developed (4,000 square miles);
- wells will be initially drilled on an 160 acre spacing (4 wells per square mile); and
- later infill drilling will likely cause a well spacing density of 40 acres (16 wells per square mile).



<sup>15</sup> Including allowing oil, gas or water to migrate to a different stratum, or unnecessary loss of oil or gas at the surface.

<sup>16</sup> Drilling more wells than are required to efficiently and economically recover the maximum amount of oil and/or gas from a pool (formation).

<sup>17</sup> Pifer, R.H., Penn State, The Dickinson School of Law, The Rule of Capture in Pennsylvania Oil and Gas Law, 2009.

<sup>18</sup> New York State, Oil, Gas and Solution Mining Law, Title 5.

<sup>19</sup> DRBC Expert Report prepared in the in the Matter of Delaware River Basin Commission Consolidated Adjudicatory Hearing on Natural Gas Exploratory Wells, by O’Dell, P.M., Potential for Development of Natural Gas Exploratory Wells to Adversely Affect Water Resources of the Delaware River Basin, National Park Service Geologic Resources Division, November 23, 2010.

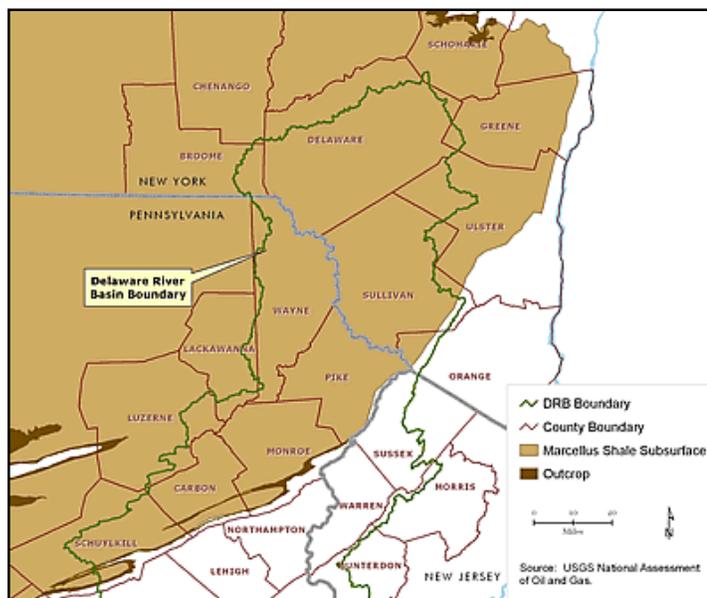
<sup>20</sup> Id.

Using a range of well spacing (40-160 acres), a total of 16,000-64,000 wells could be drilled in the Delaware River Basin.

Assuming an average of six (6) horizontal wells drilled from a single drillsite, between 2,700 and 10,700 new drillsites could be developed in the Delaware River Basin. The number of new drillsites could be substantially higher if multiple wells are not co-located on a drillsite.

While DRBC assumes that multiple wells will be directionally drilled from each drillsite, there is no requirement for operators to use this technique. This opens up the possibility of single well drillsites, and in turn a much more significant surface impact.

DRBC regulations should limit well density in the Delaware River Watershed and require operators to co-locate multiple wells<sup>21</sup> on a single drillsite.



#### Recommendation Summary:

10. More stringent review and approval requirements should be established for seismic exploration and exploration drilling operations.
11. Lower review thresholds should be set for Natural Gas Development Plan (NGDP) review.
12. Well density limits should be set to protect the Delaware River Watershed.
13. DRBC regulations should require operators to co-locate multiple wells on a single drillsite to minimize surface impacts and reduce the environmental footprint.

## 4. Subsurface Water Impacts

### 4.1 Host State Subsurface Water Protections are Inadequate<sup>22</sup>

DRBC's Proposed Regulations primarily address water withdrawals and waste production at the surface, and assume other potential pollutant pathways will be adequately handled by host states. DRBC assumes that host state regulations, inspections, and enforcement regimes adequately handle: underground transportation of pollution (e.g. stray gas migration and underground movement of fluids); surface oil,

<sup>21</sup> Multiple wells can be located on a single surface drill-site by directionally drilling wells into more distant subsurface hydrocarbon intervals.

<sup>22</sup> For more information, please refer to Dr. Tom Myers Report, Review and Analysis of DRAFT Supplemental Generic Environmental Impact Statement On The Oil, Gas and Solution Mining Regulatory Program Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs report prepared for Natural Resources Defense Council, December 28, 2009.

chemical and fuel spills; and well control issues. However, host state regulations do not currently address subsurface water impacts in a manner that will protect the Delaware River Watershed.<sup>23</sup>

While DRBC's Proposed Regulations at Section 7.5 (h)(2)(ii)(F) do include some additional subsurface monitoring to identify impact areas, the proposed regulations do not establish any limits on chemical use. Furthermore, DRBC proposes no regulations to govern well construction, or to require technologies and tactics that would prevent subsurface water contamination from occurring.

Rather than setting limits on chemical use, DRBC's Proposed Regulations at Section 7.5 (h)(2)(ii)(D) deem it acceptable to rely solely on after-the-fact reporting of chemical use, combined with groundwater monitoring. DRBC should set chemical use limits to *prevent* the introduction of harmful chemicals into the environment. These limits should be implemented in combination with long-term monitoring programs that track the fate and effect of subsurface chemical transport.<sup>24</sup>

#### 4.2 Monitoring Requirements

DRBC's Proposed Regulations at Section 7.5 (h)(2)(i)(A)(1) require groundwater and surface monitoring at a 2,000' radius threshold; the proposed regulations provide no justification for this distance. This distance should be scientifically justified.

DRBC's Proposed Regulations require groundwater and surface monitoring pre- and post-development, but they do not require the applicant to provide a list of chemicals for approval prior to use. The list of chemicals provided for approval should include the chemicals' formulas and information on the compounds in the chemicals. Absent that list, it is not possible to conduct baseline monitoring to determine whether those chemicals existed in the environment prior to development. Determining whether those chemicals existed prior to development is necessary for determining whether pollution has occurred.

#### 4.3 Gas Composition Testing

DRBC's regulations should, but currently do not, include gas composition testing. If gas is found in a water well, it is often necessary to know the gas and water composition from nearby formations to determine whether gas and associated fluids have migrated from a hydrocarbon reservoir. At present, this information is not generally available to those who are investigating problem water wells, even though individual companies may have the information.

To ensure that there is sufficient information to identify the source of gas found in a water well, a reference well system must be established to document gas and water composition. The composition of gas (the relative volume of methane and higher hydrocarbons), the isotopic characteristics of the gas, and any associated fluids should be analyzed. The resulting information should be stored in a publicly accessible database.

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<sup>23</sup> Further information on this topic can be found in Paul A. Rubin's, HydroQuest, Report for the Delaware River Basin Commission Consolidated Administrative Hearing on Grandfathered Exploration Wells To Delaware Riverkeeper Network and Damascus Citizens for Sustainability, November 15, 2010.

<sup>24</sup> For more information, please refer to Dr. Ronald Bishop's Report, Chemical and Biological Hazards Posed by Drilling Exploratory Shale Gas Wells in Pennsylvania's Delaware River Basin, Report for the Delaware River Basin Commission Exploratory Well Hearing to Delaware Riverkeeper Network and Damascus Citizens for Sustainability, November 16, 2010.

**Recommendation Summary:**

14. Establish pollution prevention standards to protect subsurface water.
15. Set chemical use limits to *prevent* the introduction of harmful chemicals into the environment. These limits should be implemented in combination with long-term monitoring programs that track the fate and effect of subsurface chemical transport.
16. Require an applicant to provide a list of chemicals, including the amount and concentration of each chemical, for approval prior to use in any part of the exploration and production process.
17. DRBC should provide scientific justification for the proposed 2,000' groundwater and surface water monitoring radius.
18. Require gas composition testing to ensure that there is sufficient information to identify the source of gas found in water. The composition and isotopic characteristics of the gas, and any associated fluids from each zone developed in the Delaware River Watershed should be analyzed. The collected information should be stored in a publicly accessible database.

## 5. Water Management and Wastewater Handling Plans

### 5.1 Water Management Plans

DRBC's regulations should require operators to submit Water Management Plans for DRBC review and approval. PADEP has inconsistently required Water Management Plans for the exploration wells that have already been drilled in the Delaware River Basin (e.g. wells examined under the DRBC 2010 consolidated hearing).<sup>25</sup>

### 5.2 Wastewater Handling Plans - "Zero Discharge" Goal

DRBC's regulations should require operators to achieve a zero (or as near to zero as possible) solid and liquid waste discharge goal into the Delaware River Basin Special Use Area. The use of closed loop tank systems, instead of reserve pits and impoundments, is best practice.

DRBC's regulations should prohibit the use of drilling mud reserve pits and onsite drilling waste burial. Drilling waste can harm the environment if not properly managed. In the Delaware River Basin, some drilling waste has already been buried onsite, instead of being transported out of the basin. PA and NYS allow the use of reserve pits, onsite waste burial, and road spreading (in some cases); therefore, DRBC will need to specify in regulations that these practices will not be allowed in the Delaware River Basin.

DRBC's Proposed Regulations at 7.5(h)(1)(iv)(A)(1-4) prohibit waste disposal in the Delaware River Basin, requiring all non-domestic wastewater to be disposed of at an approved facility. However, DRBC's Proposed Regulations at 7.5(h)(1)(iv)(A)(5) appear to negate that prohibition by allowing DRBC to waive this requirement if DRBC and the host state approve waste discharge to groundwater and/or surface water. DRBC does not provide criteria for what conditions would prompt a waiver. No waste discharge waivers should be granted.

<sup>25</sup> More information on this problem and regulatory improvement recommendations can be found in the 2010 HCLLC report on the Delaware River Basin Commission (DRBC) Consolidated Administrative Hearing on Grandfathered Exploration Wells.

DRBC's Proposed Regulations at Section 7.1 (e)(4) allow for "approved" discharges from natural gas operations to be returned to rivers. The type of "approved" discharges is not specified. Best management practice is to have no discharge ("zero discharge") to rivers.

### 5.3 Drill Cuttings and Drilling Fluids

DRBC's Proposed Regulations at Section 7.5 (h)(2)(iii) only cover drill cutting and drill fluid waste handling requirements for "horizontal" wells in the "target" formation; the proposed regulations ignore the fact that drill cuttings and fluids used in the well above the "target" formation can be harmful to the environment if improperly handled (they can contain Naturally Occurring Radioactive Materials (NORM), heavy metals, and/or other chemical additives). DRBC's Proposed Regulations should include drill cutting and drill fluid waste handling requirements for the entire well, not just select intervals.

### 5.4 NORM and Heavy Metal Pollution

DRBC's regulations should include special handling, treatment, and disposal requirements for drilling waste and equipment that contains Naturally Occurring Radioactive Material (NORM), mercury, cadmium, and/or other heavy metals. The Marcellus is considered "highly radioactive" shale.<sup>26</sup>

### 5.5 Preparedness, Prevention and Contingency (PPC) Plans

DRBC's regulations should include requirements for Preparedness, Prevention and Contingency (PPC) plans; these plans ensure that hydrocarbon and chemicals spills are prevented or responded to effectively. PADEP<sup>27</sup> requires a PPC to include: maps showing well site layout, boundaries, storage locations, high risk areas, drainage, and topography; information on the location of stored chemicals at a well site; drawings and plot plans showing sources and quantities of materials and wastes; specific countermeasures to be taken in the event of a spill, including strategies and tactics for preventing a spill from reaching water sources or environmentally sensitive areas; inspection and monitoring programs; security plans; and external factor planning. However, in practice, many PPCs in Pennsylvania do not actually include these components.<sup>28</sup> DRBC should have a parallel requirement to ensure these components are being disclosed before any drilling in the watershed is permitted to proceed.

#### **Recommendation Summary:**

19. Require operators to submit Water Management Plans for DRBC review and approval.
20. Require operators to achieve a zero (or as near to zero as possible) solid and liquid waste discharge goal in the Delaware River Basin Special Use Area. The use of closed loop tank systems, instead of reserve pits and impoundments, is best practice.
21. Prohibit the use of drilling mud reserve pits and onsite drilling waste burial. Best waste management practices in other states do not allow onsite burial of drilling waste. PA and NYS allow the use of reserve pits, onsite waste burial, and road spreading (in some cases); therefore, DRBC needs to specify in regulations that these practices will not be allowed in the Delaware River Basin.

<sup>26</sup> Hill, D.G., Lombardi, T.E. and Martin, J.P., "Fractured Shale Gas Potential in New York." *Northeastern Geology And Environmental Sciences*, 2004, Vol. 26. p. 8.

<sup>27</sup> PPC Guidance Document 400-220-001

<sup>28</sup> More information on this problem and regulatory improvement recommendations can be found in the 2010 HCLLC Report on the Delaware River Basin Commission (DRBC) Consolidated Administrative Hearing on Grandfathered Exploration Wells.

22. Eliminate waste disposal waivers at Section 7.5(h)(1)(iv)(A)(5) and 7.1(e)(4) that allow waste to be discharged into the Delaware River Basin.
23. Include drill cutting and drill fluid waste handling requirements for all drill cuttings and fluids from the entire well, not just select intervals.
24. Include special handling, treatment, and disposal requirements for drilling waste and equipment that contains Naturally Occurring Radioactive Material (NORM), mercury, cadmium, and/or other heavy metals.
25. Include PPC plan requirements to ensure that hydrocarbon and chemicals spills are prevented or responded to effectively.

## 6. Use of Best Technology and Best Management Practices

DRBC's regulations should be improved to require the use of best available technology (BAT) and best management practices (BMPs). More specifically, DRBC's Proposed Regulations at Section 7.1 (e)(3) should be revised to require that decision making be based on scientific principles, the use of BMPs and the use of BAT. DRBC's Proposed Regulations currently include requirements for BMPs, but not for BAT. State and federal regulations typically specify both best management and best technology requirements. In this way, regulations will achieve continuous improvement as new BAT and BMPs are developed over time.

BAT and BMPs have been addressed throughout Sections 1-5 above. Section 6 captures additional BAT and BMPs that should be included in DRBC's regulations; these BAT and BMPs are not currently mandated by host state regulations.

### 6.1 Cement Evaluation Tools

DRBC's regulations should require more stringent cement integrity evaluation than what exists in NYSDEC and PADEP regulations. Even the host states' proposed regulations for validating cement integrity are not sufficiently stringent to protect groundwater resources.<sup>29</sup> Existing host state regulations provide the well operator broad discretion to determine whether a cement job is adequate, and do not require a Cement Evaluation Tool (CET) or Cement Bond Log (CBL) to be run to verify cement integrity.<sup>30</sup>

### 6.2 Directional Drilling and Consolidated Drillsites

DRBC's regulations should require operators to co-locate multiple wells<sup>31</sup> on a single drillsite to minimize surface impacts and reduce the environmental footprint. While DRBC anticipates that some operators will use directional drilling and co-locate wells, DRBC regulations do not require this practice.

<sup>29</sup> The Deepwater Horizon Commission Report, January 2011 found that industry has not and will not propose more extensive cement evaluation because of the incremental costs, despite well-known cement integrity challenges and risks.

<sup>30</sup> Please see attached HCLLC reports for further explanation on the importance of cement evaluation in protecting freshwater resources.

<sup>31</sup> Multiple wells can be located on a single surface drillsite by directionally drilling wells from that single drillsite into more distant subsurface hydrocarbon intervals.

The absence of regulations requiring wells to be co-located could result in single well drillsites, increasing surface impacts.

### **6.3 Well Blowout Control**

DRBC's regulations should include a requirement for operators to demonstrate that blowout control equipment is in place and/or a minimum of two well control barriers are in place. This requirement should also ensure that there is trained and qualified staff to install and operate blowout control equipment and/or well control barriers.<sup>32</sup>

### **6.4 Well Blowout Response<sup>33</sup>**

On average, a blowout occurs in 7 out of every 1,000 on shore exploration wells.<sup>34</sup> DRBC's regulations should require a well blowout response plan, a contract retainer with an emergency well control expert, and memorandums of understanding with nearby operators for mutual response aid. Regulations should also require the identification of and access to well capping equipment and a drilling rig capable of drilling a relief well in a timely manner.

Well control methods (e.g. well capping) can require very large volumes of water (500,000 to 6,000,000 gallons per day). The impact of this water use is not addressed in DRBC's Proposed Regulations.

### **6.5 Environmentally Sensitive Area Protection**

Host states' regulations require oil, fuel, and chemical spill prevention and response plans to identify environmentally sensitive areas within the Delaware River Basin. However, in practice, plans have been submitted and approved for drilling in the Delaware River Basin (e.g., grandfathered wells) that do not identify all areas that should be protected during drilling. Furthermore, in practice, these approved plans often lack adequate tactics and strategies for protecting environmentally sensitive areas. Therefore, DRBC must evaluate not only whether a PA or NYS regulation exists, but also whether it is implemented and enforced in practice. DRBC should require plans that protect environmentally sensitive areas from oil, fuel, and chemical spills.

### **6.6 Air Quality Impacts on Water Resources**

DRBC's regulations should include air pollution control requirements to ensure that air pollutants do not adversely impact water resources.<sup>35</sup> Gaseous products from hydrocarbon evaporation and burning can cause atmosphere pollution. Additionally, aerosol particles of unburned fuel can cause atmosphere pollution. Aerosol particles can include nitrogen oxides, sulfur oxides, carbon monoxide, particulate matter, and hazardous air pollutants. These airborne pollutants can interact with atmospheric moisture, transform in the presence of solar radiation, and precipitate onto land and water surfaces, causing both local and regional pollution. Airborne pollutants can also be transported downwind and deposited on land

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<sup>32</sup> US National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling Report, January 12, 2011, concludes that agencies should require two well control barriers and improved BOP equipment, training, and maintenance programs for these important well control devices.

<sup>33</sup> Blowouts can eject drilling mud, gas, oil and/or formation water from the well and onto waters and lands adjacent to the well, within the radius of the blowout plume. Depending on the reservoir pressure, blowout circumstances, and wind speed, these pollutants can be distributed hundreds to thousands of feet away from the well. Pollutants that reach a water system can be carried downstream and contaminate even larger areas. Pollutants that reach land can migrate into groundwater resources.

<sup>34</sup> Rana, S., Environmental Risks- Oil and Gas Operations Reducing Compliance Cost Using Smarter Technologies, Society of Petroleum Engineering Paper 121595-MS, Asia Pacific Health, Safety, Security and Environment Conference, 4-6 August 2009, Jakarta, Indonesia, 2009.

<sup>35</sup> 25 PA Code § 127.14 (38) exempts oil and gas drilling operations from air quality control requirements. This exemption includes shale gas drilling; therefore, air pollution impacts are currently unregulated and unmitigated.

and water surfaces. Potential air pollution impacts to the Delaware River Basin are not well understood or mitigated.

DRBC's regulations should restrict flaring, venting, and fugitive emissions to the lowest technically feasible level. Green completion methods should be required to capture methane emissions, especially where high-volume fracture treatments and well tests are planned. Methane capture, in most cases, is profitable, because methane gas can be used as fuel or sold on the open market. Methane capture has the added benefit of capturing benzene (a known human carcinogen) and other hazardous air pollutants that may be contained in natural gas.

### **6.7 Site-Specific Mitigation Measures**

Regulations should grant DRBC authority to apply site-specific mitigation measures that exceed minimum standards. Site-specific mitigation measures allow DRBC to address unique situations and risks, new technology, and unanticipated circumstances.

### **6.8 Corrosion and Erosion Control**

DRBC's regulations should require that equipment be designed in a way that prevents corrosion and erosion. Regulations should also require monitoring, repair, and replacement programs. Corrosion and erosion, if not adequately addressed, can result in spills and releases to the environment.

### **6.9 Clean Fuels**

DRBC's regulations should require operators to use low emission fuels or electric power whenever technically feasible, rather than diesel. This requirement would reduce the volume of liquid fuels that are stored and transported, thereby reducing the risk of spills that could pollute water resources.

### **6.10 Hydraulic Fracture Design and Monitoring**

DRBC's regulations should require that best technology and best practices be used to model, design, implement, collect data for, and monitor fracture treatments.<sup>36</sup>

### **6.11 Hydraulic Fracture Treatment Additive Limitations**

DRBC's regulations should identify the type, volume, and concentrations of fracture treatment additives that are protective of human health and the environment.<sup>37</sup> DRBC's regulations should require the use of non-toxic materials to the greatest extent possible and should include a list of prohibited additives.<sup>38</sup>

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<sup>36</sup> For more information, please refer to HCLLC's, Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas & Solution Mining Regulatory Program Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs, Review of DSGEIS and Identification of Best Technology and Best Practice Recommendations, report prepared for Natural Resources Defense Council, 2009.

<sup>37</sup> For more information, please refer to Dr. Glenn C. Miller's Report, Review of the DRAFT Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program, Toxicity and Exposure to Substances in Fracturing Fluids and in the Wastewater Associated with the Hydrocarbon-Bearing Shale, report prepared for Natural Resources Defense Council, December 29, 2009.

<sup>38</sup> For more information, please refer to Dr. Glenn C. Miller's Report, Risks Associated with Permitting Exploration Wells in the Delaware River Basin, prepared for the Delaware Riverkeeper Network and Damascus Citizens for Sustainability, November 12, 2010.

## 6.12 Hydraulic Fracture Fluid Flowback Impoundments

DRBC's regulations should require that fracture fluid flowback be routed to onsite treatment systems for fracture fluid recycling and/or collected in tanks for transportation to offsite treatment systems. Surface impoundments should not be used for fracture fluid flowback.<sup>39</sup>

## 6.13 Chemical Tank Containment

DRBC should adopt regulations requiring secondary containment or the use of double-wall tanks. DRBC's regulations should require best management practices for chemicals stored on a well pad.

## 6.14 Expert Technical Review for New Technology and Waivers

New technology and procedures used by industry and approved by government officials should be subject to rigorous technical review and risk assessment. The use of new technology and procedures can have catastrophic consequences if not properly engineered, tested, and approved in advance. New technology and procedures must receive proper technical vetting.

### Recommendation Summary:

26. Require more stringent cement integrity evaluation than what exists in NYSDEC and PADEP regulations, including the use of Cement Bond Log (CBL) or Cement Evaluation Tool (CET).
27. Require a well blowout response plan, a contract retainer with an emergency well control expert, and memorandums of understanding with nearby operators for mutual response aid.
28. Require identification of and access to well capping equipment and a drilling rig capable of drilling a relief well in a timely manner.
29. Require plans to protect environmentally sensitive areas from oil, fuel, and chemical spills.
30. Include air pollution control requirements in regulations to ensure that air pollutants do not adversely impact water resources.
31. DRBC's regulations should provide DRBC with the authority to apply site-specific mitigation measures that exceed minimum standards.
32. Require that equipment be designed to prevent corrosion and erosion. Require monitoring, repair, and replacement programs.
33. Require that operators use the lowest emission energy sources for exploration and development activities.
34. Require that best technology and best practices be used to model, design, implement, collect data for, and monitor fracture treatments, and that the data be made publically available.

<sup>39</sup> For more information, please refer to HCLLC's, Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas & Solution Mining Regulatory Program Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs, Review of DSGEIS and Identification of Best Technology and Best Practice Recommendations, report prepared for Natural Resources Defense Council, 2009.

35. DRBC's regulations should identify the type, volume, and concentrations of fracture treatment additives that are protective of human health and the environment. DRBC's regulations should require the use of non-toxic materials to the greatest extent possible and should include a list of prohibited additives.
36. Require that fracture fluid flowback be routed to onsite treatment systems designed and permitted to meet specific water quality standards for fracture fluid recycling and/or collected in closed tanks for transportation to offsite treatment systems.
37. Require secondary containment and/or the use of double-wall tanks and the employment of best management practices for chemicals stored on a well pad.
38. Include a process whereby new technology and procedures used by industry and approved by government officials are subject to rigorous technical review or risk assessment.

## 7. Setback Requirements and Areas Off-Limits to E&P Operations

### 7.1 Setbacks

Surface siting criteria do not provide sufficient setbacks from sensitive water resources in the Delaware River Basin. DRBC's Proposed Regulations at Section 7.5 (b) allow natural gas operations to occur within 200'-500' of homes, public facilities, drinking water wells, and water bodies. DRBC does not provide justification for this setback distance.

Blowouts can eject drilling mud, gas, oil, and/or formation water from a well onto adjacent waters and lands. Depending on reservoir pressure, blowout circumstances, and wind speed, these pollutants can be distributed hundreds to thousands of feet away from a well. These pollutants can then be further transported in the subsurface or on the surface, creating a large area of contamination in a very short amount of time.

DRBC should provide a scientific justification for the setback distance it has selected, or DRBC should consider adopting larger setback requirements to protect the unique resources of the Delaware River Watershed. DRBC's analysis should take into account that directional drilling technology enables wells to be drilled to a bottom-hole location 3-5 miles<sup>40</sup> away from a wellhead. Therefore, directional drilling technology gives operators a greater ability to produce oil and gas while maintaining distance from public, private, and sensitive resources.

### 7.2 Setbacks Waivers

DRBC's Proposed Regulations at Section 7.5 (b)(9) allow the Executive Director of DRBC to grant variances that further reduce setback requirements, if it is deemed that a setback requirement creates an "undue burden" for the project sponsor. DRBC does not establish criteria for determining what constitutes an "undue burden." DRBC allows the Executive Director to hold a public hearing on setback waivers, but does not require one. The setback requirement in DRBC's Proposed Regulations is already unacceptably small. No waivers for this setback requirement should be granted. At a minimum, criteria for granting waivers should be established and a public hearing on waivers should be required.

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<sup>40</sup> Well step-out distance that can be achieved will depend on well depth.

### 7.3 Prohibited Exploration and Development Areas

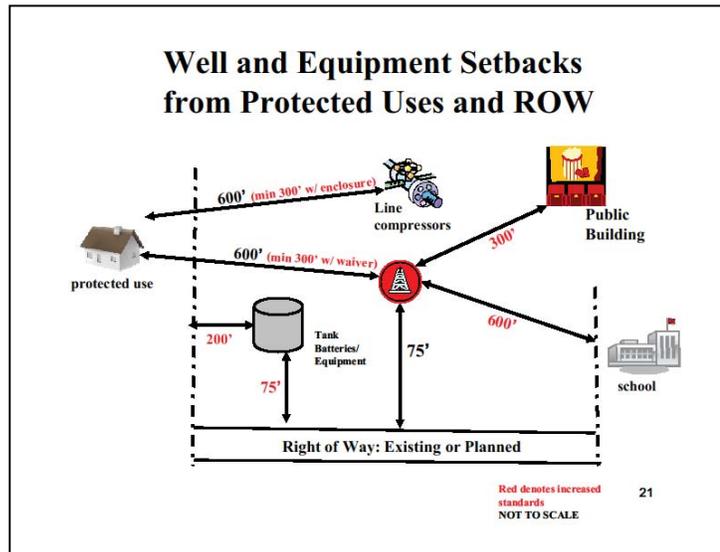
DRBC’s Proposed Regulations do not identify areas within the Delaware River Watershed that warrant special protection. DRBC’s regulations should include a map identifying areas within the Delaware River Watershed that warrant increased setbacks, seasonal operation constraints, and/or surface use prohibitions.

In Alaska, along the famous Kenai River, surface entry of oil and gas wells and the siting of related facilities are strictly prohibited on lessee tracts along the river (Kenai River Special Management Area). Surface entry of oil and gas wells and the siting of related facilities are also prohibited on state game refuges, critical habitat areas, and recreational use areas in Alaska’s Cook Inlet.<sup>41</sup> Additionally, exploration and production operations are generally prohibited within half a mile of the coastline, major rivers, and areas that receive heavy recreational use. Furthermore, exploration and production operations often are required to minimize sight and sound impacts by providing natural buffers to conceal facilities and limiting drilling activities to low use seasons.<sup>42</sup>

On the Alaska Peninsula, oil and gas facilities are prohibited within a half mile of: the coast; barrier islands; reefs and lagoons; and major river systems. Oil and gas facilities must be setback 1,500’ from all surface drinking water resources. A reduction in these setbacks is only allowed if the lessee makes a technical and scientific justification showing that the buffer is not feasible and prudent, and a different setback is environmentally preferred. No oil and gas wells or facilities are allowed at all within the Bristol Bay Fisheries Reserve.<sup>43</sup>

These Alaska examples illustrate that in other states water resources, critical habitat areas, and recreational use areas are provided substantial protections from oil and gas development. Alaska leans heavily of the use of directional drilling technology to position surface drillsites in low impact locations.

Another relevant comparison is the setback requirements implemented in the urban area of Fort Worth, Texas. Even in the urban area of Fort Worth, well and equipment setbacks (300-600’) are larger than DRBC’s proposal of 200’-500’. Fort Worth’s setback requirements are shown in the diagram to the right.<sup>44</sup>



<sup>41</sup> Alaska Department of Natural Resources, Division of Oil and Gas, Cook Inlet Areawide Oil and Gas Lease Sale, Final Finding of the Director, Volume I, January 20, 1999.

<sup>42</sup> Alaska Department of Natural Resources, Division of Oil and Gas, Cook Inlet Areawide Oil and Gas Lease Sale, Final Finding of the Director, Volume I, January 20, 1999.

<sup>43</sup> Alaska Department of Natural Resources, Division of Oil and Gas, Alaska Peninsula Areawide Oil and Gas Lease Sale, Final Finding of the Director, July 25, 2005.

<sup>44</sup> Fort Worth Gas Drilling Regulations Presentation, Barnett Shale EXPO, March 11, 2009.

**Recommendation Summary:**

39. DRBC should provide a scientific justification for the setback distance it has selected, or DRBC should consider adopting larger setback requirements to protect the unique resources of the Delaware River Watershed.
40. Setback requirements should be codified at appropriate distances, and no waivers should be granted.
41. DRBC's regulations should include a map identifying areas within the Delaware River Watershed that warrant increased setbacks, seasonal operation constraints, and surface use prohibitions.

## 8. Financial Assurance

### 8.1 Increase Financial Assurance Amount

DRBC's regulations propose a financial assurance of \$125K per well; yet, the potential human health and environmental impacts far exceed this amount of liability. Private citizens typically carry more insurance on their family car. Yet, the risk profile for a family car is substantially lower than the risk profile for a Delaware River Basin well.

### 8.2 Basis for Financial Assurance Amount

DRBC has not provided a basis or justification for its proposed \$125K financial assurance amount. DRBC should complete a risk assessment of hydrocarbon exploration and development in the Delaware River Watershed. The risk assessment should include worst-case scenario impact models. The risk assessment should be used to set a higher financial assurance requirement.

### 8.3 Financial Assurance Reduction

DRBC's Proposed Regulations include opportunities to reduce or waive the financial assurance requirement. Section 7.3(k)(8) allows DRBC's Executive Director to reduce the financial assurance requirement by 25%. Section 7.3 (k)(15) allows a project sponsor to reduce the amount of financial assurance by 75%. There is no provision for DRBC's Executive Director to increase<sup>45</sup> the financial assurance requirement to address project specific risks.

Section 7.3 (k)(15) allows a project sponsor to reduce the amount of financial assurance by 75% if DRBC's Executive Director determines that: a well has been drilled and successfully cased; fracing plans are complete; one year has passed since drilling and the completion of fracing operations; and no harm to water resources is alleged. DRBC's Proposed Regulations do not provide review criteria for DRBC's Executive Director to determine that the stipulations for reducing the financial assurance amount have been met. Technical review and approval criteria must be set for DRBC's Executive Director to determine that a reduction in the financial assurance amount is appropriate, and that in doing so, environmental resources and public health are still protected to the maximum extent possible.

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<sup>45</sup>Section 7.3(k)(8) only provides for DRBC to increase the financial assurance amount to adjust for inflation, after public notice and a hearing.

## 8.4 Financial Assurance Release

Section 7.3 (k)(17) of DRBC's Proposed Regulations provides a release from the financial assurance obligation two years after final restoration has been completed. This approach does not provide financial protection for long-term impacts, such as subsurface pollutant pathways (e.g. stray gas or subsurface chemical transport). Financial assurance releases should not be granted within two years of project termination, because subsurface pollutant transport may take many years.<sup>46</sup>

## 8.5 Expand Financial Assurance Amount to Address Oil Exploration and Production Risk

There is no financial assurance requirement for oil wells in the Delaware River Basin. The financial assurance requirements in DRBC's Proposed Regulations at Section 7.3(k) are limited to gas wells. DRBC does not provide justification for imposing financial assurance requirements for natural gas wells, while not requiring financial assurance for liquid hydrocarbon exploration and development. Liquid hydrocarbon exploration and development can also pose significant risks to a watershed, including the risk of a well blowout or contamination from oil processing and transport.

### Recommendation Summary:

42. Financial assurance requirements should be increased to address worst-case risk exposure.
43. A risk assessment of hydrocarbon exploration and development in the Delaware River Watershed should be completed. The risk assessment should include worst-case scenario impact models. The risk assessment should be used to set a higher financial assurance requirement.
44. Technical review and approval criteria must be set for DRBC's Executive Director to determine that a reduction in the financial assurance amount is appropriate.
45. Financial assurance releases should not be granted within just two years of project termination, because subsurface pollutant transport may take many years.
46. Financial assurance requirements should be expanded to address the risks from oil wells and hydrocarbon liquid development (oil and condensate).

## 9. Public Notification and Access

### 9.1 Public Notification

DRBC's Proposed Regulations require notification to property owners that a project will be occurring within 2,000'. DRBC has not justified its selection of a 2,000' notification threshold. The notification threshold should be defined by parameters that take into account the radius of visual, noise, blowout trajectory, and groundwater impacts.

<sup>46</sup> For more information on the time period for subsurface pollutant transport, please refer to Dr. Tom Myers Report, Review and Analysis of DRAFT Supplemental Generic Environmental Impact Statement On The Oil, Gas and Solution Mining Regulatory Program Well Permit Issuance for Horizontal Drilling and High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs, report prepared for Natural Resources Defense Council, December 28, 2009.

## 9.2 Public Access to Data

DRBC's Proposed Regulations do not allow for sufficient public access to data and findings on inspection, compliance, and enforcement issues (Sections 7.3 (m) and (n)). Members of the public are often frustrated by their inability to obtain information on nearby projects that may affect their health and welfare. Public notification should not be limited to the fact that a project is occurring; it should also include notifications of violations and enforcement actions. Sections 7.3 (m) and (n) should include a public information process whereby affected members of the public are provided access to sample data, compliance resolution updates, and final enforcement action requirements.

## 9.3 Waiver Authority

DRBC's Proposed Regulations allow for various types of waivers to be issued without public review and appeal opportunities. In some cases, the option to issue waivers should be removed from DRBC's regulations entirely. In other cases, the issuance of waivers should require a high level of justification and should include a public review process.

### Recommendation Summary:

47. All members of the public who are directly affected by exploration and production operations should be notified. The notification threshold should be increased beyond 2,000', and should be defined by parameters that take into account the radii of visual, noise, blowout trajectory, and groundwater impacts.
48. Improve public access to data and findings on inspection, compliance and enforcement issues. Public notification should not be limited to the fact that a project is occurring; it should also include notifications of violations and enforcement actions.
49. Waivers to regulations should not be granted without public review. Waivers should require a higher level of justification than currently proposed.

## 10. Violations and Enforcement

DRBC's Proposed Regulations provide a process for reporting violations at Section 7.3 (m) and conducting enforcement of DRBC's rules at Section 7.3 (n). However, it is not clear how DRBC will be involved in handling violations of host state regulations. Because DRBC's Proposed Regulations rely heavily on host state natural gas regulations to protect the Delaware River Watershed, DRBC should explain how it will enforce host state regulations that are violated in the Delaware River Basin.

Host state inspection and enforcement personnel are already stretched thin. It is a very likely scenario that violations of host state regulations will occur and there will be insufficient host state personnel to respond to those violations. Sufficient personnel are needed to not only investigate violations, but also to conduct routine inspections. Will DRBC have the authority and resources to pursue violations of host state regulations if the host states do not?

**Recommendation Summary:**

50. DRBC either needs to ensure there are sufficient host state personnel and resources to enforce reported violations and conduct routine inspections, or DRBC needs to obtain the authority and resources to pursue violations of host state regulations.

## 11. Definitions

DRBC's Proposed Regulations at Section 7.2 should be revised to include definitions for: Best Available Technology (BAT), Best Management Practices (BMP) and Environmentally Sensitive Areas (ESA).

A number of the definitions in Section 7.2 include oil waste potential (e.g. non-domestic wastewater containing oil, drill cuttings containing oil, produced water), but the proposed regulations do not cover oil impacts. As recommended in Section 1 of this report, DRBC's regulations should be expanded to include liquid hydrocarbons; the definitions in DRBC's regulations should be expanded correspondingly.

The following Section 7.2 definitions need to be revised:

- A **High Volume Hydraulically Fractured Well** is defined as a well that will be fractured with more than 80,000 gallons of frac fluid. However, DRBC does not provide any technical justification for its selection of an 80,000 gallon threshold. DRBC should provide this technical justification. DRBC should also provide a technical justification for its conclusion that environmental impacts to the Delaware River Watershed are automatically mitigated, without regulation, for frac jobs that use less than 80,000 gallons of frac fluid.
- A **Horizontal Wellbore** is defined by DRBC as a diagonally drilled or horizontally drilled wellbore. A diagonally drilled section of a wellbore (for example at 30 degrees) is not a horizontal well because that section of the well is only drilled at a 30 degree deviation from vertical and will not create a horizontal wellbore section. A horizontal wellbore is the section of a wellbore that is oriented 90 degrees to vertical. DRBC should use the term "high angle well" for wells that are not drilled on a true horizontal plane.
- **Pollutants** are defined as a substance that degrades surface water or groundwater. This definition should include substances that impact air, soils, crops, and human and wildlife food sources.
- A **Post Hydraulic Fracturing Report** is defined as a report provided after a frac job that lists the volumes and amounts of all chemicals and additives used during fracturing. A pre hydraulic fracturing report should be submitted to DRBC prior to a frac job. A pre hydraulic fracturing report should list: each type of chemical that will be used, chemical composition, dosage rate, the amount planned for use, and information on harmful chemical-related impacts to human health and the environment. A pre hydraulic fracturing report should be reviewed and approved by DRBC prior to a frac job. A post hydraulic fracturing report should be used to compare actual chemical use with planned use.
- The definition for **Setback** should specify the distance exploration and production activities must be setback from drinking water wells, endangered species, and critical habitat.
- The definition for **Wetlands** should mirror the federal wetlands definition.

**Recommendation Summary:**

- 51.** Revise the definitions in DRBC's Proposed Regulations to address the recommendations in Section 11 of this report.