Potential for Development of Natural Gas Exploratory Wells to Adversely Affect Water Resources of the Delaware River Basin

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Geologic Resources Division

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Natural Gas Exploratory Wells

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Author Background

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Mr. Patrick O'Dell has a BS in petroleum engineering from Montana College of Mineral Science and Technology (1982). He is a registered professional petroleum engineer in the State of California (Certificate No. 1529) and has been employed in both the private and public sector.

Mr. O'Dell worked for Marathon Oil Company in Bakersfield, California as a production engineer, where he was responsible for maintaining production and controlling expenses in older oil and gas fields undergoing secondary recovery (e.g., waterflooding and gas cycling). In 1986, he relocated to Anchorage, Alaska with Marathon. In Anchorage, he worked as a reservoir engineer responsible for field development planning, reserve determination, and property evaluation for purchase or sale. While in Alaska, Mr. O'Dell became accountable for the region's new well completions, major workover projects, and the Alaska Region's hydraulic fracture stimulation program. Environmental and safety compliance was a significant part of project design and execution. He also worked on drilling and abandonment operations.

Mr. O'Dell joined the National Park Service in 1992 as a petroleum engineer. He functions as the Service's nationwide technical specialist and authority in the application of best available fluid mineral exploration and development technology to ensure protection of park resources and values. Mr. O'Dell is responsible for assessing impacts of oil and gas activity in and around parks, and developing measures to minimize or remove such impacts via site-specific recommendations and through development of minerals management and training programs.

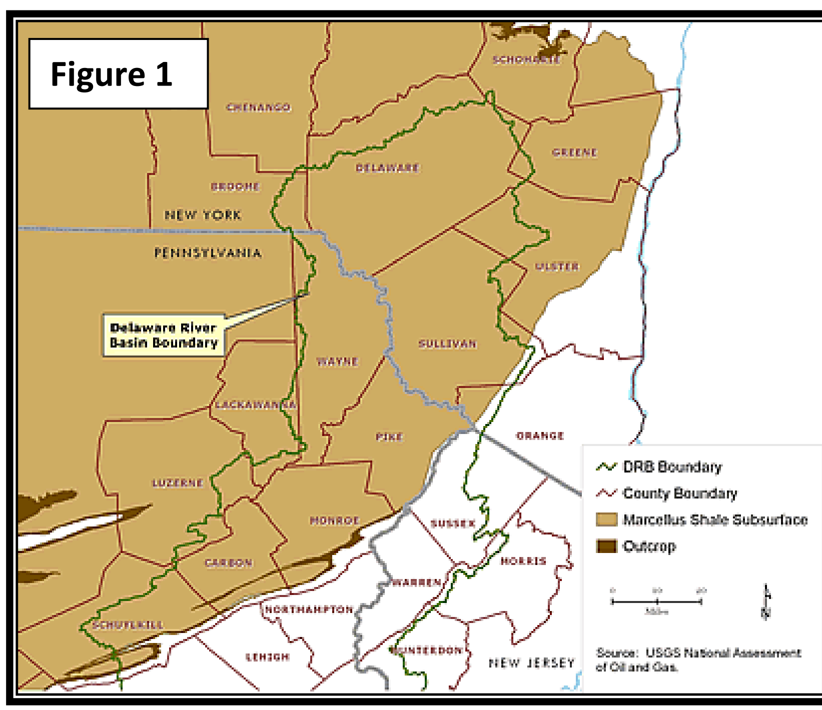
Overview

The Marcellus Shale underlies a significant part of the Delaware River Basin that drains to Special Protection Waters (*also* "SPW"), waters for which the policy is "no measurable change to water quality except toward natural conditions." *See* DRBC Water Quality Regulations, sec. 3.10.3 A.2. It is inconceivable that Marcellus Shale exploration and production will improve water quality in the Special Protection Waters of the Delaware River Basin. It is also improbable that such a widespread and water resource-intensive industrial activity in a rural setting will never adversely affect water quality. The question is whether focused attention by both industry and regulatory agencies can keep water quality and quantity degradation to localized and intermittent events – as opposed to a broad and long-term adverse impact.

The focus of this report is whether "exploration wells" have the potential, either individually or cumulatively, to have a substantial effect on water resources of the basin, and in particular, whether these projects have the potential to cause "measurable change" to the exceptionally high quality of the basin's Special Protection Waters. This report provides support for the conclusion that exploration wells do indeed have such potential.

Background

Natural gas exploration and production is an industrial activity. Shale gas exploration and production is proving to be very extensive industrial activity with a network of well pads, access roads, compressor stations, and gas transportation lines often dispersed over thousands of square miles.



The Marcellus Shale is a vast, natural gas-bearing formation extending 50,000 square miles from southern New York across Pennsylvania and through West Virginia. USGS Fact Sheets acknowledge that over 300 trillion cubic feet (TCF) of natural gas could ultimately be produced – enough gas to supply the entire United States for about 15 years. Economic and environmental stakes are high.

The horizontal drilling and large multi-stage hydraulic fracturing stimulations being used to tap the shale require large drilling locations and millions of gallons of water per well. Development in the coming years and decades will vary across the play but could ultimately be 4, 8, or even 16 wells per square mile. Infrastructure build out (roads, transmission pipelines, compressor stations, etc.) will be substantial. Today, there are about 100 active rigs drilling the Marcellus. (Baker Hughes, Nov 2010)

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 (Figure 1). 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. (DRBC)

Figure 2 (Photo by Soete)

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. Figure 3 is a map of Pennsylvania showing the net feet of organic-rich shale in the Marcellus Formation. John Harper of the Pennsylvania Geological Survey believes that the thickness of organic-rich shale may be more important than the total Marcellus thickness in assessing the production potential of a well site.

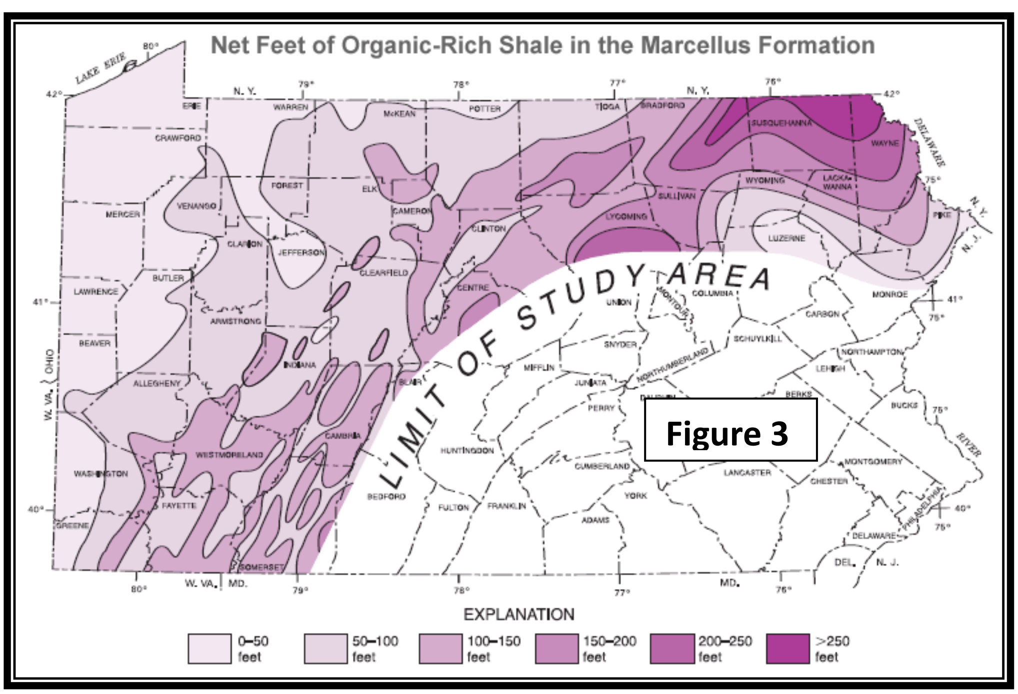


Figure 3

Figure 4 shows a map ranking Pennsylvania counties based on depth, thickness, and thermal maturity of the Marcellus Shale. Note the core area that includes a substantial area within the Upper Delaware River Basin including all of Wayne County, PA and portions of Broome, Delaware, and Sullivan Counties, NY.

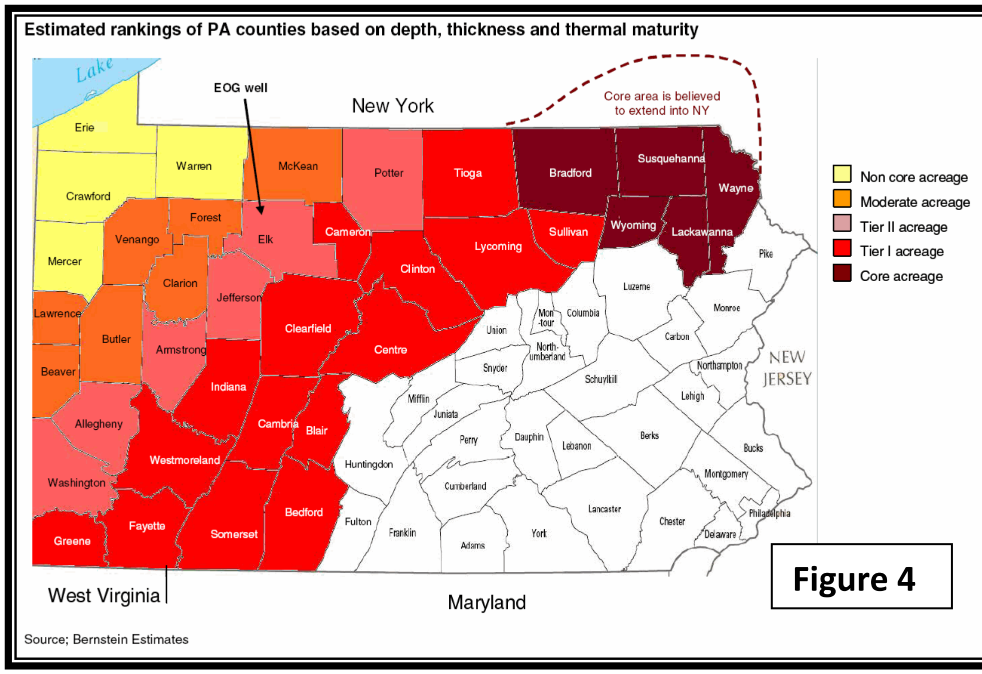


Figure 4

Figures 3 and 4 present the most promising areas of the Marcellus Shale in a slightly different manner, but based on the same geological information.

Figure 5 is a map of Marcellus wells drilled to date in Pennsylvania. Note the concentration of wells in the northeastern counties of Tioga, Bradford, and Susquehanna that correspond to an area mapped in Figures 3 and 4 as having high net feet of organic rich shale. This appears to be industry's confirmation of the focus on net feet of organic-rich shale.

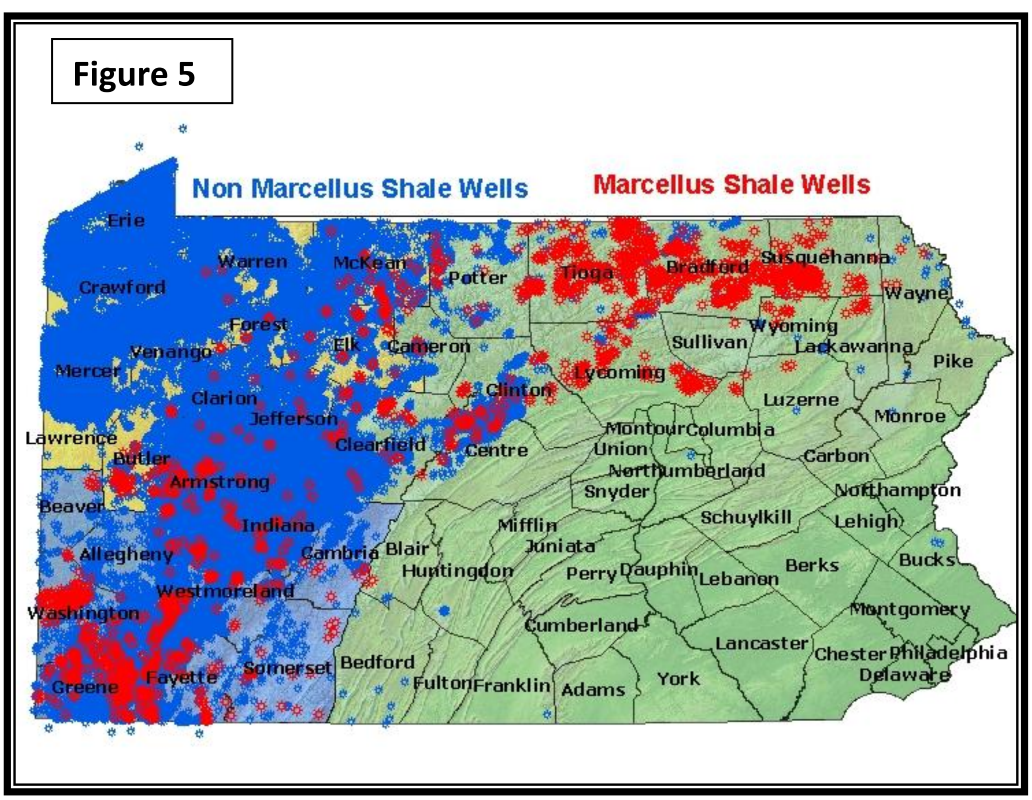


Figure 5

It is reasonable to conclude (and the extent of lease holdings of parties to this hearing confirm) that areas within the Delaware River Basin are of primary interest to the industry.

Federal legislation established the Upper and Middle Delaware River as part of the National Wild & Scenic River Management program in 1978 in recognition of the scenic and recreational values and uses and exceptionally high water quality of these reaches. DRBC's SPW program, established in 1992 and modified in 1994, 2005 and 2008, created an anti-degradation management regime – the SPW program – to implement the objective established by the Upper Delaware Scenic and Recreational River Management Plan (Conference 1986), and the General Management Plan for the Delaware Water Gap National Recreation Area/ Middle Delaware Scenic and Recreational River (DWGNRA 1987) of preserving and protecting the exceptionally high quality of these waters. For more than three decades, the water resources of the upper and middle Delaware River have been accorded special status and protections by agencies of federal and state government. In my opinion, if the quality of these water resources is to be protected, then natural gas development activity within the Delaware Basin must be undertaken – from start to finish – with this goal as an industry and regulatory agency priority.

The Role of Exploration Wells in Shale Development

In the Delaware River Basin, there is a strong likelihood that a well labeled as an "exploration well" will become a producer. Further, the well site and access road that supports the initial "exploration well" could very likely support additional wells and all the related activities and associated production/transportation facilities. An explanation follows.

In a conventional sense, wells drilled for oil and gas are classified as either exploration or development wells. An exploration well is drilled either in search of an as-yet-undiscovered pool of oil or gas (a wildcat well) or to extend greatly the limits of a known pool. Exploration wells may be classified as (1) wildcat, drilled in an unproven area; (2) field extension or step-out, drilled in an unproven area to extend the proved limits of a field; or (3) deep test, drilled within a field area but to unproven deeper zones.

Development wells are wells drilled in proven territory in a field to complete a pattern of production.

With a continuous or unconventional resource play such as the Marcellus Shale, the "exploration drilling" phase is focused on determining if the shale can be stimulated in such a manner as to obtain gas in sufficient rates and volumes to make the endeavor economical. More importantly, the "exploration" phase is designed to ascertain whether the formation is receptive to a process that is economical (e.g., horizontal wellbores with multi-stage hydraulic fracture treatments) and repeatable. Basically, the driller is seeking to determine whether a technical and financial "assembly line" can be applied to the geology of the shale to make a reasonable rate of return.

Figure X shows the geological differences between the "conventional" oil and gas pools historically sought by the industry and the emerging "unconventional" or "continuous resource" plays now garnering so much attention. In conventional plays, much of the risk is geological. Is there good reservoir rock? Is there a geologic trapping mechanism? Have hydrocarbons migrated into and become trapped in sufficient volumes within the reservoir rock? As to these conventional pools, the exploration well's primary purpose is to address the geologic risk.

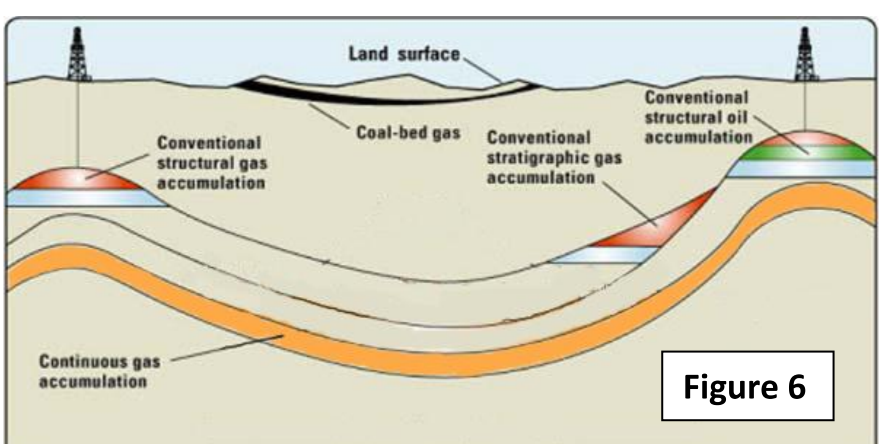


Figure 6

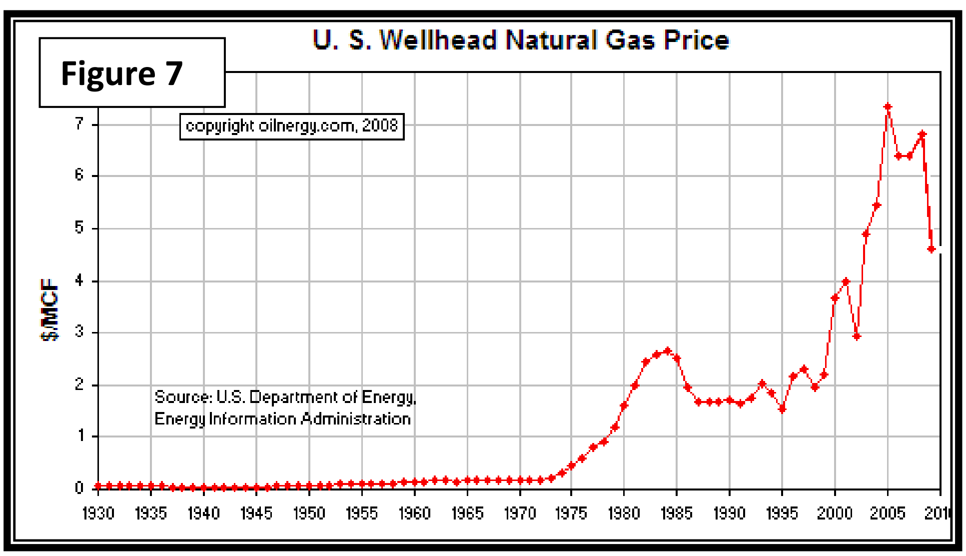
In unconventional plays, the geological risk is exceedingly lower than for conventional targets. For example, the depth and areal extent of the Marcellus is well known. Enough geologic information is already available to have mapped the net feet of organic rich shale for the Marcellus. True, additional drilling will hone the accuracy of existing maps, but industry activity demonstrates that the primary risks have already shifted from geological to technical and financial. Companies are leasing large acreages at highly competitive prices far from the nearest Marcellus well because, in practice, there is little need for a "discovery" well.

While the "intent" of a well as exploration or development in the Delaware River Basin is inarguable, there can be little doubt that the "first" well establishes the access route and operational location of perhaps decades of drilling and production activity.

Environmental protection from the adverse impacts of an activity hinges on best management practices that consider time, place, and manner. Distance between an activity and the resource at risk is fundamental to that resource's protection. Eliminating the "place" consideration is perhaps the most serious handicap that could be put upon an environmental protection regulatory scheme.

Scope of Anticipated Marcellus Shale Development

Development of the Marcellus is currently following the pattern of other continuous gas shale plays, but at a faster pace.



With natural gas prices off the peaks of the last few years (Figure 7), drilling has generally slowed in gas shales. However, the Marcellus Shale drilling activity has bucked the trends of others. This probably has much to do with the stage of development.

During the early phase of leasing and drilling, holding leases by production has a strong influence on drilling activity. Drillers have an incentive to begin production before a lease expires in order to avoid additional transaction costs and the potential for less favorable terms under a re-negotiated agreement. Once leases are secured by production, supply and demand (natural gas wellhead prices) will have a more profound influence on the rate of development.

The moratorium on production well approvals in the Delaware Basin imposed by the Commission in May of 2010 pending promulgation of new DRBC regulations, no doubt has raised concerns among some lessors (landowners) and their lessee operators that leases will expire before DRBC approvals are issued. It is certainly likely that the existence of an exploration well in the ground and capable of conversion to production may provide both landowner and operator with some comfort that they are in a position to proceed as soon as rules are adopted and approvals can be processed. It is also possible that the Commission's moratorium might inadvertently create an incentive for project sponsors to classify their wells as exploratory in order to meet lease obligations and be poised to produce when the regulations are in place. By allowing only a limited number of exploration wells to proceed, the Executive Director appears to have balanced the interests of those who had relied on a previous exemption to advance their exploratory well projects. Importantly, she also closed off the potential for a wave of exploratory wells to be drilled without any DRBC review as to their placement vis `a vis valued water resources.

Spacing of oil and gas wells ordinarily is dictated not by environmental concerns but by the extent of the area from which a single well can extract the maximum amount of commercially recoverable oil or gas. The spacing histories of the Barnett, Fayetteville, Antrim, New Albany, Ohio, and Woodford shales as shown in Table 1 all trend from larger to smaller spacing units over time. For the Marcellus Shale, it is reasonable to expect 320-acre or 160-acre spacing initially, and eventually some areas experiencing infill drilling to 80-acre or even 40-acre spacing should infill drilling produce an economic return.

Table 1 – Sample of Well Spacing in Gas Shale Plays

Gas Shale Name	**States**	**Well Spacing**
Barnett Shale	TX	• 40- to 160-acre spacing typical • 20-acre spacing being tested
Fayetteville Shale	AR	• 40-acre spacing by rule (Arkansas Oil and Gas Commission Rule B-43) • 80- to 160-acre spacing in practice • 60-acre spacing being tested
New Albany Shale	IL, IN, KY	• 160-acre spacing initially • 80-acre spacing now common
Antrim Shale	MI	• 40- to 80-acre spacing
Ohio Shale	OH	• 40- to 160-acre spacing
Woodford Shale	OK	• 640-acre spacing initially • 160-acre spacing now common • 80-acre spacing proving effective • 40-acre spacing being tested
Marcellus Shale	NY, PA, OH, WV	• 160- to 320-acre spacing initially • 40- to 80-acre spacing can be expected

Source: Modified from Sumi 2008.

Using 80% of the 5,000 square mile Marcellus area in the Delaware River Basin developed at 160-acre spacing yields 16,000 wells. An 80-acre spacing pattern would result in doubling the number to 32,000 wells. Of course, voluntary restrictions by private agreement may limit this number. For example, NWPOA's current lease with Newfield Appalachia PA, LLC provides for an 80-acre spacing equivalent by means of a single 8-well drilling pad per each square mile. Such private agreements of course are subject to change by contracting parties.

One of the benefits of horizontal well completions is the ability to site multiple wells on one location. So while each multi-well pad constructed for a group of six or eight or ten horizontal wells may occupy a much larger land area than the pad for a single vertical well, the overall disturbance on an acres/well basis could ultimately be much less than for a traditional vertical well build-out. Also, with the capability to drill horizontal sections ranging up to 5,000 feet, there may be opportunities to site surface operations away from sensitive areas, such as the basin's Special Protection Waters, without losing the ability to recover the gas. However, if the Commission intends to implement its Special Protection Waters program, it will need to find ways to incentivize or compel the industry to develop at a pace and manner that allows for natural gas extraction while simultaneously optimizing water resource protection. Otherwise, my experience indicates that water resources will not be a priority in the industry's rate-of-development, well spacing, and siting equations.

In addition to the Marcellus Shale, the Utica Shale may be targeted for natural gas production within the Delaware River Basin. One shale play on top of another could in theory double the environmental impacts, in particular those related to water resource demands and surface disposal of waste streams to surface waters. In practice however, technical innovation and economic constraints would produce impacts less than double, but certainly greater than one.

Risks to the Water Resource from Surface Operations of Natural Gas Exploratory Well Drilling

For purposes of this report, "exploration" drilling consists of access road and well pad construction followed by drilling and casing of a vertical well through the Marcellus Shale. The effects on and risks to surface and groundwater from well completion, hydraulic fracture stimulation, development well drilling on the same site, installation of gas handling facilities, gathering lines, compressors and waste handling areas, and long-term production and maintenance of wells are directly proportional to the activities' proximity to the water resources. That proximity of drilling is key to water resource protection is acknowledged by the many federal and state oil and gas regulatory agencies that include minimum setbacks in their policies and regulations. It is reasonable to conclude that site selection for both well pads and access roads is a crucial component of mitigating risks and effects on water resources. As noted above, the locations of the exploration well and its access road set the stage for the location of the activities that follow.

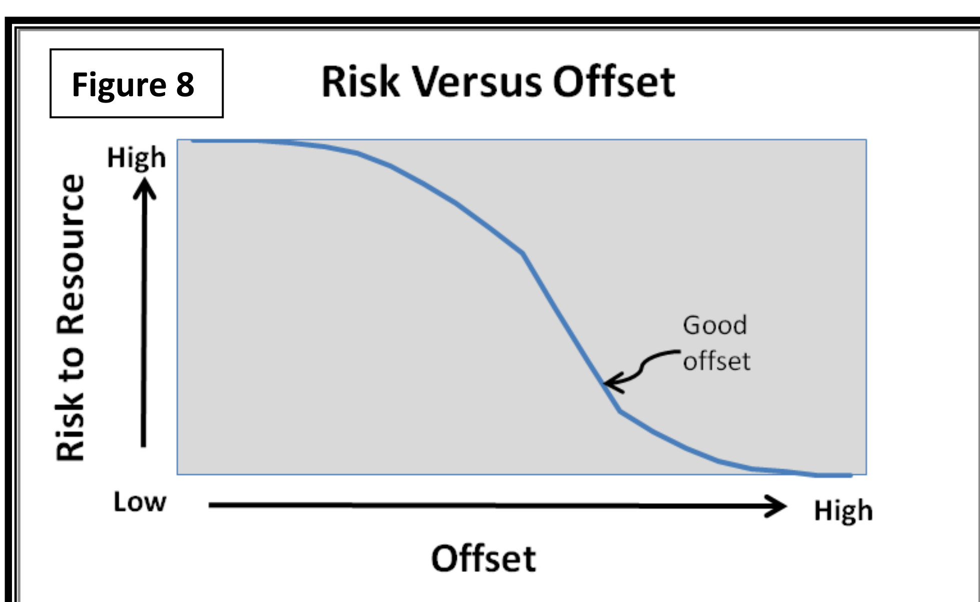


Figure 8 is a graphical representation of a minimum offset being used to reduce the risk to a resource. At some point the incremental offset begins to accelerate the rate of risk reduction to the resource. This is typically the area where site specific environmental conditions begin to provide time and space to react to accidents or spills so as to prevent or minimize impacts to the resource. Finally, offsets become great enough that incremental offset distance provides very little additional risk reduction. Each site is unique. Environmental conditions may provide natural or human-made barriers that would justify a reduced setback. Site conditions such as steep slopes or annually high precipitation can enhance pathways between the activity and resource, and thus justify greater setbacks. Regulatory establishment of a "good offset" that considers both the activities and the average environmental conditions provides a beginning point for site location considerations. Additionally, having a regulatory process for adjusting site-specific setbacks – either lower or higher – based on project and environmental conditions is the key to successful use of setbacks.

The remainder of this section highlights the primary risks to water resources from Marcellus Shale exploration well drilling. Perfect execution by industry and regulatory agencies is necessary to lower these risks to a level that will not result in measurable impacts to water resources – at least on a localized and short-term basis. Since it is unrealistic to expect perfection over the course of time, it is reasonable to conclude that not only is there a potential for measurable impacts to water resources, but that measurable impacts will occur.

Erosion and Sedimentation

Erosion is a natural process by which the surface of the land is worn away by water, wind or chemical action. Erosion and subsequent deposition of eroded materials to surface waters (sedimentation) are a primary threat to water quality associated with road and well pad construction activities. Realizing the potential for erosion and sedimentation associated with oil and gas development to adversely impact water resources, state and federal oil and gas management agencies have developed best management practices and require operators to use them.

Road and pad construction for an exploration well often involves extensive earth disturbance that can speed erosion. For a vertical Marcellus well, the pad size will most likely be between 2 and 3 acres of level, usable space just to support the drilling operations. Construction on sloped areas can substantially increase the area of disturbance when considering cut and fill requirements.

Vegetation is a significant check on natural erosion rates. Accelerated erosion occurs when human activities increase the rate of erosion above the natural processes.

Road and well pad construction necessitate removal of the vegetation that serves to check the natural rates of erosion. A well pad and half-mile access road may require a footprint of approximately 4 acres on level ground. Placement of roads and pads in the hilly terrain of the Upper Delaware River Basin will involve some degree of cut and fill construction techniques on most, if not all, projects. This increases both the area of disturbance (by up to 50% on slopes exceeding 15 degrees) and the efforts required to mitigate erosion and sedimentation.

In general, the proximity of roads and well pads to surface waters increases the risk that erosion and sedimentation will cause measureable impacts on water quality. Stream crossings will be unavoidable for some projects.

Materials Used or Generated Onsite Create a Potential Source of Water Contamination

In well drilling, sources of potential contamination to surface and ground water include spills of fuels, lubricants, and chemicals used in mud systems or air drilling systems, as well as fluid (or "brine") returned from deep rock formations. While amounts vary, it would not be uncommon to have several thousand gallons of diesel fuel stored on site at any given time, and 4 or 5 fuel deliveries each week. For an 8,500-foot vertical Marcellus Shale well, that could be 20 fuel deliveries. Chemicals such as pH buffers, water loss agents, friction reducers, corrosion inhibitors, biocides, foaming agents, and others are typically used in very low concentrations within mud or air drilling systems. However, these chemicals are stored in concentrated liquid or solid form on location, and if handled improperly, are sources of potential contamination of surface and ground water.

Drill cuttings from an 8,500-foot Marcellus Shale well can amount to approximately 200 cubic yards of material. A portion of the drill cuttings may come from formations bearing heavy metals and elevated levels of naturally occurring radioactive materials (NORM). Shales are also known to contain minerals such as pyrite and sulfides, which when brought to the surface and exposed to air can break down to form sulfuric acid and iron hydroxide. The acid in turn can mobilize metals in the cuttings, creating a potential source of contamination to both surface and ground waters.

If air drilling is utilized, as compressed air and additives (the "air system") are pumped down the hole, water, additives, drill cuttings and formation fluid are returned to the surface. The formation fluid, or "brine" consists of water into which salts and other minerals have leached from the surrounding rock for millennia. Formation fluid from the Marcellus formation tends to be extremely high in total dissolved solids (TDS). With concentrations of as much as 300,000 mg/l of TDS, Marcellus brine is five times as salty as ocean water (35,000 mg/l TDS) (PA EQB 2010). In addition to chlorides, this solution carries high concentrations of barium and strontium and may be radioactive due to the presence of naturally-occurring radium. Although quantities produced during construction of a vertical exploration well will be much smaller than for a horizontal or production well, if not carefully contained, brines or oily water can be sources of contamination to both surface and ground water.

Water Needs

Well drilling requires the use of water. The volume of water varies depending on well depth and the mud system used to drill the well. A typical Marcellus Shale well drilled vertically to 8,500 feet in depth may require 50,000 to 300,000 gallons of water, the lesser volume being associated with air drilling operations. The source of water and the withdrawal methods used may cause or accelerate bank erosion, diminish streamflow, elevate water temperature, and introduce invasive species, all of which may potentially adversely affect water quality and aquatic biota.

Mitigation of Risks to Water Resources

A comprehensive regulatory system helps to ensure that each of the identified risks to water resources is reduced by mandatory use of established protective management practices. The idea that regulation is a necessary means of protecting water (and other resources) from the adverse effects of oil and gas development activities is virtually uncontested, as evidenced by existing state regulatory regimes.

For Marcellus Shale "exploration" well drilling in the Delaware River Basin, examples of best management practices that in my view should be applied in the land development aspects of drilling to protect water resources include, but are not limited to:

- Use and upgrade of existing roads, rather than construction of new roads
- Implementation of strong erosion and sedimentation control plans
- Seasonal or other timing restrictions to avoid construction during periods of high precipitation
- Avoidance of steep slopes
- Well site construction that conforms to the landscape in lieu of insistence on rectangular sites for all locations
- Appropriate setbacks from surface waters, including wetlands
- Minimization of stream crossings
- Stormwater management that ensures discharges are uncontaminated and do not exacerbate erosion
- Strong spill prevention, containment, and response equipment, structures, and methods, designed and implemented throughout the construction and drilling process (for example, bermed locations, with appropriate placement of impermeable liners beneath potential spill sources)
- Closed-loop drilling systems in lieu of earthen (including lined) pits
- Offsite disposal of drilling wastes for sites in close proximity to surface waters or with near-surface groundwater
- Exotic species control
- Establishment of adequate performance bonding and liability insurance standards to ensure that remediation will be provided in the event of accidents or poor operator performance that results in impacts to water resources

In the experience of the National Park Service, it can be fairly said that the most environmentally conscientious operators willingly, but only minimally, comply with those regulatory requirements that serve only to protect a natural, cultural, or recreational resource. [Note: There are many actions taken by industry that serve operational or financial purposes and coincidentally serve to reduce environmental impacts. For example, drilling multiple wells from a single well pad has both operational/financial and environmental benefits.] Any regulatory agency can and reasonably should expect no more from an operator than full compliance with its regulations. The point being that if the public depends on operators in general to voluntarily use measures such as "best management practices" to meet an agency's standards of resource protection, the public will be disappointed. This is because operators are sometimes willing to assume more environmental risk in exchange for a reduction in expense or acceleration of project completion (i.e., time to production).

The recent British Petroleum Mississippi Canyon Well #252 blowout is a spectacular example of a company making choices that increase the risk of an incident in an effort to reduce expenses or speed the time to production. While incidents of the scope experienced in the Gulf are not expected in the Marcellus, the Punxsutawney Hunting Club 36H well incident in Clearfield County, Pennsylvania, is a closer-to-home example of an operator's willingness to take on environmental and human health and safety risk in order to decrease costs or speed the time to production, while at the same time staying within, but perhaps testing the envelope, of regulatory requirements. This incident involved loss of well control during post stimulation cleanout activities. The Pennsylvania Department of Environmental Protection's (PA DEP) July 12, 2010 letter to operators states, "Over a period of 17 hours, gas and hydraulic fracturing wastewater flowed uncontrolled into the environment and impacted nearby waters." As a result of the post-incident investigation, PA DEP determined the operator used inadequate equipment and practices to maintain control of the well. The PA DEP issued further direction to the Marcellus Shale industry in Pennsylvania that mandated specific equipment and practices necessary to meet regulatory requirements of well control (PADEP July 2010).

Although the Punxsutawney Hunting Club incident occurred during operations associated with a production well, not an exploratory well, the incident illustrates that accidents will occur in development of natural gas, whether as a result of equipment failure, human error, or simply by miscalculations of human safety and environmental risk by project managers. Risk is the probability of an incident occurring multiplied by the consequences of the incident. Reducing the consequences of an incident can and should receive appropriate weighting when selecting the location of roads and well pads. The importance of selecting a well site in full consideration of distance and pathway between the well and the water resource cannot be overstated – particularly when the inevitable accident such as the Punxsutawney blowout occurs.

Simultaneous Regulation by NPS and Other Agencies

Oil and gas operators in units of the National Park System must comply with both NPS regulations and state oil and gas regulations. The National Park Service regulations are generally more restrictive than state regulations on surface use requirements. This does not mean some states may have lax environmental standards, but rather that states typically leave the bulk of surface use issues to be settled between the private landowners and the operators. It has never been the experience of the National Park Service that its rules and state rules contradict each other. Rather, they supplement each other with respect to various environmental issues.

Most states' oil and gas regulations include some provisions that serve to protect the environment and human health. For example, all states' rules contain provisions for the protection of fresh water and for public and worker safety. However, a primary focus of state regulations generally is the conservation of the oil and gas resource and protection of the associated ownership interests.

In contrast, the National Park Service's mission is to prevent or minimize damage to the environment and other resource values and insure that parks are left unimpaired for the enjoyment of future generations. To that end, the NPS controls nonfederal oil and gas development in parks under regulations codified at 36 CFR, Part 9, Subpart B (the "9B" regulations). These regulations oversee an activity that in large part also is regulated by the states – but with a different focus.

The NPS 9B regulations focus on surface use and groundwater issues and require that operators apply methods that will avoid or minimize impacts to park resources and values, as well as public health and safety. These priorities and constraints may also be addressed by state regulations, but they are the sole focus of the NPS program.

Reasonable time, place, and manner considerations are fundamental to the 9B regulation program.

Place. One of the strongest regulatory tools in the 9B regulations is establishment of a 500-foot setback of operations from surface waters (36 CFR §9.41(a)). This requirement gives the operator and the park resource manager a starting point in locating drilling or other operational sites. The regulations provide a process for increasing or easing the 500-foot setback requirement if the particular conditions of the project warrant an adjustment.

The National Park Service has undergone five park-specific planning efforts to furnish operators and park managers with guidance on implementing the 9B regulations, given the local environments, park uses, and the scope of operations – either ongoing or forecast. The planning effort in each case focused most intensively on identifying sensitive resource areas (e.g., surface waters, wetlands, endangered species habitat, high visitor use areas, etc.) and considering the level of expected impacts for various setbacks. These efforts have resulted in park-specific setbacks ranging from zero to 1,500 feet. For example, short-term foot-traffic-only recording operations for a seismic survey may occur within a wetland with negligible post-operational effects. Conversely, a full-scale drilling operation may require a much more substantial setback from a nature trail to retain a high quality visitor experience.

Manner. An example of how the natural gas drilling requirements imposed by most states and those required by the National Park Service differ relates to the handling of drilling muds and drill cuttings. Drilling muds and well cuttings may contain chemical and material contaminants, including petroleum products. Most states allow the use of earthen pits for storing muds during operations, and for ultimate disposal of drilling waste solids. The NPS requires the use of above ground tanks ("containerized mud systems"). Earthen pits are prone to leaks, which can go undetected for long periods of time and lead to costly cleanup. Above ground tanks provide a higher degree of environmental protection because leaks from the tanks are readily apparent, and the tanks are removed from the site upon completion of the drilling phase of operations. Many companies have voluntarily adopted the NPS approach outside of parks. However, the State of Texas, for example, does not require the use of tanks. Instead, it has developed guidance for Texas Statewide Rule No. 8 (TAC), Protection of Water, which regulates the use of earthen pits through a permitting system. As soil permeability and proximity to water increase, state rules "recommend" but do not require more stringent construction methods for such pits, including the use of leak detection.

Timing. The regulations adopted by most states do not include timing restrictions, though operators may necessarily have to time their operations to meet compliance with other federal laws such as the Endangered Species Act. The National Park Service uses daily, weekly, and seasonal timing restrictions to augment resource protection and visitor experience. For example, limiting oil/fuel hauling to daylight hours has been found to reduce accidental spills. Scheduling mobilization of equipment for a drilling operation to avoid times of heavy visitor use on weekends may serve an operator and park visitors by avoiding conditions adverse to both. Where water resources are of high value, additional protection may be afforded by avoiding construction of roads and pads during seasonally wet periods.

Overlapping NPS authority is sometimes used to back up state resources where the staff of state agencies, charged with a broad range of responsibilities and concerns, are spread thin. For instance, on the day that the surface casing for a well in Padre Island National Seashore is run and cemented, state inspectors for the area may have a dozen or more other active drilling sites, compliance responsibilities for several thousand well sites, and so on. The National Park Service wants 100 per cent monitoring/ inspection of casing and cementing activities. Although state inspectors may be unable to be present, the National Park Service can commit staff resources to ensure that the casing and cementing are completed to NPS standards.

Conclusion

My opinion based on some 18 years of experience with oil and gas development activities on lands managed by the National Park Service is that "exploration wells" have the potential, either individually or cumulatively, to have a substantial effect on water resources of the Delaware River Basin, and in particular, that these projects have the potential to cause "measurable change" to the exceptionally high quality of the basin's Special Protection Waters.

The "place" factor in the "time, place, and manner" equation is most important in terms of ability to protect an environmental resource such as water. The risks created by a poorly selected location cannot easily be overcome with even the best operational methods or timing. Conversely, proper site selection can do much to mitigate the effects of accidents or environmentally unsound practices.

Reverences

36 CFR §9.41. Code of Federal Regulations, Title 36 Chapter 1, Part 9, Subpart b: National Park Service, Minerals Management, Non-Federal Oil and Gas Rights, Operating standards.

36 CFR §9.41(a). Ibid. Section 9.41(a)

Baker Hughes 2010. Baker Hughes Investor Relations. Interactive Rig Counts, Nov. 2010. Found at: http://gis.bakerhughesdirect.com/RigCounts/default2.aspx

Conference 1986. Conference of Upper Delaware Townships in cooperation with the National Park Service. Upper Delaware Scenic and Recreational River Final River Management Plan. November 1986.

DWGNRA 1987. Delaware Water Gap National Recreation Area General Management Plan. US Dept. of Interior/ National Park Service. May 1987.

PA EQB 2010. Pennsylvania Environmental Quality Board, Notice of Final Rulemaking for Wastewater Treatment Requirements. Pennsylvania Bulletin Vol. 40 No. 34 (4835), August 21, 2010.

PADEP July 2010. Pennsylvania Dept of Environmental Protection. Investigative Report on Punxsutawny Hunting Club Well 36H. July 13, 2010. Found at: http://www.dep.state.pa.us/dep/deputate/minres/oilgas/PunxsutawneyHuntingClub36HWell%20Report/EOG.htm)

TAC. Texas Administrative Code , Title 16, Part 1, Chapter 3, Section 3.8

Sumi, Lisa 2008. *Shale Gas: Focus on the Marcellus Shale.* Oil and Gas Accountability Project/Earthworks. Durango CO. May 2008.