WATER SOURCING AND WASTEWATER DISPOSAL:
TWO OF THE LEAST WORRISOME ASPECTS OF
MARCELLUS SHALE DEVELOPMENT IN
PENNSYLVANIA

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INTRODUCTION

As this country searches for reliable energy sources in the face of political, technological, and environmental challenges, development of the Marcellus Shale in Pennsylvania has expanded rapidly in recent years. The Pennsylvania Department of Environmental Protection (“PaDEP” or “Department”) issued 3,314 permits for Marcellus wells in 2010, and 1,446 Marcellus wells were drilled in 2010, up from 795 drilled in 2009.1 Of the 71,000 active gas wells in Pennsylvania,

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however, only 3.5% are Marcellus wells. This article will review the interrelationships among Marcellus Shale development in Pennsylvania, water resources of the Commonwealth, and the evolving regulatory regimes that manage the drilling activities affecting those resources.

Recovering natural gas from the Marcellus Shale requires horizontal drilling and hydraulic fracturing ("fracking") technologies, which implicate significant water management and logistics issues throughout many phases of Marcellus drilling operations. First, operators must locate reliable sources of water and purchase or withdraw sufficient water in accordance with various regulatory regimes. Second, water sources are often some distance from the well sites, requiring transportation by trucks and/or pipelines. Third, once the water arrives on site, operators provide for storage in various impoundments and tanks, which may be on a particular pad or centralized for multiple well pads. Fourth, before water is used for fracking, it is blended with sand and chemical additives to facilitate the release of gas from the shale. Approximately 10-30% of this slickwater used for fracking comes back up to the surface as flowback, which must be recovered, handled and stored before it is treated for recycling and reuse or disposal and discharge. The scope of this article is limited to the two ends of this water management spectrum – water sourcing and wastewater reuse and disposal.

The regulatory regime for water withdrawal and wastewater disposal depends on the activity and the location where the drilling occurs. Some aspects of sourcing and disposal are managed by PaDEP; other aspects are managed by one of two Commissions—the Susquehanna River Basin Commission ("SRBC") or the Delaware River Basin Commission ("DRBC"). With regard to disposal of wastewaters, the relevant federal agency is the Environmental Protection Agency ("EPA"), which has delegated its permitting authority to PaDEP but retains its oversight and supervision of wastewater disposal to waters

2. Draft Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources ("EPA HF Study Plan"), UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF RESEARCH AND DEVELOPMENT (February 7, 2011), http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/index.cfm. Table 4 provides an example of the volumetric composition of hydrofracturing fluid ("HF Fluid" or "slickwater").

3. Other surface water issues, not addressed here, include stormwater management, erosion and sedimentation plans, spills and releases. Gas migration impacts on groundwater are also outside the scope of this article.
of the United States. The relevant federal statutes include the Clean Water Act and the Safe Drinking Water Act; relevant Pennsylvania laws include the Clean Streams Law, the Dam Safety and Encroachments Act, the Solid Waste Management Act, and the Oil and Gas Act.  

State and federal regulatory regimes, as well as industry practices, are rapidly evolving and responding to water management issues as they arise. While there is a public perception that the water demands of Marcellus drilling are excessive, the regulatory agencies recognize that other uses are significantly higher and that this particular use can be accommodated with proper management. Likewise, there is a public perception that wastewater disposal from Marcellus drilling activities threatens our rivers and drinking waters, but the industry has significantly reduced its wastewater volume through recycling and reuse of flowback and PaDEP has adopted strict discharge limitations on the treated effluent from this source of wastewater. Thus, while the system is somewhat in flux, there are significant protections in place, as well as widespread awareness of best practices to ensure that the development of this energy source takes place in a manner that protects both the people and the environmental resources of this Commonwealth.

I. Overview of Marcellus Shale

“Unconventional” gas, which includes shale gas like Marcellus, accounts for about 60% of onshore recoverable gas resources, with enough estimated natural gas to supply the United States for the next


Shale formations across the United States have been developed to produce gas since 1821. Large scale hydraulic fracturing, developed in Texas in the 1950s, has been used in shale plays across the United States. In 2009, unconventional gas production accounted for over 40% of the total U.S. gas production. According to many, it is the fuel of the century.

Of the seven largest shale plays in the country, the Marcellus Shale covers the largest area, estimated to be about 95,000 square miles, with more technically recoverable resources than any other shale play. The Marcellus Shale spans six states and spreads across the upper Appalachian Water Basin. The Marcellus Shale play in Pennsylvania crosses three key river basins—the Delaware, Susquehanna, and Ohio River Basins. Each basin has its unique features, which will be discussed in more detail below. The geology of the Marcellus formation suggests that areas in the northcentral and northeastern regions of Pennsylvania that have not traditionally seen much gas well drilling may be particularly productive.

Drilling and completion of Marcellus gas wells differs from conventional gas wells because it includes both vertical and horizontal wells, at a depth of 5,000 to 8,000 feet below surface. While fracking has been used in Pennsylvania since the 1950s, a key element enabling shale gas production in recent years has been the development of cost-effective horizontal drilling and fracking technologies. Since the 1980s, nearly all wells drilled in Pennsylvania have been fractured.

Because of its tight formations and low permeability, Marcellus Shale development requires fracking to create fractures in geologic layers of shale and coal to allow the natural gas to flow to a well.

7. Id. at 13.
8. Id.
9. Id. at 17, Exhibit 11.
10. The Marcellus Shale extends from west central New York down into Pennsylvania, Ohio and West Virginia, with minor portions extending into Maryland and Virginia.
11. STRONGER, supra note 5, at 10.
12. DOE Primer, supra note 6, at ES-4, 15.
Fracking in Pennsylvania involves forcing a combination of water, sand, and chemical additives into a rock layer at high pressure, with water and sand making up from 98% to 99.5% of the HF Fluid, or slickwater. Fracking occurs in phases over the course of several days and the process requires one to five million gallons of HF Fluid per well. While there is a public perception that this volume of water consumption is high, regulatory authorities believe that the water use, which is relatively small compared to other uses, can be accommodated; it is just a matter of careful management.

II. Water Sources

While water is plentiful in Pennsylvania compared to other parts of the country, water availability varies across the Commonwealth. Some shale development in Pennsylvania is occurring in areas with limited groundwater and small headwater streams, which presents water management challenges in low flow conditions. Water source logistics, therefore, depend upon location and timing of water needs. Operators, however, need not rely entirely on fresh water for fracking, but also blend fresh water with: 1) recycled flowback; (2) treated water from acid mine drainage (“AMD”); or (3) publicly owned treatment work (“POTW”) effluent. Stakeholders in both government and industry are actively investigating these alternatives to reduce fresh water withdrawals.

A. Three Major River Basins in Pennsylvania

1. Ohio River Basin

13. Id. at 61. The makeup of HF Fluid varies to meet specific needs of each area; there is no one formula. Id. at 62.


15. Pennsylvania has many water sources impacted by acid mine drainage. See STRONGER, supra note 5, at 21 (noting studies by Pennsylvania universities to provide for greater use of water impacted by acid mine drainage for fracking). PaDEP has encouraged the treatment of use of AMD, as well as the use of POTW effluent, for fracking. Id. at 22, 24. There are some obstacles, however, to the use of AMD for fracking, including compatibility with operations, treatment needs for the AMD, as well as environmental liability for abandoned mine pools, which arises under the current regulatory structure in Pennsylvania.
The Ohio River is 981 miles long, starting at the confluence of the Allegheny and Monongahela Rivers in Pittsburgh, Pennsylvania and ending in Cairo, Illinois, where it flows into the Mississippi River. It flows through or borders six states and is a source of drinking water for more than three million people. The Ohio River watershed is over 200,000 square miles, most of which is outside of Pennsylvania. The Ohio River Valley Sanitation Commission (“ORSANCO”), established in 1948, is an interstate commission representing eight states, including Pennsylvania, and the federal government. ORSANCO operates programs to improve water quality in the Ohio River and its tributaries, including setting wastewater discharge standards. Unlike the SRBC and the DRBC, ORSANCO does not currently oversee water withdrawals or manage allocation of uses, but is examining the possibility of expanding its authority into these areas.

2. Susquehanna River Basin

The Susquehanna River watershed is the second largest—next to the Ohio River Basin—east of the Mississippi River. It includes over 27,000 square miles in parts of New York, Pennsylvania and Maryland, where over four million residents live. Over 8,000 miles of rivers and streams drain into the Susquehanna River before emptying into the Chesapeake Bay. The watershed covers about 50% of Pennsylvania’s land area, and 72% of the basin is underlain by Marcellus Shale, including areas in Tioga, Bradford, and Lycoming Counties. The basin is home to many high consumptive uses, such as power plants and recreation, i.e., golf courses, both of which use far more water than natural gas extraction. The SRBC has estimated that annual consumptive use for all gas well development, when full scale de-

17. Id.
development is reached, will be about twenty-eight million gallons per day (“mgd”), or about 3% of total basin consumptive use.\textsuperscript{21}

3. \textit{Delaware River Basin}

The Delaware River watershed is the smallest of the three, covering about 12,800 square miles in parts of New York, Pennsylvania, New Jersey and Delaware.\textsuperscript{22} The Delaware River itself serves as a border between New York and Pennsylvania. Several miles of the Lower, Middle, and Upper Delaware River are designated as National Wild and Scenic Rivers,\textsuperscript{23} which requires preservation of their free flowing condition and protection of their immediate environments for the benefit and enjoyment of present and future generations. The watershed is an important drinking water supply to New York City and Philadelphia, drawing from over 4,000 miles of rivers and streams. About 36% of the basin is underlain by Marcellus, including areas in Pike, Monroe and Wayne counties in Pennsylvania. The Delaware River basin is also home to many special protection waters,\textsuperscript{24} which heightens water management controls and complicates water withdrawals.

B. \textit{Different Regulatory Requirements for Water Sourcing in Each River Basin}

Source water program objectives in Pennsylvania include monitoring, tracking and reporting of water use and disposal. The three regulatory regimes attempt to: 1) minimize the volume of fresh water withdrawn for natural gas development; 2) assure adequate stream flow and aquifer capacity under all conditions; 3) encourage the use of previously approved sources and inter-company sharing arrangements; and 4) encourage the reuse, recycling and use of otherwise im-


\textsuperscript{23} More information about the National Wild and Scenic River System, which was created by Congress in 1968, is available at http://www.rivers.gov.

\textsuperscript{24} Each state is required to maintain and protect existing instream uses and levels of water quality necessary to maintain those uses. 40 C.F.R. § 131.12(a)(1) (2010). In Pennsylvania, special protection waters are listed in accordance with 25 Pa. Code § 93.4a-93.4d (1999). See 25 Pa. Code §§ 93.9-93.9z for listings that are updated regularly.
pacted water, such as AMD and POTW effluent. Other than state laws regulating withdrawal of surface water by public water utilities, there is no statewide water withdrawal permit requirement or regulatory system in Pennsylvania. Water withdrawal in Pennsylvania has traditionally been governed under common law riparian rights. The SRBC and DRBC, however, have largely displaced the courts in determining water rights in the eastern two-thirds of the Commonwealth.

1. **PaDEP’s Regulatory Regime for Water Sourcing**

PaDEP bases its authority to review water withdrawals for gas well operations on the Clean Streams Law. The Clean Streams Law prohibits discharges and activities that may cause pollution but does not directly address water withdrawals. In the absence of a general regulatory regime for water withdrawal, PaDEP’s Bureau of Oil and Gas Management has required Water Management Plans (“WMP”) since 2008 as part of Marcellus well permitting under the Oil and Gas Act to protect water resources from diminution and pollution. WMPs are thus the key to monitoring, tracking and reporting water use outside of SRBC and DRBC jurisdictions.

In April 2009, PaDEP adopted a separate WMP approval process and includes a standard condition in all Marcellus well permits that requires a WMP before any water is withdrawn or obtained for fracking. WMPs must identify sources by sub-basin, answer questions regarding impact for each type of source, and provide a monitoring and reporting plan. Applicants for WMPs are also required to comply with SRBC or DRBC regulations as applicable. As noted above,

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26. 35 P.S. § 691.1 et seq. See Sections 301 and 401 regarding prohibitions against pollution. PaDEP claims authority to regulate water withdrawals to avoid depletion of stream flows, which may cause pollution.

27. 58 P.S. § 601.101 et seq.

28. PaDEP does not purport to grant withdrawal rights when it approves a WMP; these continue to be governed by riparian rights under the common law. See Weston, supra note 25.

29. PaDEP provides a model WMP that operators can fill in and submit for approval. The model and instructions are available at http://www.dep.state.pa.us/dep/deputate/minres/oilgas/new_forms/marcellus/marcellus.htm.
PaDEP reviews the WMP to protect stream flow. According to a recent review of Pennsylvania’s regulatory program, the Department intends to revise Chapter 78 of the Pennsylvania Code to propose additional WMP requirements.\textsuperscript{30}

The Pennsylvania Water Resources Planning Act (“Act 220”) provides for preparation and periodic updating of the State Water Plan.\textsuperscript{31} The State Water Plan is recognized as a mandatory consideration in some state regulations and serves as a policy and guidance document for others. Act 220 requires registration and annual reporting of withdrawals and water uses by anyone who withdraws or obtains more than 10,000 gallons per day averaged over any thirty-day period, from surface water, groundwater, or purchase. PADEP promulgated rules in 2008 to govern the monitoring, recordkeeping and reporting of water use.\textsuperscript{32} Nothing in Act 220 or its regulations authorizes or expands PaDEP’s authority to regulate, permit or control water allocation or water withdrawal, but the registration of water uses allows the Department to begin the process of tracking this activity.

2. \textit{The SRBC Regulatory Regime for Water Sourcing}

The SRBC is a federal/interstate commission that was created by the Susquehanna River Basin Compact\textsuperscript{33} in 1970. Since 2008, the SRBC has had jurisdiction over withdrawal and consumptive use of water for all natural gas well development projects, irrespective of water quantity.\textsuperscript{34} The SRBC adapted its water management program for natural gas extraction with rule revisions in January 2009, November 2009, and again on November 1, 2010.\textsuperscript{35}

Under SRBC rules, operators obtain approval for water withdrawal at SRBC quarterly business meetings called “dockets.” The SRBC evaluates water withdrawal applications on the basis of environmental screening, aquatic resource surveys, aquifer testing, cumulative im-

\begin{itemize}
\item 30. STRONGER, \textit{supra} note 5, at 11.
\item 31. 27 Pa. Cons. Stat. § 3101 \textit{et seq.}
\item 33. 18 C.F.R. §§ 806.2 - 806.3 (2010).
\item 34. 73 Fed. Reg. 78618 (Dec. 23, 2008); 18 C.F.R. § 806. The SRBC, however, does not regulate water quality of surface waters in the basin; water quality management is left to each of the states in the commission. Likewise, the SRBC does not regulate flowback disposal, but does require reporting of information to allow the commission to track water uses and destinations.
\item 35. 75 Fed. Reg. 60617 (Oct. 1, 2010); 18 C.F.R. §§ 806, 808.
\end{itemize}
pact evaluations, intake design and metering plans. Environmental screenings consider stream classifications, passby flow determinations, water quality, adjacent wetlands, and other factors. Docket approvals take from six months to a year to complete. Between June 2008 and June 2010, the SRBC issued 123 approvals for surface water withdrawals for natural gas operations, 22 approvals for use of water from public water supply systems, and 1 approval for groundwater withdrawal. While water in the basin may be plentiful, the SRBC closely reviews withdrawals from headwater streams and exceptional value streams and considers ecological flows and long-term planning.

In addition to withdrawal approvals, operators must obtain consumptive use approvals for water that is not returned to the basin, such as water used in fracking wells. SRBC staff may approve consumptive uses on a drilling pad basis under the Approval by Rule ("ABR") process, which takes up to thirty days and is effective for five years from issuance. As of September 2010, SRBC had approved consumptive use at approximately 1,000 drilling pad sites. Operators are required to mitigate consumptive uses during times of low flows to protect water supplies and instream uses.

3. The DRBC Regulatory Regime for Water Sourcing

The DRBC is a federal/interstate commission that was created under the Delaware River Basin Compact among the federal government and the states of Delaware, New Jersey, New York and Pennsylvania to manage water resources in an integrated manner for the benefit of all citizens of the basin. In May 2009, the DRBC Executive Director issued a determination under 18 C.F.R. § 401.35(a) that the DRBC has jurisdiction over all shale gas development projects in special pro-

37. Id. at 15. The SRBC may also approve diversions of water into the basin for the use of water that has been withdrawn outside of the basin. See 18 C.F.R. § 806.24(c) (2010).
38. See 18 C.F.R. § 806.22(c).
40. 18 C.F.R. § 401 (2009)
tection water drainage areas, which is effectively all Marcellus Shale projects in the basin.\textsuperscript{41}

The DRBC reviews projects within its jurisdiction for consistency with the Delaware River Basin Comprehensive Plan, most of which is compiled as the DRBC Water Code.\textsuperscript{42} Projects are reviewed for such factors as the need for the withdrawal, alternative sources available, impacts on other uses in the area and on instream uses downstream of the point of extraction, proposed mitigation measures and other issues.

In December 2010, the DRBC proposed a new Article 7 of its Water Quality Regulation to protect water resources of the basin during construction and operation of natural gas development projects.\textsuperscript{43} Proposed Article 7 applies to water withdrawal, well pad infrastructure, and wastewaters. Existing regulations apply to water withdrawals that are triggered by volume thresholds; the proposed regulation will require approval of water sources for all natural gas development irrespective of volume.

The proposal requires a Natural Gas Development Plan if the operators have total lease holdings in the basin over 3,200 acres or intend to construct more than five natural gas well pads for any type of natural gas well. The plan must identify the foreseeable development in a defined geographic area so that water resources can be protected through broad scale lease planning rather than site-by-site decision making.

Existing procedures for obtaining a Commission decision on a project application, like docket approvals under SRBC jurisdiction, generally take six to nine months. The proposal provides a streamlined ABR process, like the SRBC practice noted above, for eligible projects. ABR will be available for water supply projects involving reuse of recovered flowback and production fluids as make-up water for fracking natural gas wells, while docket approvals will still be required for new water sources. The proposal encourages the use of AMD, POTW effluent and cooling water, as well as recovered flowback and production water for fracking.

\textsuperscript{41} Determination of the Executive Director Concerning Natural Gas Extraction Activities in Shale Formations within the Drainage Area of Special Protection Waters, DRCB (May 19, 2009), http://www.state.nj.us/drbc/naturalgas.htm.

\textsuperscript{42} The DRBC Water Code is available at www.state.nj.us/drbc/regula.htm.

\textsuperscript{43} The proposal is available at http://www.state.nj.us/drbc/notice_naturalgas-draftregs.htm.
The final DRBC rule will likely be modified in response to comments, which were accepted through mid-April, 2011. As of April 13, over 6,000 comments had been received, including those of the PaDEP. The Commission issued a moratorium in June 2010 on new applications for pad or drilling approvals until rulemaking is complete.

C. Evolving Regulatory Issues for Water Sourcing

While the water demands to develop Marcellus Shale are relatively small when compared to other uses, e.g., golf courses and power plants, there is some concern with the cumulative impacts from all consumptive uses during drought and low flow. In response, federal and state regulatory agencies are all strengthening their focus on and requirements for cumulative impacts analysis (“CIA”). Both SRBC and DRBC require CIA as part of the approval process for water withdrawals. PaDEP also considers CIA when it approves WMPs under the oil and gas permitting program. In early April 2011, a coalition of environmental groups petitioned the Council on Environmental Quality and numerous federal agencies to complete a “programmatic environmental impact statement and regulations addressing the cumulative impacts of drilling in the Marcellus Shale formation in the Chesapeake Bay states.” The petition asks for more than the EPA HF Study Plan, which is focused on drinking water impacts, discussed below. It remains to be seen how the White House will respond to this latest demand for additional federal oversight of Marcellus drilling operations.

III. Flowback - Recycling, Reuse, Treatment and Disposal Issues

44. The Groundwater Protection Council estimates that water use for shale gas development will range from less than 0.1% to 0.8% of total water use by basin. DOE Primer, supra note 6, at ES-4.

45. The petition is also directed to EPA, U.S. Departments of Interior, Agriculture, Energy, and Transportation, as well as the U.S. Army Corps of Engineers and the Federal Energy Regulatory Commission.

Anywhere from 10-30% of HF Fluid used in fracking Marcellus wells is brought back to the surface after fracking.\textsuperscript{47} Flowback in Pennsylvania is managed in four different ways: 1) reuse to fracture additional wells; 2) treatment and discharge to surface waters;\textsuperscript{48} 3) injection into underground disposal wells; or 4) transportation to out-of-state facilities. Typical flowback contains 4-25% salts, including constituents from underground formations. Flowback and produced waters present treatment and discharge challenges because of high total dissolved solids (“TDS”), as well as high chlorides.\textsuperscript{49} Other constituents of concern include barium, strontium, and naturally occurring radioactive material (“NORM”), which is discussed below. With TDS levels exceeding 100,000 mg/l, flowback and produced water treatment and transportation present significant costs that are driving operators to investigate all available options for on-site treatment, as well as recycling and reuse.\textsuperscript{50} Large operators are currently reusing 95-100% of flowback in response to operational costs, sourcing, and disposal challenges.\textsuperscript{51}

A. Federal and State Regulation of Wastewaters

1. Federal Regulation and Oversight

\textsuperscript{47} EPA HF Study Plan, supra note 2, at 36.
\textsuperscript{48} On April 19, 2011, PaDEP called on natural gas drillers to stop sending wastewater to treatment facilities in Pennsylvania by May 19. See http://www.portal.state.pa.us/portal/server.pt/community/news_releases/14288. While fifteen treatment facilities have valid permits to accept such waste, this “request” will significantly affect those operations.
\textsuperscript{49} Chemical additives in HF Fluid, which account for .01% to .05% of the volume, include biocides, corrosion inhibitors, acids and friction reducers. See DOE Primer, supra note 6, at 61; EPA HF Study Plan, supra note 2, at Table 4. Operators and service providers are actively researching and developing “green” alternatives to accomplish the same functions as the chemical additives.
\textsuperscript{50} The U.S. Department of Energy’s National Energy Technology Laboratory sponsors numerous research projects related to shale gas drilling and water issues. See http://www.netl.doe.gov/technologies/oil-gas/Projects/ENV_TOC.html#Produced for a list of ongoing projects, including Sustainable Management of Flowback Water during Hydraulic Fracturing of Marcellus Shale for Natural Gas Production, being conducted by the University of Pittsburgh and Carnegie Mellon University.
\textsuperscript{51} Joe Frantz, Vice President of Engineering for Range Resources, Mike Butcher, Director of Drilling for EQT, and Martyn Memory, Water Usage Engineer for Talisman Energy, Comments at the Shale Gas Water Management Conference, Canonsburg, PA (April 13, 2011).
The Clean Water Act is the primary federal law governing pollution of surface water. The Act requires National Pollutant Discharge Elimination System (“NPDES”) permits for any discharge of treated flowback or produced waters.\textsuperscript{52} Effluent limits under the Clean Water Act are based on either technology-based or water quality-based limits.\textsuperscript{53} PaDEP administers the NPDES permitting system in Pennsylvania, as discussed below. Flowback water is exempt from Resource Conservation and Recovery Act (“RCRA”) Subtitle C hazardous waste regulation, but is subject to state regulatory regimes for solid wastes.\textsuperscript{54}

The Clean Water Act also requires states to identify waters for which technology-based effluent limits fail to achieve water quality necessary to protect designated and existing uses.\textsuperscript{55} In its Integrated Water Quality Report, submitted to EPA for approval in December 2010, PaDEP proposed to list sixty-eight miles of the Monongahela River as being impaired for sulfate. If EPA approves the report, a Total Maximum Daily Load (“TMDL”) must be established for sulfate in the designated reaches of the Monongahela River.\textsuperscript{56} A new TMDL for sulfate would allocate loadings among point and non-point discharges, which may further restrict discharges from new and existing treatment facilities accepting wastewater from gas extraction activities. It remains to be seen how this will impact flowback and produced water disposal options.

In 2010, Congress directed EPA to conduct a study on risks to surface and/or underground sources of drinking water presented by hydraulic fracturing activities.\textsuperscript{57} EPA submitted its Draft HF Study Plan to the Science Advisory Board (“SAB”) for review in February

\textsuperscript{52} 33 U.S.C. § 1342 (1948, as amended) requires NPDES permits for any point source discharge of pollutants to surface waters of the United States.

\textsuperscript{53} 40 C.F.R. § 435 Subpart C (2010) applies to discharges associated with shale gas development. PaDEP administers the NPDES permitting program in the Commonwealth and has its own effluent limits at 25 Pa. Code Chapter 95, discussed further below.


\textsuperscript{55} 33 U.S.C. § 1313(d) (1948, as amended).


\textsuperscript{57} Further information about EPA’s Hydraulic Fracturing study is available at http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/index.cfm.
2011. The study will review issues related to water acquisition, flowback treatment and disposal, and all of the steps in between. As for wastewater treatment, EPA has posed the research question as “What are the possible impacts of inadequate treatment of hydraulic fracturing wastewaters on drinking water resources?” Noting that underground injection is the primary method for disposal in all major gas shale plays except Marcellus, EPA intends to analyze existing data, conduct laboratory studies and prospective case studies to evaluate treatment and disposal methods in this region. While some reports from the study are due in 2012, reports from prospective case studies related to wastewater treatment and disposal are expected in 2014.

2. State Regulation of Transfer, Treatment and Disposal of Flowback

If it is not recycled or reused, flowback is residual waste under Pennsylvania law. In addition, any residuals from wastewater treatments, including salts, must be managed under Pennsylvania solid waste rules. PaDEP rules require natural gas extraction operators to send all wastes to appropriate permitted facilities. PaDEP standard

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60. EPA has proposed both retrospective and prospective case studies, including possible locations in Bradford, Susquehanna, Green, and Washington Counties in Pennsylvania. Retrospective studies will be related to suspected impacts of spills, as well as source determination of methane in private wells, two areas outside the scope of this article.

permit conditions also require generators of flowback to conduct waste characterization in accordance with residual waste rules. Operators use both their knowledge and sampling to determine the physical and chemical composition of the materials being disposed. Information pertaining to waste volumes and disposal or recycling are submitted annually to the Bureau of Oil and Gas Management.

Treatment facilities receiving new types of industrial wastes must obtain PaDEP approval if those types were not reflected in the original NPDES permit application. In 2010, the Department received inquiries about new wastewater treatment facilities for treatment of flowback; at the end of 2010, regional staff was reviewing about twenty-five applications that were submitted. Newer centralized treatment facilities have no discharge, but sell treated water back to operators for reuse. In Pennsylvania there is no additional permitting requirement to reuse flowback water at another well site.

In addition to its solid waste rules, PaDEP recently finalized Chapter 95 revisions, which include provisions to address the discharge of wastewaters from natural gas operations. Revised Chapter 95 creates a new requirement for each operator to adopt and implement a wastewater source reduction strategy by August 2011. These strategies are to maximize recycling and reuse of flowback to fracture other wells or for other beneficial uses. New discharges from natural gas operations are allowed only through centralized treatment facilities with strict direct discharge and indirect pre-treatment discharge limits. As noted above, TDS levels in flowback and produced water may exceed 100,000 mg/l; Chapter 95 requires monthly average effluent limits of 500 mg/l TDS and 250 mg/l of total chlorides for flowback discharge from centralized waste treatment facilities. Note that operators

2540-PM-BWM0347 (Rev. 7/2009), which was recently revised to incorporate a comprehensive list of constituents to be analyzed.
63. NPDES permitting is conducted by PaDEP under delegated authority from EPA, pursuant to 33 U.S.C. § 1251 et. seq. and in accordance with 40 C.F.R. § 122.
65. STRONGER, supra note 5, at 23. See also 25 Pa. Code § 287.1 et seq. regarding co-products and beneficial uses that remove those materials from the definition of solid waste.
68. 25 Pa. Code § 95.10(b)(2).
cannot discharge to surface waters from a well site, even where treatment options are utilized. High transportation and treatment costs of compliance with revised TDS limits under Chapter 95 provide all the more incentive for industry to develop alternatives to disposal of flowback and produced water.

In May 2010, PaDEP had proposed new Chapter 93 instream water quality criteria for chlorides, for the protection of aquatic life. The Department’s proposed chloride standard was based upon 1988 EPA Guidance. In July, however, the Independent Regulatory Review Commission reviewed the standard, noting concerns that the 1988 standard was out of date. The rule has not been finalized as of April 2011.

3. **DRBC Proposed Regulations for Flowback and Wastewater Treatment and Disposal**

As noted above, the DRBC proposed a new article to its Water Quality Regulations to address both water sources and wastewater from natural gas activities. Proposed Section 7.6 creates requirements for wastewater treatment facilities within the basin. Such facilities may accept wastewater from natural gas development projects only if the facility first obtains approval from the DRBC in the form of a docket or modification of an existing docket. Treatability studies must demonstrate that acceptance of the wastewater will not interfere with the facilities operations and that the discharge will comply with applicable Safe Drinking Water Act standards where surface water may be used as a public water supply. The DRBC’s basin-wide objective for TDS is 133% of background, not to exceed 500 mg/l.

B. **Industry Response to Wastewater Issues**

1. **Treatment Technologies**


   70. See details of the regulatory process as well as comments by the Independent Regulatory Review Commission at http://www.irrc.state.pa.us/Regulations/RegInfo.cfm?IRRCNo=2841.

Conventional treatment technologies had not addressed the TDS and chloride challenges presented by flowback or produced waters from natural gas extraction. Existing treatment facilities that discharge to surface waters of the Commonwealth have limited capacity and capability to handle the volumes, constituents or concentrations of wastewater generated by drilling operations. Large quantities of sodium and chloride may be detrimental to digesters and can result in high TDS concentrations in the effluent. Pennsylvania regulations currently limit the disposal of production waters at POTWs to less than one percent of the POTW average daily flow.

Developing treatment technologies include evaporation, crystallization, ion exchange, reverse osmosis membrane desalination, nanofiltration, carbon adsorption, pressure filtration, and dissolved air flotation. TDS reduction is possible through reverse osmosis, which can be effective for influents with TDS concentrations of about 40,000 to 50,000 mg/L, or ppm. Given the high TDS levels in Marcellus produced wastewater, reverse osmosis is not feasible without some form of pretreatment. Evaporation/crystallization is a treatment technology being developed as both mobile and permanent treatment technologies. This technology reportedly can achieve the new Pennsylvania Chapter 95 effluent limit of 500 mg/l TDS but yields a significant amount of a solid waste residual, a salt cake, that must be disposed if it cannot be beneficially used. The process is expensive and energy intensive but service providers are developing treatment options for a variety of conditions. As noted above, PaDEP has received numerous applications for new treatment facilities, which must also meet requirements for state and local criteria, zoning, discharge permitting, air quality permitting, and management of residuals.

2. Recycle and Reuse

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72. EPA HF Study Plan, supra note 2, at 40.
74. Id.
Due to costs and restrictions related to transportation, treatment, and discharge of high TDS wastewater, interest in reuse of flowback is high. Reuse of flowback requires treatment and/or dilution to address a series of technical issues, including the lowering of TDS that could interfere with fracking and other uses. Operators can dilute flowback water with fresh or treated water to attain the necessary TDS/chlorides values for reuse, but researchers and private entities are also developing mobile treatments to treat flowback at the well site to enable efficient reuse possibilities. PaDEP has issued three residual waste beneficial use general permits, which are available for facilities that treat flowback for reuse in the Marcellus Shale. Under these beneficial use permit conditions, flowback that is processed under the permit is not considered to be a waste under Chapter 287 of the Pennsylvania Code. Estimates of recycling rates of flowback exceed 60% in Pennsylvania in 2010, while some operators now claim 100% reuse. There is some question about whether reusing flowback without registering under a beneficial use permit constitutes disposal of a residual waste without a permit, or if such use meets a recycling exemption under Section 287.1 of Title 25 of the Pennsylvania Code. This regulatory issue is yet to be resolved.

3. Underground Injection Control (“UIC”)

75. STRONGER, supra note 5, at 22. See also supra note 39 regarding projects conducted in conjunction with the U.S. Department of Energy, including Pilot Testing: Pretreatment Options to Allow Re-Use of Frac Flowback and Produced Brine for Gas Shale Resource Development, being performed by Texas A&M University, among others.


77. STRONGER, supra note 5, at 22. See also Expert Says Drillers Reusing Two-Thirds of Water, NGI’S SHALE DAILY (Mar. 23, 2011), available at http://marcelluscoalition.org/2011/03/what-independent-experts-are-saying-about-marcellus-shale-water-management/. Industry has claimed up to 100% recycling of flowback, but these numbers have been challenged because reporting numbers to PaDEP have not yet matched up to support that claim. Scott Perry, PaDEP Director of the Bureau of Oil and Gas Management, Comments at the Shale Water Management Conference, Canonsburg, PA (April 14, 2011).
EPA administers the Safe Drinking Water Act\textsuperscript{78} UIC program in Pennsylvania.\textsuperscript{79} The UIC program does not generally apply to the hydraulic fracturing operations related to gas production.\textsuperscript{80} According to EPA, however, the UIC program does apply to hydraulic fracturing operations using diesel fuel as an additive, and the associated wells are Class II wells. The Independent Petroleum Association of America and the U.S. Oil and Gas Association have challenged this new interpretation of the UIC’s applicability,\textsuperscript{81} which was not promulgated through notice and comment rule-making procedures under the Administrative Procedures Act.\textsuperscript{82} As for UIC wells used for disposal of flowback or produced waters from fracking operations, however, there are very few in Pennsylvania because of both regulatory and geologic hurdles.\textsuperscript{83} The geology beneath Ohio appears to be better suited for disposal of flowback in UIC wells and many Pennsylvania operators send wastewaters to Ohio for underground injection.

**CONCLUSION**

As Marcellus Shale has gained the attention of the media,\textsuperscript{84} environmental groups,\textsuperscript{85} the United States Congress, and the public at

\textsuperscript{78.} 42 U.S.C. § 300f, et seq.
\textsuperscript{79.} Federal standards for UIC can be found in 40 C.F.R. § 146.1 et seq. Class II wells may inject brines and other fluids associated with oil and gas production. In Pennsylvania, injection wells are also regulated under 25 Pa. Code § 78.18, which provides for permitting of disposal or enhanced recovery wells under a gas well permit. PaDEP requires submission of the federal UIC permit, as well as control and disposal plans under 25 Pa. Code § 91.34. The DRBC invokes project review jurisdiction over UIC wells in the Delaware Basin.
\textsuperscript{80.} The Energy Policy Act modified Clean Water Act Section 402 in 2005; 42 U.S.C. § 300h(d) exempts fracking from the definition of “underground injection.”
\textsuperscript{82.} 5 U.S.C. § 500 et seq. (1946, as amended).
\textsuperscript{83.} STRONGER, supra note 5, at 11; DOE Primer, supra note 6, at 69, Exhibit 39.
\textsuperscript{84.} The New York Times conducted data reviews and printed stories alleging that Pennsylvania waters were contaminated with radiation from natural gas production wastewaters. Toxic Contamination From Natural Gas Wells, NEW YORK TIMES, (Feb. 26, 2011), http://www.nytimes.com/interactive/2011/02/27/us/natural-gas-map.html. DEP has refuted the claim based on its own studies and monitoring results, which are ongoing. Some soils and geologic formations contain low levels of naturally occurring radioactive material (“NORM”). DOE Primer, supra note 6,
large, there is increasing scrutiny of both the regulatory regimes and industry practices. As noted above:

- EPA has heightened its scrutiny of Pennsylvania’s regulations, as well as the water implications of hydraulic fracturing across the United States.
- STRONGER evaluated Pennsylvania’s regulatory structure for natural gas extraction and gave it high marks; and
- PaDEP, SRBC and DRBC continue to evaluate and revise the relevant regulations to manage water withdrawals and wastewater disposal.

In addition, Pennsylvania’s Governor Tom Corbett created a Marcellus Shale Advisory Commission, which is to “develop a comprehensive, strategic proposal for the responsible and environmentally sound development of Marcellus Shale.” The Commission is made up of key stakeholders and experts from the environmental community, natural gas industry, local government representatives and state government officials. The Commission has begun meeting, formed work groups, and is to report to the Governor by July 22, 2011.

As for industry practices, the Marcellus Shale Coalition (“MSC”) (a private coalition of operators, service providers, and other interested parties) has numerous subcommittees that develop and share best practices so that all operators, large and small, can benefit from their collective experience. Through the MSC and elsewhere, industry and the agencies are working, both independently and together, to develop rules and practices that allow for safe and effective development of this important energy resource.

at 70. The fracking process that releases gas from the formation also releases uranium trapped inside the shale, but the radiation from this NORM is generally weak. Id. at ES-4. Operators need to be vigilant on this question and continue to monitor radioactive levels in wastewaters.

85. In March 2011, two environmental groups—Clean Water Action and Three Rivers Waterkeeper—served a sixty-day Notice of Intent to sue treatment operations in Greene County, claiming that the facilities are in violation of the federal Clean Water Act for discharging Marcellus wastewater without a permit. This may be the first legal action, but likely not the last, challenging the discharge of Marcellus wastewater through municipal treatment facilities.

While there was a lot of public attention in early 2011 to the issues of water sourcing and disposal resulting from the active development of Marcellus Shale in Pennsylvania, these may be two of the least controversial water issues by the end of 2011, as both regulators and industry increase the efficiencies and reduce the impacts of water use and management. There is, however, no foreseeable end to this multifaceted and fascinating conversation, in which every person of this Commonwealth is a stakeholder.