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Hannah J. Wiseman

Florida State University College of Law

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REGULATORY ADAPTATION IN FRACTURED APPALACHIA

HANNAH WISEMAN¹

Abstract: America faces a growing energy challenge. We require energy for our every activity, yet we increasingly recognize that there are no easy energy solutions. Reliance upon traditional fossil fuels—many of them imported—jeopardizes our national security and releases harmful emissions, yet renewable energy technologies require high capital investments and have environmental impacts of their own. As we address this challenge and move toward a more sustainable energy future, “bridge fuels” like domestically-produced natural gas offer a near-term compromise between renewables and traditional fossil fuels. A growing quantity of bridge fuel in the form of domestic natural gas is produced from American shales through a process called hydraulic fracturing, and this practice is booming in the Appalachian region. Some residents of this region are now asking how this type of extraction can and should occur while adequately preventing potential harm to their health and their treasured natural resources. This Article investigates how state regulation has adapted to address this concern and argues that regulations must improve in some areas; it suggests steps toward state improvement and briefly explores additional federal options. The Article concludes that improved regulations are important to address potential environmental- and health-related concerns and to serve as a model for future regulatory transitions in the energy area as America slowly shifts toward a new energy base.

INTRODUCTION

America is witnessing a historic shift in the fuels used to power factories, homes, businesses, and vehicles. As climate change and energy security concerns have expanded² since the last sharp warning of the 1970s oil crisis, the need to rethink our reliance upon traditional energy sources has become even more apparent and

1. Visiting Assistant Professor, University of Texas School of Law. Beginning in August 2010, the author will be an Assistant Professor at the University of Tulsa College of Law. The author wishes to thank Phillip Bender of K&L Gates in Pittsburgh for his extensive comments on this piece.

2. See, e.g., Jacqueline Lang Weaver, *The Traditional Petroleum-Based Economy: An “Eventful” Future*, 36 CUMB. L. REV. 505, 506 (2005-06) (describing energy companies’ advertisements featuring citizens concerned about “the future of energy and global climate change”).

has, along with volatile energy prices, contributed to this shift.³ Careful consideration of the several options for fuels that could be part of a changing energy mix, however, shows that the choices are difficult. Renewable resources like solar, wind, and geothermal heat are sustainable, clean fonts of energy, but they are not immediately accessible. The materials required to build the thousands of solar panels and wind turbines necessary to capture abundant renewable fuels are in high demand,⁴ and the many infrastructural changes needed for a massive renewables construction effort cannot be made overnight and have important environmental impacts.⁵ Assuming that Americans are not willing to uproot themselves en masse to move to energy sources or to immediately build enough distributed renewable generation (rooftop solar panels and backyard wind turbines, for example⁶) to power their own neighborhoods, utilities must construct thousands of miles of transmission lines from the areas where the renewable resources are most abundant to regions of high energy demand.⁷ And the grid—the sprawling infrastructure of wires and computers that balances electron flow and ensures a constant, reliable supply of electricity—must be upgraded to accommodate the more variable quantities of electricity produced by solar and wind.⁸

3. See Stephen Harland Butler, Comment, *Headwinds to a Clean Energy Future: Nuisance Suits Against Wind Energy Projects in the United States*, 97 CAL. L. REV. 1337, 1338 (2009) (observing that “[w]hile gasoline prices have remained volatile since a spike in 2008, climate change concerns have intensified, the . . . administration has pushed for increased investment in renewable energy, and America’s economic dependence on imported fossil fuels appears increasingly unsustainable”).

4. F.E. Trainer, *Can Renewable Energy Sources Sustain Affluent Society?* 23 ENERGY POL. 1009, 1018 (1995) (describing massive demand for materials such as steel and glass that would arise if renewable sources provided the world’s power).

5. See, e.g., Craig K.R. Willis et al., *Bats are not Birds and Other Problems with Sovacool’s (2009) Analysis of Animal Fatalities Due to Electricity Generation*, 38 ENERGY POL. 2067, 2067, 2069 (2009) (observing that “bats face the most widespread and worrisome species-level conservation consequences from wind turbines” and estimating, from a sample of six sites, a total fatality rate of 2.94 birds and bats (combined) per gigawatt-hour of wind energy produced).

6. Thomas Ackermann, Göran Andersson, Lennart Söder, *Distributed Generation: A Definition*, 57 ELECTR. POWER SYS. RESEARCH 195, 198 (2001) (listing distributed generation technologies).

7. See, e.g., Public Utility Comm’n of Tex., Docket No. 33672, *Competitive Renewable-Energy Zones Transmission Optimization Study 24* (Apr. 2, 2008) (describing a chosen transmission scenario that would require approximately 2,334 miles of new 345-kilovolt transmission lines to transmit electricity from wind farms in West Texas to population centers). Not all of these lines, however, would require new rights-of-way.

8. N. AM. ELEC. RELIABILITY CORP., *ACCOMMODATING HIGH LEVELS OF VARIABLE GENERATION 2* (Apr. 2008), available at http://www.nerc.com/docs/pc/ivgtf/IVGTF_Outline_Report_040708.pdf.

Several nonrenewable energy options offer a quicker, although not ultimately sustainable,⁹ fix. These are sometimes called “bridge fuels”—a term that describes the domestically-available, relatively clean resources upon which Americans can rely as we move toward a more sustainable energy base.¹⁰ The quintessential bridge fuel in America may be natural gas,¹¹ which is abundant and unit-per-unit releases relatively few greenhouse gas emissions when burned, as compared to other traditional fuels such as coal.¹² For the many energy-consuming entities that have relied upon traditional fuels for the past century or so, moving from petroleum or coal to a lower-emission fuel like natural gas produced in America is not as difficult as the longer-term transition to renewables. Some fuel-switching power plants, for example, can quickly shift from petroleum to natural gas.¹³ And trucks, cars, and buses can be—and al-

9. In a draft report on a sustainable energy economy, the National Science Board defines “sustainable energy” “broadly,” as including energy sources with “lower total and per unit green house gas emissions” that also “reduce U.S. dependence on imported energy sources” and are “affordable, safe, and available in sufficient quantity to enable continued economic and social development while promoting environmental stewardship.” NAT’L SCI. BD., BUILDING A SUSTAINABLE ENERGY FUTURE 9 (Apr. 2009), available at http://www.nsf.gov/nsb/publications/2009/comments_se_report.pdf. This Article envisions a similar definition when applying this term, although with more of a focus on the availability of the energy source. The fact that nonrenewable sources of energy cannot be regenerated within a short period of time in human terms makes them ultimately unsustainable. See Alicia Valero et al., *Inventory of the Exergy Resources on Earth Including its Mineral Capital*, 35 ENERGY 989, 989 (2010). Of course, as discussed in the text, nonrenewable fuels, although not sustainable, seem to be a necessary bridge to a future, more sustainable energy economy. See, e.g. OUR COMMON FUTURE: REPORT OF THE WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT, Ch. 2, Item 1.12 (1987), available at <http://www.un-documents.net/ocf-02.htm#I> (last visited Feb. 10, 2010) (explaining that the use of nonrenewable fossil fuels “reduces the stock available for future generations” but that these fuels are necessary in the absence of substitutes).

10. See J. Rothstein, *Hydrogen and Fossil Fuels*, 20 INT’L J. HYDROGEN ENERGY 283, 284 (1993); CTR. FOR AM. PROGRESS, NATURAL GAS: A BRIDGE FUEL FOR THE 21ST CENTURY, available at http://www.americanprogress.org/issues/2009/08/bridge_fuel.html (last visited Feb. 10, 2010).

11. But see John Gray, *Comment, Choosing the Nuclear Option: The Case for a Strong Regulatory Response to Encourage Nuclear Energy Development*, 41 ARIZ. ST. L.J. 315, 324 (2009) (arguing that natural gas is not a bridge fuel because “[i]t produces harmful emissions that contribute to global warming and it risks economic and political instability as global demand continues to outpace supply”).

12. Weaver, *supra* note 2, at 515-16 (explaining the benefits of natural gas).

13. See, e.g., U.S. Energy Info. Admin., *Electric Power Annual, Electric Power Industry 2008: Year in Review*, http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html (last visited Feb. 10, 2010) (indicating that power plants representing thirty percent of electric capacity reported an ability to switch between oil and natural gas in 2008).

ready have been—built to burn natural gas instead of gasoline.¹⁴ Alternatively, plug-in hybrid drivers will soon¹⁵ be able to charge their vehicles with electricity produced from a variety of energy sources, including natural gas-fired power plants.¹⁶

Quick-fix bridge fuels like natural gas will be a necessary piece of America's energy transition to a sustainable future, and their production has rapidly increased.¹⁷ Like renewables, however, these fuels introduce important concerns. One of the greatest challenges is the regulation of the means of extracting these fuels. In the rush to make America more energy secure, communities around the country that are experiencing the brunt of the boom are raising a legitimate and difficult issue: how regulators will ensure that a move toward cleaner fuel does not damage essential natural resources, from drinking water and wetlands to treasured trout streams and secluded lakes.¹⁸ This question is central because the

14. See Natural Gas and the Pickens Plan: Reducing Our Reliance on Foreign Oil, available at http://www.pickensplan.com/energy_independence/ (last visited Feb. 10, 2010) (discussing cars that run on natural gas). T. Boone Pickens estimates that there are "10 million vehicles in the world running on natural gas," 130,000 of which are in the United States. *Id.*

15. See Toyota, 2010 Prius Plug-in Hybrid Makes North American Debut at Los Angeles Auto Show, <http://pressroom.toyota.com/pr/tms/toyota/2010-prius-plug-in-hybrid-makes-149402.aspx> (last visited Feb. 10, 2010); Chevrolet, 2011 Volt, <http://www.chevrolet.com/pages/open/default/future/volt.do> (last visited Apr. 12, 2010) (advertising a plug-in car).

16. Natural gas produced more than twenty-one percent of America's electricity in 2008. U.S. Energy Info. Admin., Electric Power Annual, available at http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html (last visited Feb. 10, 2010); see also Weaver, *supra* note 2, at 518 (observing that "[o]f the new power plants built between 2000 and 2004, 90% were powered with natural gas and many had no alternative fuel capability").

17. U.S. Energy Info. Admin., Monthly U.S. Dry Natural Gas Production, <http://tonto.eia.doe.gov/dnav/ng/hist/n9070us2m.htm> (last visited Apr. 19, 2010) (showing a generally steep monthly rise in U.S. natural dry gas production since 2006, with occasional declines).

18. Delen Goldberg, *Syracuse Urges State DEC to Ban Hydrofracking in the Skaneateles Lake Watershed*, POST-STANDARD, Jan. 12, 2010, available at http://www.syracuse.com/news/index.ssf/2010/01/syracuse_urges_state_dec_to_ba.html (discussing city officials' concern about possible future contamination of Skaneateles Lake by fracking); Mike Lee & Elizabeth Campbell, *Rural Residents Worry About Barnett Shale Disposal Wells*, STAR-TELEGRAM, Dec. 26, 2009, available at <http://www.star-telegram.com/local/v-print/story/1854766.html> (describing residents' concerns about possible groundwater contamination); Fox 23 News, *Groups Protest Hydro-Fracking*, Jan. 26, 2010, available at <http://www.fox23news.com/news/local/story/Groups-Protest-Hydro-Fracking/XtTenR4bLEisDaFPAjxTPQ.csp> (last visited Feb. 15, 2010) (describing groups' protests of hydraulic fracturing in Albany and the groups' concerns about potential drinking water contamination). See also Pa. Council of Trout Unlimited, *Gas Drilling in the Marcellus Shale and Pennsylvania's Coldwater Resources*, Feb. 13, 2009, http://www.patrou.org/PDFS/Marcellus_Final_21309.pdf (stressing that the group is "adamant that this drilling be done in a manner that does not damage our natural resources").

methods of extracting America's abundant supplies of natural gas have recently changed substantially and have raised new concerns.

Natural gas extraction technology has rapidly advanced in the past several decades because many of the conventional natural gas fields in the United States are on the decline; they still produce massive quantities of fuel, but U.S. conventional reserves of natural gas peaked in the 1970s.¹⁹ The unconventional sources of gas²⁰—trillions of cubic feet of gas that are stubbornly attached to the substrate in which they rest—are therefore essential,²¹ and the primary method of natural gas extraction from these unconventional sources is a procedure called “hydraulic fracturing” or “fracing” (pronounced and sometimes spelled as “fracking”).²² Natural gas producers have used this extraction method for more than half a century,²³ but it only became commercially prevalent in shale formations in the 1990s, when fracing operators began drilling and

19. Weaver, *supra* note <CITE_Ref254021206>, at 519 (explaining that “[t]he production of natural gas from conventional domestic sources in the United States peaked in 1973”).

20. There are several forms of unconventional gas, some of which include coalbed methane, “deep natural gas” (typically 15,000 or more feet below ground), “tight” natural gas, and, more generally, “shale gas.” See U.S. Energy Info. Admin., *Impact of Unconventional Gas Technology in the Annual Energy Outlook 2000*, http://www.eia.doe.gov/oiaf/analysispaper/unconventional_gas.html (last visited Mar. 2, 2010); NaturalGas.org, *Unconventional Natural Gas Resources*, http://www.naturalgas.org/overview/unconvent_ng_resource.asp (last visited Mar. 2, 2010).

21. See, e.g., U.S. Energy Info. Admin., *International Energy Outlook 2009*, <http://www.eia.doe.gov/oiaf/ieo/highlights.html> (explaining the growth of the world energy market). The Outlook states that where “current laws and policies remain unchanged, the “world marketed energy consumption is projected to grow by 44 percent over the 2006 to 2030 period” and that “the largest increase [in natural gas production] among the OECD nations is projected for the United States, with unconventional gas comprising the “largest contributor to the growth in U.S. production.” *Id.*

22. Ben Casselman & Russell Gold, *Drilling Tactic Unleashes a Trove of Natural Gas—And a Backlash* A20, WALL ST. J., Jan. 21, 2010 (noting that “[t]oday, the industry estimates that 90% of all new gas wells are fractured”). The Texas Supreme Court uses the term “fracing” (see *Coastal Oil & Gas Corp. v. Garza Energy Trust*, 268 S.W.3d 1, 6 (Tex. 2008)), as do others in the industry. See, e.g., Chesapeake Energy, *Marcellus Shale Hydraulic Fracturing Fact Sheet 1* (Oct. 2009), available at http://www.chk.com/Media/MarcellusMediaKits/Marcellus_Hydraulic_Fracturing_Fact_Sheet.pdf. Others, however, use the term “fracking.” See, e.g., Jeff Brady, *Face-Off Over ‘Fracking’: Water Battle Brews on Hill*, NPR, May 27, 2009, available at <http://www.npr.org/templates/story/story.php?storyId=104565793>.

23. See *Coastal Oil & Gas Corp.*, 268 S.W.3d at 2 (identifying 1949 as the first date of commercial fracing); see also *Crocker v. Humble Oil & Refining Co.*, 419 P.2d 265, 271 (Okla. 1965) (explaining that “sandfracing was first discovered in 1948 and was first used commercially in 1949”).

fracing the Barnett Shale that underlies North Central Texas.²⁴ Since that time, fracing operators have rapidly and steadily increased production.²⁵ As their success in the Barnett has become apparent, Texas companies have moved north to the Marcellus Shale,²⁶ which is the largest unconventional natural gas shale play in the world.²⁷ In the Appalachian region, which overlies this massive formation, long convoys of seismic trucks and tankers have begun to roar through the rural hills of Pennsylvania and New York in search of more pools of abundant gas.²⁸

This Article focuses on this juncture. It follows the tankers and trucks through the winding roads of Appalachia and investigates the Marcellus states' adaptive responses to this groundswell of fracting activity—and particularly the Marcellus states' regulations that address potential damage to natural resources on the surface and associated human health concerns. This brief window of regulatory transition and its varied evolution by state is important because it provides valuable lessons for the future. As more technologies emerge to tap unconventional resources within America, state regulators—if they will continue to shoulder much of the regulatory burden—will need to develop effective methods of rapid adaptation to ensure that the extraction activity does not move at a pace that exceeds needed regulation.

24. R.R. Comm'n of Tex., Newark, East (Barnett Shale) Gas Well Gas Production 1993-2008, available at http://www.rrc.state.tx.us/barnettshale/NewarkEastField_1993-2008.pdf; see also John A. Harper, *The Marcellus Shale—An Old “New” Gas Reservoir in Pennsylvania*, 38 PA. GEOL. 2-10 (Spring 2008), available at <http://www.dcnr.state.pa.us/topogeo/pub/pageolmag/pdfs/v38n1.pdf> (observing that “it was not until development of the Barnett Shale play in the 1990s that a technique suitable for fracing shales was developed”).

25. R.R. Comm'n of Tex., *supra* note 24 (showing natural gas production from wells drilled in the Barnett Shale as increasing each year between 1993 and 2008, and rising from an initial 11 billion cubic feet in 1993 to 1.4 trillion cubic feet of natural gas producing in 2008).

26. Nat'l Energy Tech. Laboratory, U.S. Dep't of Energy, *Appalachian Shale Gas—Success in the Marcellus Brings Renewed Attention to NETL's Past and Present Gas Shale Programs*, E & P FOCUS 3 (2009), available at <http://www.netl.doe.gov/technologies/oil-gas/publications/newsletters/epfocus/EPNewsSummer09.pdf> (“In 2005, Range Resources took slick-water hydraulic fracturing techniques that had proved successful in the Barnett shale of Texas, and applied them to the Marcellus shale in Pennsylvania.”).

27. Timothy Considine et al., *An Emerging Giant: Prospects and Economic Impacts of Developing the Marcellus Shale Natural Gas Play* 3 (July 24, 2009), available at <http://www.allegHENYconference.org/PDFs/PELMisc/PSUStudyMarcellusShale072409.pdf>.

28. See, e.g., Tom Wilber, *Landowners Cry Foul over Seismic Searches*, MONTGOMERY ADVERTISER, Sept. 21, 2008, available at <http://www.montgomeryadvertiser.com> (describing the rise in seismic activity and landowners' objections).

Part I of this Article introduces the practice of hydraulic fracturing, particularly within the Marcellus states, and Part II sets the stage for the focus on state regulation, describing the lack of federal intervention into several aspects of the fracing process. Because this article focuses on the regulation of activities at the surface—as opposed to the introduction of substances into underground formations²⁹—Part II discusses federal regulation of fracturing-related activities and the exemption of certain of these activities from federal cradle-to-grave regulation of hazardous wastes. Part III introduces the state players, investigating the Marcellus states' regulatory approaches to this relatively new gas extraction practice. Finally, Part IV evaluates these approaches, asking whether the regulations are likely to prevent incidents of surface contamination of soil and water and accordingly ensure adequate protection of natural resources and human health.

The Article will conclude that progress has been made in reducing the risk of surface contamination from fracing activities but that more is needed in some areas. In light of the current absence of federal regulation of several stages of the fracing process, states and the federal government must reevaluate the assumption that individual state regulations consistently and adequately fill each and every federal gap. States, which currently administer many of the regulations that apply to fracing, also must ensure that fracing operators moving from one state to another—particularly from a state like Texas (with relatively low levels of regulation) to states overlying the Marcellus Shale³⁰—are aware of heightened regulatory requirements. Finally, federal and state regulators must focus

29. See generally Hannah Wiseman, *Untested Waters: The Rise of Hydraulic Fracturing in Oil and Gas Production and the Need to Revisit Regulation*, 20 *FORDHAM ENVTL. L. REV.* 115 (2009) (focusing on the introduction of substances subsurface).

30. Texas, for example, does not require minimum distances between gas wells and natural resources or water wells; it only provides basic "spacing" requirements, which are minimum required distances from property lines and from other wells on a tract. 16 *TEX. ADMIN. CODE* § 3.37 (2010). Further, fracing flowback water impoundments—the pits where waste from fracing is stored—appear to fall under the definition of "completion/workover pits" in Texas. 16 *TEX. ADMIN. CODE* § 3.8(a)(4) (defining a completion/workover pit as a "[p]it used for storage or disposal of spent completion fluids, workover fluids and drilling fluid, silt, debris, water, brine, oil scum, paraffin, or other materials which have been cleaned out of the wellbore of a well being completed or worked over"). See also R.R. Comm'n of Tex., *Water Use in the Barnett Shale*, Apr. 7, 2010, http://www.rrc.state.tx.us/barnettshale/wateruse_barnettshale.php (last visited Apr. 21, 2010) (describing "slick water fracing of a vertical well completion"). Texas does not require that a well operator obtain a permit to "maintain or use" completion/workover pits and reserve pits, and there is no liner requirement for these pits. 16 *TEX. ADMIN. CODE* § 3.8(d)(4).

more on the informational side of fracing. Regulatory agencies and policymaking bodies at the federal and state levels need more and better information to understand the composition of fracing materials as well as potential contamination routes and exposure pathways at the surface. While regulation should not and has not waited for information—millions of gallons of fluids are already being stored on the surface and disposed of³¹—regulators should refine their regulatory regimes as further information becomes available. And perhaps most importantly, they should ensure that the information needed is produced in the first place by requiring adequate reporting and disclosure of relevant facts.

I. HYDRAULIC FRACTURING IN THE MARCELLUS STATES

Hydraulic fracturing—a method of natural gas (and oil)³² extraction—is increasingly common throughout the United States but is expanding most rapidly in certain regions, including the Appalachian region that overlies the Marcellus Shale.³³ This Part describes the physical process of fracturing a gas well and then discusses the expansion of this process from Texas's Barnett Shale to the Marcellus states.

A. The Physical Practice of Hydraulic Fracturing

When a gas well is “fractured,” an operator first drills a well, just as it would do for a typical natural gas drilling operation. To drill this well, after obtaining the required land use approvals, leasing rights, and a permit to drill, the operator constructs a road to a planned well pad,³⁴ prepares and levels the pad with earthmoving equipment,³⁵ and then brings in drilling rigs. Many fractured wells

31. The New York State Department of Environmental Conservation estimates that a typical frac job would require “2.4 million to 7.8 million gallons of water.” N.Y. STATE DEP'T OF ENVTL. CONSERVATION, SUPPLEMENTAL GENERIC ENVIRONMENTAL IMPACT STATEMENT 5-92- 5-93 (2009), available at <ftp://ftp.dec.state.ny.us/dmn/download/OGdSGEISFull.pdf>.

32. Fracing is also sometimes used to extract oil. See Am. Petroleum Inst., Hydraulic Fracturing, <http://www.api.org/policy/exploration/hydraulicfracturing/> (last visited Apr. 16, 2010) (explaining that hydraulic fracturing in the United States has helped “produce 7 billion barrels of oil”).

33. See *infra* text accompanying notes 66-73. Shale fracing, or leasing with the intent to frac, is also becoming more common in the Fayetteville, Haynesville, Woodford, Antrim, and New Albany Shales. For a useful overview of these shales, see GROUND WATER PROTECTION COUNCIL & ALL CONSULTING, MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES: A PRIMER 19-24 (prepared for U.S. Department of Energy, Apr. 2009), available at http://www.netl.doe.gov/technologies/oil-gas/publications/EPreports/Shale_Gas_Primer_2009.pdf.56.

34. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-5.

35. *Id.* at 5-9.

are horizontal—a rig drills a vertical wellbore thousands of feet underground³⁶ and then “deviates” the drill bit, thus drilling a long,³⁷ lateral bore through the shale from the initial vertical bore. The drilling and later production processes bring up salty brine from underground,³⁸ which the operator temporarily stores on site before disposing of it. Prior to fracturing, the operator also “cases” (lines) the wellbore by cementing tubes made of steel or similarly strong material to the wellbore;³⁹ the casing helps to maintain the structure of the wellbore and to isolate the substances moving through the wellbore from other underground resources like fresh water.⁴⁰

There are several basic stages in the ensuing fracturing operation. The ultimate goal is to fracture and to encourage the expansion of natural fractures in the shale around the drilled well, thus exposing more shale surface area⁴¹ and releasing gas trapped within the shale. In what is called a “slickwater” fracture operation,⁴² which is an increasingly common method of fracing,⁴³ a frac-

36. See, e.g., *Coastal Oil & Gas Corp. v. Garza Energy Trust*, 268 S.W.3d 1, 5 (Tex. 2008) (describing a fraced formation in Texas that lies “11,688 and 12,610 feet below” the surface); N.Y. State Dep’t of Env’tl. Conservation, Marcellus Shale, <http://www.dec.ny.gov/energy/46288.html> (last visited Apr. 12, 2010) (explaining that “drilling activity [in the Marcellus shale] is expected to focus on areas where the Marcellus shale is deeper than 2,000 feet”).

37. In New York, “lateral distance drilled will normally exceed 2,000 feet and would most likely be 3,500 feet or more.” N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 5-19. In one Texas case, “fracing hydraulic length was designed to reach over 1,000 feet from the well,” although the evidence did not indicate whether the artificially-induced fractures had extended this far. *Coastal Oil*, 268 S.W.3d at 7.

38. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 5-128-5-129.

39. GROUND WATER PROTECTION COUNCIL, STATE OIL AND GAS REGULATIONS DESIGNED TO PROTECT WATER RESOURCES, 18 (prepared for the U.S. Department of Energy, May 2009), available at <http://www.gwpc.org/e-library/documents/general/State%20Oil%20and%20Gas%20Regulations%20Designed%20to%20Protect%20Water%20Resources.pdf> (explaining that casing is “typically steel pipe”).

40. See TED G. BYROM, CASING AND LINERS FOR DRILLING AND COMPLETION I (2007) (describing the three purposes of casing as maintaining “the structural integrity of the bore hole,” keeping “formation fluids out of the bore hole,” and keeping “bore hole fluids out of formations”).

41. See Nathan Houston et al., *Fracture-Stimulation in the Marcellus Shale—Lessons Learned in Fluid Selection and Execution*, SPE 125897 at 1 (2009), available at <http://www.onepetro.org/mslib/app/pdfpurchase.do?itemChronicleId=09014762801c4ad5&itemSocietyCode=SPE>.

42. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 3-5 (defining “slickwater fracturing” as “high-volume hydraulic fracturing”).

43. See, e.g., N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 3-3 (explaining that the New York State Department of Environmental Conservation determined that this supplemental study was needed in part because proposed “multi-stage hydraulic fracturing of horizontal shale wells may require the use and

ing operator induces these fractures by injecting large volumes of fluids at high pressure into the wellbore.⁴⁴ The operator also sends solid materials called proppants—which are typically sands⁴⁵—into the fractures to prop open the fractures and allow the gas to flow back to the well.⁴⁶

To begin this fracture and fracture “propping” process, a fracturing operator punches holes in (“perforates”) the well casing.⁴⁷ After conducting several fracturing-related tests, the operator then cleans the shale around the wellbore by injecting acid down the well and forcing it out of the perforated areas; cleaning is required because the well drilling process can plug the shale pores.⁴⁸ Following the acid treatment, the well is ready to be fractured. To prepare the fracturing fluid, the operator brings millions of gallons of water to the well pad; the operator either hauls in the water by tanker truck or carries the water to the site through a pipeline, and the operator sometimes stores the water on site in large tanks or impoundments.⁴⁹ The operator then mixes what can amount to several thousand gallons of chemicals⁵⁰ with the several million of gallons of water⁵¹ to create a fracturing “fluid.” About a dozen or

management of millions of gallons of water for each well”); Harper, *supra* note 24, at 10 (explaining that the technique suitable for fracturing shales, which was developed in the Barnett Shale, is called a “slick-water” frac).

44. GROUND WATER PROTECTION COUNCIL, *supra* note 33, at 56.

45. Harper, *supra* note 24, at 2-10.

46. GROUND WATER PROTECTION COUNCIL, *supra* note 33, at 56.

47. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-93.

48. GROUND WATER PROTECTION COUNCIL, *supra* note 33, at 60.

49. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-75.

50. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-65 (explaining that “[o]verall the concentration of additives in most slickwater fracturing fluids is a relatively consistent 0.5% to 2% with water making up 98% to 99.5%”); *id.* at 5-94–95 (explaining that a single well “would require 2.4 million to 7.8 million gallons of water,” although this varies depending on local conditions); DANIEL J. SOEDER AND WILLIAM M. KAPPEL, WATER RESOURCES AND NATURAL GAS PRODUCTION FROM THE MARCELLUS SHALE 4 (2009), available at <http://pubs.usgs.gov/fs/2009/3032/pdf/FS2009-3032.pdf> (explaining that “the percentage of chemical additives in a typical hydrofrac fluid is commonly less than 0.5 percent by volume,” but that “the quantity of fluid used in these hydrofracs is so large that the additives in a three million gallon hydrofrac job . . . would result in about 15,000 gallons of chemicals in the waste,” since one-half percent of 3 million is 15,000). The waste water that returns to the surface, however, will be a smaller quantity, since much of the flowback water may remain in the ground. See, e.g., N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-97 (explaining that “[f]lowback water recoveries reported from horizontal Marcellus wells in the northern tier of Pennsylvania range between 9 and 35 percent of the fracturing fluid pumped”).

51. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-94–95 (explaining that a single well “would require 2.4 million to 7.8 million gallons of water,” although this varies depending on local conditions); SOEDER AND KAPPEL, *supra* note 50, at 4 (explaining that a fractured well “may require up to 3 million

fewer chemicals,⁵² selected from a pool of more than 250 available fracing chemicals,⁵³ are used. These chemicals, among other functions, allow the fracturing fluid to better carry the proppants, ensure that bacteria do not grow and contaminate the natural gas, and reduce the friction generated when millions of gallons of fluid are pumped through the well bore.⁵⁴ The company injects the water mixed with chemicals, which forms the "fracing fluid," at high pressure into the perforated wellbore; this pressurized fluid that is forced down and out of the wellbore causes the shale to fracture or enhances existing fractures,⁵⁵ and injected proppants move into these fractures; natural gas then begins to flow through the fractures toward the well. This gas eventually travels back up through the wellbore, through a natural gas processor, and into a gas flowline.⁵⁶ Following the fracturing process, some of the fracturing fluid also flows back up through the well; this "flowback water" is stored in an impoundment at the surface⁵⁷ and eventually disposed of.

This complex process, from preparation of the well pad through the drilling and fracing stages, creates much activity at the surface. Earthmoving equipment, drilling rigs, and trucks that deliver fracing chemicals and other equipment move on and off site, and at various stages tanks, impoundments, and fracing machinery sit in orderly formations on the site.

gallons of water per treatment"); R.R. Comm'n of Tex., *supra* note 30 (explaining that a horizontal fractured well "can use over 3.5 million gallons (over 83,000 barrels) of water" and that "[i]n addition, the wells may be re-fractured multiple times after producing for several years").

52. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-69 (stating that "there are twelve classes of additives, based on their purposes or use; not all classes would be used at every well; and only one product in each class would typically be used per job").

53. Some fracing service companies and chemical suppliers have disclosed information about fracing chemical additives to the New York State Department of Environmental Conservation. The 197 products disclosed contain "approximately 260 unique chemicals" and an "additional 40 compounds," many of which are mixtures. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-34.

54. *Id.* at 5-94 (describing the proppant as well as the chemicals used to kill bacteria, increase viscosity, and perform other functions important to fracing).

55. *Id.* at 5-90-5-93 (describing the fracing process and the development of the fractures in the shale).

56. *Id.* at 5-127 (noting the method by which gas flows back up through the wellbore).

57. *Id.* at 6-17 (explaining the impoundments associated with the flowback water stage).

B. Fracing Expands

As hydraulic fracturing becomes more common, communities in Appalachia are increasingly experiencing scenes of busy surface fracing activity. The first gas well in the Marcellus Shale was drilled and fraced in 2003⁵⁸ and began producing in 2005,⁵⁹ and this shale “play” has increasingly drawn the attention of producers because of its staggering size. The Marcellus Shale underlies more than 34 million acres of land,⁶⁰ and, in 2008, it was estimated to have more than “500 trillion cubic feet of gas in-place” according to Professors Terry Engelder and Gary Lash⁶¹ (an estimate that has since risen). Not all of this gas in-place can be extracted, but Engelder and Lash in 2008 believed that the play could produce “nearly” 50 trillion cubic feet of natural gas;⁶² some of the early wells drilled in the Marcellus in Pennsylvania, which have shown high daily production rates,⁶³ might support these predictions. More recent estimates by Engelder, based on updated production data, “yield[] a 50 percent probability that the Marcellus will ultimately yield 489” trillion cubic feet of natural gas.⁶⁴

Perhaps as a result of the promising estimates of gas reserves in the Marcellus Shale and its sheer size, the “rush is on.”⁶⁵ Between 2008 and 2009, the number of Marcellus wells drilled in Pennsylvania more than quadrupled.⁶⁶ Pennsylvania has led the fracing charge in the Marcellus Shale, but other states that overlie this vast

58. Harper, *supra* note 24, at 2-9 (explaining that “Pennsylvania’s Marcellus shale play began in 2003, when Range Resources-Appalachia, LLC . . . drilled a well to the Lower Silurian Rochester Shale in Washington County”).

59. CONSIDINE ET AL., *supra* note 27, at 5.

60. Terry Engelder and Gary G. Lash, *Marcellus Shale Play’s Vast Resource Potential Creating Stir in Appalachia*, AM. OIL & GAS REP. (May 2009), available at <http://www.geosc.psu.edu/~engelder/references/link150.pdf>.

61. *Id.*

62. *Id.*

63. See Nat’l Energy Tech. Laboratory, *supra* note 26, at 3 (describing an Atlas Energy Resources, LLC well in “southwestern Pennsylvania” that “yielded initial gas production of over 10 million cubic feet per day” and a Range Resources well that “topped all previous records with an initial natural gas production rate of over 24 million cubic feet per day”).

64. Terry Engelder, *Marcellus*, FORT WORTH BASIN OIL & GAS MAG. 22, Aug. 2009, available at <http://www.geosc.psu.edu/~engelder/references/link155.pdf>.

65. Engelder and Lash, *supra* note 61.

66. Pa. Dep’t of Env’t. Protection, Bureau of Oil & Gas Mgmt., Wells Drilled, available at <http://www.dep.state.pa.us/dep/deputate/minres/oilgas/BOGM%20Website%20Pictures/2008/2008%20Wells%20Drilled.jpg> (last visited Feb. 10, 2009) (showing 195 Marcellus Shale wells drilled in 2008); Pa. Dep’t of Env’t. Protection, Bureau of Oil & Gas Mgmt., Wells Drilled, <http://www.dep.state.pa.us/dep/deputate/minres/oilgas/BOGM%20Website%20Pictures/2009/2009%20%20Wells%20Drilled.jpg> (showing 768 Marcellus Shale wells drilled in 2009).

shale resource are also on the verge of heightened activity. Hess Corporation has entered into a lease agreement with a coalition of landowners who own more than 19,000 acres in Binghamton and Conklin, New York,⁶⁷ and more than 40 large frac jobs have been proposed within just four counties in New York.⁶⁸ Ohio, Maryland, and West Virginia are also gearing up for fracing. Maryland reports that several counties in the western portion of the state have “attracted. . . interest for gas extraction.”⁶⁹ Further, Ohio issued sixteen permits to drill in the Marcellus in 2008,⁷⁰ and regulators in West Virginia believe that areas of the state “that have not traditionally experienced much gas well drilling might soon experience exploration” and fracing.⁷¹ Stone Energy has already drilled at least three vertical Marcellus gas wells in West Virginia and three vertical development wells there, which it expects to frac.⁷² Trans Energy fraced a well in Marion County, West Virginia in 2008, and an agreement to construct a gas processing facility in the West Virginia panhandle was reached in September 2009.⁷³ If the current pace of permitting and extraction activity continues, the Appalachian region is likely to see rising levels of hydraulic fracturing in the coming years.

II. EXEMPTION OF OIL AND GAS WASTES FROM HAZARDOUS WASTE REGULATION AND OTHER FEDERAL LAWS

As natural gas development in the Marcellus Shale underlying Appalachia marches forward at a quick pace, it is important to understand the regulatory context in which hydraulic fracturing in this region operates. The oil and gas industry, including members

67. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 2-6.

68. *Id.* at 5-6 (explaining that “[t]he Department has received applications for 47 horizontal Marcellus Shale wells to be developed in Broome, Chemung, Delaware and Tioga Counties by high-volume hydraulic fracturing”).

69. Md. Dep't of the Env't, Facts About . . . Marcellus Shale in Maryland 1, available at http://www.mde.maryland.gov/assets/document/mining/Marcellus_Fact_Sheet_01.25.10.pdf.

70. Div. of Mineral Res. Mgmt., Summary of Ohio Oil and Gas Activities 2008 at 1, available at <http://www.dnr.state.oh.us/Portals/11/publications/pdf/oilgas08.pdf>.

71. W. Va. Dep't of Env'tl. Protection, Industry Guidance 1 (Jan. 8, 2010), available at <http://www.dep.wv.gov/oil-and-gas/GI/Documents/Marcellus%20Guidance%201-8-10%20Final.pdf> [hereinafter W. Va. DEP, Industry Guidance]. Small portions of the Marcellus also underlie Virginia and Tennessee, but this Article does not address these states.

72. Foster Associates, Inc., GAS PIPELINE AND STORAGE PROJECTS TARGET PRODUCTION GROWTH IN APPALACHIAN BASIN, MARCELLUS SHALE, Foster Natural Gas Report, Report No. 2781 (Jan. 29, 2010).

73. *Id.*

of the industry that hydraulically fracture gas wells, must comply with several federal laws and regulations.⁷⁴ Under the Clean Water Act, no entity (including an oil or gas producer) may discharge pollutants into waters of the United States without a permit.⁷⁵ Further, any oil or gas producer that contaminates a site with wastes other than petroleum or natural gas may be subject to future liability for clean-up costs under the Comprehensive Environmental Response, Compensation, and Liability Act (“Superfund”).⁷⁶ Oil and gas producers, depending on the location of a proposed well site, may also face regulation under the federal Endangered Species Act.⁷⁷ Fur-

74. See generally GROUND WATER PROTECTION COUNCIL, *supra* note 33 (observing that “[t]he development and production of oil and gas in the U.S., including shale gas, are regulated under a complex set of federal . . . laws”). The Author disagrees, however, with the Council’s statement that “federal, state, and local” laws address “every” aspect of exploration and operation, as the Groundwater Protection Council argues at ES-2. As discussed *infra*, the practice of pumping hydraulic fracturing fluid into the wellbore and shale is expressly exempted from federal regulation, and states do not regulate the practice. Although the Marcellus states all have casing requirements to address groundwater contamination concerns, and some require the disclosure of fracing chemicals used, these requirements do not address the pumping of fluid into the wellbore and shale or regulate the chemicals that may be used. Only the use of diesel fuel in fracing—now a rare practice—may count as a federally regulated underground injection process. See 42 U.S.C. § 300(h) (West 2010) (exempting hydraulic fracturing fluids (“other than diesel fuels”) from the definition of “underground injection” regulated by the Safe Drinking Water Act; A Memorandum of Agreement Between The U.S. Env’t. Prot. Agency and BJ Services Company, Halliburton Energy Services, Inc., and Schlumberger Technology Corp., Dec. 12, 2003, available at <http://www.epa.gov/ogwdw000/uic/pdfs/moauichyd-fract.pdf> (demonstrating a commitment by the largest fracing operators to stop using diesel fuel). For select state casing regulations, see MD CODE REGS. 26.19.01.10 (O),(P) (2009); N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 55, at 7-44–7-45 (describing existing casing requirements); OHIO REV. CODE ANN. § 1509.17 (LexisNexis 2009) (requiring casing to “exclude all surface, fresh, or salt water” from the well); 58 PENN. CONS. STAT. ANN. § 601.207 (LexisNexis 2009) (requiring casing through each fresh water bearing strata); W. VA. CODE R. § 35-4-11.4 (2010) (requiring fresh water casing to “extend at least thirty (30) feet below the deepest fresh water horizon”).

75. 33 U.S.C. § 1311 (West 2010) (prohibiting “the discharge of any pollutant by any person,” except as in compliance with other portions of the Clean Water Act); 33 U.S.C. § 1342 (West 2010) (allowing the administrator of EPA to “issue a permit for the discharge of any pollutant” (a permit commonly referred to as an NPDES permit, which stands for “National Pollutant Discharge Elimination System”)); 33 U.S.C. § 1362(12) (West 2010) (defining “discharge of a pollutant” as, *inter alia*, “any addition of any pollutant to navigable waters from any point source”); 33 U.S.C. § 1362(7) (West 2010) (defining “navigable waters” as “the waters of the United States, including the territorial seas”).

76. 42 U.S.C. § 9607 (West 2010) (imposing liability for cleanup costs of hazardous substances on certain parties); 42 U.S.C. § 9601 (14) (West 2010) (exempting petroleum, natural gas, liquefied natural gas, natural gas liquids, and “synthetic gas usable for fuel” from the definition of “hazardous substance”).

77. See, e.g., N.Y. STATE DEP’T OF ENVTL. CONSERVATION, DIVISION OF MINERAL RESOURCES, ENVIRONMENTAL ASSESSMENT FORM, ATTACHMENT TO DRILLING PERMIT APPLICATION, No. 85-16-5, available at http://www.dec.ny.gov/docs/materials_

ther, any hazardous fracturing fluids that are transported to a frac site are covered by comprehensive federal hazardous transportation laws.⁷⁸

Fracing operators, although subject to a range of federal environmental regulations, also enjoy several major exemptions in this area. The practice of fracing itself—the pumping of fracing fluid into the wellbore—has its own exemption. In 2005, Congress expressly excluded hydraulic fracturing from the definition of “underground injection,”⁷⁹ meaning that the federal Safe Drinking Water Act requirements for the prevention of contamination of groundwater do not apply to the practice.⁸⁰ Prior to 2005, EPA had not treated hydraulic fracturing as regulated underground injection under the Act, but a federal court case in 1997 determined that, at least under one state-administered federal program, it should.⁸¹ In 2005, however, Congress made clear that it would exclude hydraulic fracturing from regulation under the Safe Drinking Water Act.⁸² Under another federal exemption, oil and gas producers are also not required to report their annual releases of toxic chemicals under the Emergency Planning and Community Right to Know Act.⁸³

The most substantial exemption for fracing operators, from the perspective of activities at the surface, is the exemption of “ex-

minerals_pdf/eaf_dril.pdf (requiring an operator to disclose whether the site on which proposed drilling will occur has any listed threatened or endangered species).

78. See N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 5-65 - 5-67 (citing the Hazardous Material Transportation Act (1975) and the Hazardous Materials Transportation Uniform Safety Act (1989)).

79. 42 U.S.C. § 300h (d)(1) (West 2010).

80. See 42 U.S.C. § 300h (a)(1) (West 2010) (providing that “[t]he Administrator shall publish proposed regulations for State underground injection control programs within 180 days after the date of enactment of this title”); 42 U.S.C. § 300h (b)(1) (West 2010) (providing that “[r]egulations under subsection (a) for State underground injection programs shall contain minimum requirements for effective programs to prevent underground injection which endangers drinking water sources”).

81. EPA interpreted “underground injection” to only include “those wells whose ‘principal function’ is the underground emplacement of fluids” and thus excluded hydraulic fracturing. *LEAF v. EPA*, 118 F.2d 1467, 1471 (11th Cir. 1997). The Eleventh Circuit rejected this interpretation in a challenge to Alabama’s Underground Injection Control program, concluding that “hydraulic fracturing activities constitute ‘underground injection’ under Part C of the” Safe Drinking Water Act. *LEAF*, 118 F.2d at 1478.

82. See *supra* note 79 and accompanying text (describing Congress’s exemption of hydraulic fracturing from the definition of “underground injection” under the Safe Drinking Water Act).

83. See *infra* note 125 (describing how oil and gas operations are not covered facilities for purposes of toxic chemical release reporting).

ploration and production" oil and gas wastes—or "E & P" wastes, as they are commonly called—from Subtitle C of the Resource Conservation and Recovery Act (RCRA), which regulates hazardous waste in a "cradle-to-grave" system, from the generation of the waste through disposal.⁸⁴ In shorter terms, oil and gas wastes—even if they would otherwise be listed or characterized as hazardous wastes or exhibit hazardous characteristics—are not subject to federal laws that apply to the generation, transportation, and disposal of hazardous wastes. Oil and gas wastes were not initially excluded from RCRA when it was first enacted in 1976,⁸⁵ but "intense lobbying by the oil-and-gas industry"⁸⁶ led to a Congressional exemption in 1980.⁸⁷ This exemption was temporary and required agency action in order to be finalized; EPA, within six months after completing a required study in October 1982, was to decide either to "promulgate regulations" for oil and gas waste under RCRA Subtitle C or to find that the regulations were "unwarranted."⁸⁸ Congress directed EPA, through the required study, to identify the "adverse effects, if any" of oil and gas waste on "human health and the environment" and to identify "measures currently employed" by industry and regulators to "prevent or substantially mitigate such adverse effects."⁸⁹

In 1987, following a lawsuit to pressure EPA to meet Congress's deadline for the study,⁹⁰ EPA completed its report, and in 1988 EPA determined that regulation of oil and gas wastes as hazardous wastes was "unwarranted."⁹¹ As it is currently interpreted by the agency, this exemption covers all wastes "intrinsic to and uniquely associated with primary E&P operations,"⁹² which means all waste

84. 42 U.S.C. § 6922(a) (West 2010) (describing regulations to be promulgated by EPA to create "standards . . . applicable to generators of hazardous wastes"); 42 U.S.C. § 6922(b) (West 2010) (describing regulations to be promulgated by EPA to create "standards . . . applicable to transporters of hazardous wastes"); 42 U.S.C. § 6922(c) (West 2010) (describing regulations to be promulgated by EPA to create "standards . . . applicable to owners and operators of facilities for the treatment, storage, or disposal of hazardous wastes").

85. James R. Cox, *Revisiting RCRA's Oilfield Waste Exemption as to Certain Hazardous Oilfield Exploration and Production Wastes*, 14 VILL. ENVTL. L.J. 1, 2 (2003).

86. *Id.* at 3.

87. 42 U.S.C. § 6921(b)(2)(A) (West 2010).

88. 42 U.S.C. § 6921(b)(2)(B) (West 2010).

89. 42 U.S.C. § 6982(m)(1) (West 2010).

90. *See* Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Rates, 53 Fed. Reg. 25,446, 25,442 (July 6, 1988) (describing the lawsuit).

91. *Id.* at 25,447.

92. Clarification of the Regulatory Determination for Wastes From the Exploration, Development and Production of Crude Oil, Natural Gas and Geothermal Energy, 58 Fed. Reg. 15,284, 15,284 (Mar. 22, 1993).

that has “come from down-hole” (waste that has been brought to the surface during oil and gas E&P operations) or waste that has “otherwise been generated by contact with the oil and gas production stream during the removal of produced water or other contaminants from the product.”⁹³

In determining that oil and gas wastes should be exempt from federal hazardous waste regulation, EPA noted that a “portion” of oil and gas wastes do exceed certain health- and environmental-based standards.⁹⁴ At 23 percent of the sampled oil and gas extraction sites that generated “produced water” (the water that comes up out of a formation when oil or gas is drilled), the produced water contained “one or more toxic constituents of concern at levels greater than 100 times the health-based standards.”⁹⁵ These constituents were most commonly “benzene, arsenic, barium, and boron.”⁹⁶ The same held true for seven percent of the sampled sites that generated drilling fluids, except the toxic constituents exceeding the health-based standards at these sites were typically “fluoride, lead, cadmium, and chromium.”⁹⁷ And in 62 cases identified by EPA, oil and gas wastes caused “damage.”⁹⁸ Ultimately, EPA concluded that “10 to 70 percent of large volume wastes” from oil and gas production (drilling muds, for example⁹⁹) and “40 to 60 percent of associated wastes” (wastes used to enhance extraction, for example¹⁰⁰) “could potentially exhibit RCRA hazardous waste characteristics.”¹⁰¹ It concluded that regulation under RCRA was unnecessary, however, resting its determination on several pillars. First, EPA explained that the expense of handling and disposing of

93. *Id.* at 15,285; *see also* Cox, *supra* note 85, at 7 (describing this as EPA's current “interpretation of the statute”).

94. Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes, 53 Fed. Reg. 25,446, 25,454 (July 6, 1988).

95. *Id.* at 25,455.

96. *Id.*

97. *Id.*

98. *Id.* EPA does not define “damage,” but the factors that it mentions in evaluating the effects of the wastes beyond toxicity are “the rate of release of contaminants from different management practices, the fate and transport of these contaminants in the environment, and the potential for human health or ecological exposure to the contaminants.” *Id.*

99. *See* Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes, 53 Fed. Reg. 25,446, 25,455 (July 6, 1988) (describing large-volume wastes as including wastes such as “drilling muds and produced waters”).

100. *See id.* at 25,446, n.1 (defining “associated wastes” as those wastes other than produced water, drilling muds and cutting, and rigwash that are intrinsic to exploration, development and production of crude oil and natural gas”).

101. *Id.* at 25,455.

the wastes would be “extremely” high, and that compliance costs could “reduce domestic production by as much as 12 percent.”¹⁰² Next, it discussed existing state and federal regulation of oil and gas wastes under programs that were not part of the federal hazardous waste regulations and concluded that the regulations were generally adequate for “protecting human health and the environment” and ensuring proper management of the wastes, although it identified “regulatory gaps” at both levels.¹⁰³ EPA went on to determine how it would fill in these gaps, and it crowned its analysis with a discussion of the impracticality and inefficiency¹⁰⁴ of attempting to regulate oil and gas wastes under what it viewed as a burdensome¹⁰⁵ and complex¹⁰⁶ statute.

EPA completed its analysis of oil and gas wastes and its resulting determination to exempt these wastes from federal hazardous waste regulation in the late 1980s, before fracing in shales had boomed. The analysis includes some wastes typically associated with fracing,¹⁰⁷ but of the more than 250 types of chemicals from which fracing operators may now choose,¹⁰⁸ several may not have been in common fracing use more than twenty years ago.¹⁰⁹ Many

102. *Id.*

103. *Id.* at 25,455-25,456.

104. Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes, 53 Fed. Reg. 25,446, 25,456 (July 6, 1988) (concluding that “[i]t is impractical and inefficient to implement Subtitle C for all or some of these wastes because of the permitting burden that the regulatory agencies would incur”).

105. *Id.* (describing the “permitting burden” that would be caused by Subtitle C regulation).

106. *Id.* (describing the “comprehensive ‘cradle to grave’ management requirement” of Subtitle C and the “long periods of times” typically required to process Subtitle C permits).

107. EPA analyzed “[p]roduced sand,” for example. *See id.* at 25,454. Note that the analysis excludes consideration of “unused fracturing fluids or acids,” which EPA believed to not fall within the RCRA exemption. *Id.*

108. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 55, at 5-45-5-51 & n.28 (listing approximately 259 chemical constituents “that have been extracted from complete chemical compositions and Material Safety Data Sheets submitted to the NYSDEC”). Note that each fracing operation does not use all of these constituents. A typical operation might use ten chemicals, for example, to perform the functions of cleaning the shale near the wellbore, inhibiting corrosion, and improving the viscosity of the fluid so that it can effectively carry proppant into the fractures. *See, e.g., id.* at 5-41-5-42 (describing the purpose of the chemicals).

109. The changes in the exact composition of the fracturing fluids occur over time are not easy to determine, as many companies treat the fluids as trade secrets. *See* Katie Howell, *More Oversight Sought for Hydraulic Fracturing*, N.Y. TIMES, Nov. 4, 2009, available at <http://www.nytimes.com/gwire/2009/11/04/04greenwire-more-oversight-sought-for-hydraulic-fracturing-35961.html> (explaining that “[i]n the past, companies have been loath to disclose the components of fracturing fluids, saying the ingredients were the equivalent of trade secrets”).

companies perfected their fracing fluid mixtures for slickwater (high-fluid volume) fracing jobs in the Barnett Shale,¹¹⁰ which began producing in substantial quantities in the 1990s¹¹¹ (after EPA completed its analysis).

If industry practices and state regulations are adequately reducing the risk of human exposure and damage to natural resources, then this deficiency in the federal analysis as applied to modern practices is not of great concern. The lack of “proven” contamination of groundwater directly by fracing chemicals since the inception of hydraulic fracturing—a statistic cited by industry and state regulators¹¹² but disputed by some groups¹¹³—may indeed show

110. See N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 55, at 5-43 (explaining that the “Barnett Shale is considered to be the first instance of extensive high-volume hydraulic fracture technology use; the technology has since been applied in other areas such as the Fayetteville Shale and the Haynesville Shale”). See also Casselman & Gold, *supra* note 22, at A20 (observing that “in the past decade the technology has really taken off,” that “[f]irst in East Texas and in the outskirts of Fort Worth, companies began pumping water under enormous pressure,” and that “[a]s the industry has honed its techniques, hydraulic-fracturing has become more complex, requiring far more water and chemicals”).

111. See *supra* text accompanying note 24.

112. See Casselman & Gold, *supra* note 22, at A20 (explaining that “[t]he industry says fracturing is safe and argues that there have been only a handful of incidents among the millions of wells that have been fractured over the past 50 years”); *id.* (quoting Aubrey McClendon, Chesapeake’s chairman and chief executive officer, as stating, “We’ve done it 10,000 times in the company’s history without incident”); Commissioner Victor G. Carrillo, Testimony Submitted to the House Committee on Energy and Commerce Representing the Interstate Oil and Gas Compact Commission (Feb. 10, 2005), available at <http://www.irc.state.tx.us/commissioners/carrillo/press/energytestimony.php> (testifying, from the perspective of underground sources of drinking water, that “an IOGCC survey concluded that not a single instance of harm to drinking water was found in over one million hydraulic fracturing operations”); Ground Water Protection Council, Survey Results on Inventory and Extent of Hydraulic Fracturing in Coalbed Methane Wells in the Producing States 3 (Dec. 15, 1998), available at <http://www.gwpc.org/e-library/documents/general/State%20Oil%20and%20Gas%20Regulations%20Designed%20to%20Protect%20Water%20Resources.pdf> (citing its 1998 survey, which found no “recorded . . . complaints of contamination” to an underground source of drinking water that a state “agency could attribute to hydraulic fracturing of coalbed methane zones”).

113. Earthworks, Hydraulic Fracturing Myths and Facts, <http://www.earthworksaction.org/publications.cfm?pubID=395> (arguing that “[c]omplaints have been documented in Alabama, Colorado, New Mexico, Ohio, Texas, Virginia, West Virginia and Wyoming in which residents have reported changes in water quality or quantity following fracturing operations of gas wells near their homes”); Casselman & Gold, *supra* note 22, at A20 (“Whether it is the act of fracturing itself or the risk of contamination from related activities is somewhat beside the point, says Amy Mall, a senior policy analyst for the Natural Resources Defense Council. . . . ‘Ultimately it’s semantics. Somebody’s water got contaminated,’ she says”); Abraham Lustgarten & ProPublica, EPA: Chemicals Found in Wyoming Drinking Water Might Be From Natural Gas Drilling, SCI.AM., Aug. 26, 2009, available at <http://www.scientificamerican.com/article.cfm?id=chemicals-found-in-drinking-water-from-natural-gas-drilling> (reporting that “[f]ederal environment officials in-

that state regulations are working. Yet in addition to omitting wastes associated with recently improved practices such as fracing in its RCRA analysis, EPA may have placed too much reliance on the states—and goals related to improving state regulations—in assuming that regulatory gaps would be filled. Even in identifying the gaps in 1988, EPA conceded that “some [s]tates do not have adequate requirements controlling roadspreading or landspreading of large-volume wastes, design or maintenance rules for reserve pits, or have insufficient management specifications for centralized and commercial disposal facilities.”¹¹⁴ It also worried that “[s]tates such as Texas do not specifically address associated wastes and other [s]tates have general standards that provide partial control of those wastes”;¹¹⁵ that some states had “relaxed controls pertaining to land application of large-volume wastes”;¹¹⁶ and that “[p]roblems also remain regarding adequate [s]tate implementation and enforcement of existing regulations.”¹¹⁷

EPA confidently exempted oil and gas waste from hazardous waste regulation despite these gaps by assuming that certain regulatory modifications would ensue. It pledged to work “with the States to encourage changes in their regulations and enforcement programs to achieve more uniformity in the administration of their programs,” and indeed, it has begun this work. Following its decision to exempt oil and gas wastes from Subtitle C of RCRA, EPA provided a grant to the Interstate Oil and Gas Compact Commission to investigate state regulatory programs and develop guidelines, and a nonprofit corporation called State Review of Oil and Gas Environmental Regulations, Inc. (STRONGER) was later organized to continue to review state regulations and to improve guidelines.¹¹⁸ The following Part discusses the state regulations that have emerged—or have continued to apply—since EPA set these lofty goals in 1988.

vestigating drinking water contamination near the ranching town of Pavillion, Wyo., have found that at least three water wells contain a chemical used in the natural gas drilling process of hydraulic fracturing”).

114. Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes, 53 Fed. Reg. 25,446, 25,455 (July 6, 1988).

115. *Id.* at 25,455.

116. *Id.*

117. *Id.*

118. EPA described the need for “more uniformity in the administration” of state oil and gas programs at 53 Fed. Reg. 25,446, 25,446. For the organization of STRONGER, see GROUND WATER PROTECTION COUNCIL, *supra* note 39, at 33; see also *infra* note 218, and accompanying text (briefly discussing a STRONGER review of Ohio’s regulations).

III. STATE REGULATION OF FRACING: SURFACE IMPACTS

In its 1988 analysis of oil and gas wastes, EPA determined that state programs were generally protective of human health and the environment but also identified several gaps in state regulation of the hazards posed those wastes.¹¹⁹ This section investigates these state regulatory programs from the perspective of fracing, an extraction technique that has become much more prevalent in the United States since EPA published its 1988 report.¹²⁰ It investigates how states—particularly those overlying the Marcellus Shale—control the risks to the environment and human health potentially posed by fracing. Existing analyses have focused primarily on groundwater and possible contamination of groundwater as a result of underground fracing activity,¹²¹ so this Article looks to the surface.¹²² Specifically, this Part compares the Marcellus states' regulatory efforts to prevent fracing-related wastes from contaminating soil and surface water bodies.

Although fracing has sporadically caught the attention of Congress,¹²³ the states are and will likely remain¹²⁴ the central regula-

119. See *supra* notes 114-17 and accompanying text.

120. See *supra* note 25 and accompanying text.

121. See generally U.S. ENVTL. PROTECTION AGENCY, EVALUATION OF IMPACTS TO UNDERGROUND SOURCES OF DRINKING WATER BY HYDRAULIC FRACTURING OF COALBED METHANE RESERVOIRS, EPA 816R04003 (June 2004), available at <http://www.epa.gov/OGWDW/uic/pdfs/cbmstudyattachuicch04hyfracfluids.pdf>; GROUND WATER PROTECTION COUNCIL, *supra* note 39, at 19-21, 23-24 (focusing on casing and cementing and the protection of groundwater); but see GROUND WATER PROTECTION COUNCIL, *supra* note 39, at 28-31 (also addressing surface concerns).

122. "Surface" and "subsurface" cannot be fully separated. Contaminants in soil may seep into groundwater sources. See, e.g., N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 6-16, 6-17, 6-34 (describing how "[s]pilled, leaked, or released fluids could flow to a surface water body or infiltrate the ground, reaching subsurface soils and aquifers"). The author uses "surface" generally to indicate her exclusion, in this Article, of concerns regarding potential contamination of groundwater as a result of the pumping of fracing fluid underground.

123. On February 18, 2010, the House Energy and Commerce Committee announced that it had begun investigating potential environmental and public health concerns related to fracing, and Committee chairman Henry A. Waxman, D-Calif., sent letters to several fracing companies seeking information about whether chemicals used in fracturing fluids could contaminate drinking water and create health risks. Law 360, *House Probes Controversial Gas Drilling Process*, <http://environmental.law360.com/articles/150575> (last visited Mar. 3, 2010). Representative Waxman began corresponding with the Environmental Protection Agency as early as 2002, and in 2007 he sponsored a hearing addressing landowners' health concerns related to fracing. See Wiseman, *supra* note 29, at text accompanying n.334, n.336, n.120-21 (discussing the letters and the hearing).

124. The author believes that states will remain the central regulatory players in the "near future" because of the strong and apparently influential resistance from industry, state, and even some federal players to federal regulation of hydraulic fracturing under the Safe Drinking Water Act. See Wiseman, *supra* note 29, at

tory players at least in the near future. As discussed in Part II, several of the core aspects of fracturing—including the pumping of the fluids into the ground and the storage and disposal of wastes once fluids re-emerge—have been exempted from federal regulation,¹²⁵ with the exception of basic Clean Water Act prohibi-

notes 124, 157, 158 and accompanying text (discussing industry's and state's arguments against regulating hydraulic fracturing under the Safe Drinking Water Act); David O. Williams, *COGCC Director: Unnecessary FRAC Act Would Spread Staff Too Thin*, COLORADO INDEP. (Aug. 12, 2009), available at <http://coloradoindependent.com/35388/cogcc-director-unnecessary-frac-act-would-sprad-staff-too-thin> (last visited Jan. 14, 2010) (describing the Colorado oil and gas agency head's objections to federal regulation of fracing under the Safe Drinking Water Act); Ian Talley, *EPA Official: State Regulators Doing Fine on Hydrofracking*, DOW JONES NEWSWIRES, Feb. 15, 2010, <http://www.foxbusiness.com/story/markets/industries/energy/epa-official-state-regulators-doing-fine-hydrofracking/> (last visited Mar. 2, 2010) (describing an EPA official's argument that states are adequately regulating fracing). But see U.S. Envtl. Protection Agency, Comments on the New York State Department of Environmental Conservation September 2009 draft at 2 (Dec. 30, 2009), available at http://www.epa.gov/region2/spmm/Marcellus_dSGEIS_Comment_Letter_plus_Enclosure.pdf (stressing that “[d]espite the mitigation measures already proposed by NYSDEC in the . . . [draft Supplemental Generic Environmental Impact Statement, which would place limiting conditions on fracing once finalized], EPA has serious reservations about whether gas drilling in the New York City watershed is consistent with the vision of long-term maintenance of a high quality unfiltered water supply”). Senators and representatives simultaneously submitted bills to require disclosure of the contents of fracing fluids and include hydraulic fracturing within the definition of “underground injection” under the Safe Drinking Water Act in June 2009, but the bills remain in committee. H.R. 2766, Fracturing Responsibility and Awareness of Chemicals Act of 2009 (June 2009) (commonly referred to as the “FRAC Act”); The Library of Congress, Thomas, H.R. 2766, <http://thomas.loc.gov/cgi-bin/bdquery/z?d111:HR02766:@@K> (last visited Apr. 19, 2010) (showing the “last major action” as “Referred to the House Committee on Energy and Commerce”); S. 1215, Fracturing Responsibility and Awareness of Chemicals (FRAC) Act (June 2009); The Library of Congress, S. 1215, <http://thomas.loc.gov/cgi-bin/bdquery/z?d111:SN01215:> (last visited Apr. 19, 2010) (showing the last major action as “[r]ead twice and referred to the Committee on Environment and Public Works”).

125. Congress exempted hydraulic fracturing—the activity of pumping fluids into the wellbore—from the definition of “underground injection” in the Safe Drinking Water Act of 2005, thus expressly exempting the practice from regulation under this Act. See 42 U.S.C. § 300h (d)(1) (West 2010) (defining “underground injection”). Further, Congress conditionally exempted the disposal of the hazardous wastes associated with oil and gas production from Subtitle C of the Resource Conservation Recovery Act (RCRA) (the portion of the Act addressing the transportation, labeling, and disposal of hazardous wastes) in 1980. 42 U.S.C. § 6921(b)(2)(A) (West 2010); Cox, *supra* note 85, at 3 (describing the passage of the exemption). EPA fully exempted these wastes from regulation in 1988. Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes, 53 Fed. Reg. 25,446, 25,447 (July 6, 1988). The Emergency Planning and Community Right to Know Act (EPCRA), which requires certain organizations that use toxic chemicals to, among other things, complete annual forms that report toxic releases from the facility, does not apply to oil and gas production operations. 42 U.S.C. § 11023(a) (West 2010) (requiring the preparation of a toxic chemical release form); 42 U.S.C. § 11023(b) (West 2010) (explaining that “[t]he requirements of this section shall apply to owners and

tions.¹²⁶ Within the context of this federal gap, the Marcellus states have begun to address environmental concerns associated with hydraulic fracturing. Their approaches vary substantially, however, and some states have been more aggressive than others in attempting to ensure that the rush of extraction does not result in environmental damage or harm to human health. New York has taken a somewhat precautionary approach, placing permits for slickwater fracing on hold while it completes a comprehensive study of the potential impacts of fracturing.¹²⁷ Pennsylvania, on the other hand, has in many respects been forced into a reactionary mode as a result of a rapid expansion of fracing in the state¹²⁸—assessing fines¹²⁹ and developing new regulations¹³⁰ as incidents with the

operators of facilities that have 10 or more full-time employees that are in Standard Industrial Classification Codes 20 through 39"); Community Right-to-Know; Toxic Chemical Release Reporting Using North American Industry Classification System (NAICS), 71 Fed. Reg. 32,464, 32,465 (Dec. 22, 2006) (to be codified at 40 C.F.R. pt. 372) (amending EPA regulations to use the North American Industry Classification System (NAICS) codes that "correspond to the Standard Industrial Classification (SIC) codes that are currently subject to Toxics Release Inventory (TRI) reporting requirements); Community Right-to-Know, 71 Fed. Reg. at 32,474 (amending 40 C.F.R. pt. 372.22(b) to define "[c]overed facilities for toxic chemical release reporting" as ones "for which the . . . North American Industry Classification System . . . subsector and industry codes are listed in [pt.] 372.23(b) or [pt.] 372.23(c)"); *id.* (amending 40 C.F.R. pt. 372.23 (b) and listing the NAICS codes—none of which include oil and gas production activities).

126. *See supra* note 75 (describing the prohibition of discharge into U.S. waters without a permit).

127. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 1-1 (explaining that the DEC "has received applications for permits to drill horizontal wells" and to frac them). "In reviewing and processing permit applications for horizontal drilling and hydraulic fracturing . . . DEC will apply the findings and requirements of the SGEIS, including criteria and conditions for future approvals." *Id.* Although permits are on hold for horizontal slick water wells, some vertical Marcellus wells are already producing in southern New York. *See* N.Y. State Dep't of Envtl. Conservation, Marcellus Shale Formation 2008 Production, *available at* <http://www.dec.ny.gov/energy/46381.html> (last visited Feb. 15, 2010). No horizontal wells have yet been drilled in the Marcellus in New York. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-43. *But see infra* text accompanying notes 307-308, 313, and 317 (discussing concerns expressed by EPA, Cornell University professors, and the New York City Department of Environmental Protection, that New York's regulations are not sufficiently stringent to protect human health and the environment).

128. *See supra* text accompanying notes 66-73.

129. James Loewenstein, *DEP Fines Chesapeake Appalachia, Schlumberger for Acid Spill in Bradford County*, TIMES-TRIBUNE, Dec. 8, 2009, *available at* <http://thetimes-tribune.com/news/dep-fines-chesapeake-appalachia-schlumberger-for-acid-spill-in-bradford-county-1.469155> (describing fines exceeding \$15,500 for each hydrochloric acid spill).

130. *See* 30 PA. BULL. 6467 (Nov. 7, 2009), *available at* <http://www.pabulletin.com/secure/data/vol39/39-45/2065.html> (proposing, under 25 PA. CODE § 95.10(c), to establish "new effluent standards for new sources of a wastewaters containing high Total Dissolved Solids (TDS) concentrations," including "[n]ew

potential to damage natural resources have emerged.¹³¹

A. Measuring the Adequacy of Regulation

The metric for determining whether state regulatory efforts adequately prevent potential surface contamination and thus reduce the risk of harm to the environment and human health is, by necessity, a sloppy one; attempts to measure risk and the adequacy of regulations to reduce risk are difficult ventures¹³² that depend largely on science, economics, local norms, and ethical questions such as intergenerational priorities, and I do not purport to convey expert knowledge in any of these fields. The area of shale fracing is relatively young, and there is currently little useful available information about its risks; much more is needed. Industry states that fracing has occurred in the United States for half a century with no proven incidents of groundwater contamination,¹³³ but this does not account for the fact that fracing methods have recently substantially changed¹³⁴ and that fracing rates, in areas that have not previously experienced this practice, have also dramatically increased;¹³⁵ nor does it address incidents of surface contamination. Groups concerned about the potential impacts of fracing, on the other hand, point to recent incidents such as spills, as well as what they believe to be incidents of groundwater contamination associated with fracing, and they attempt to extrapolate from this relatively

discharges of wastewaters resulting from fracturing, production, field exploration, drilling or completion of oil and gas wells” and limiting the concentrations of permitted barium and strontium concentrations of these discharges, as well as holding them to additional standards); Pa. Dep’t of Envtl Protection, Advanced Notice of Proposed Rulemaking, *available at* <http://www.dep.state.pa.us/dep/deputate/minres/oilgas/Oil%20&%20Gas%20Documents/CHAPTER%2078%20Revisions%20January%2027%202010.pdf> (proposing new casing and cementing requirements for gas wells and broadening requirements for gas producers to replace polluted or diminished water supplies).

131. *See, e.g., infra* text accompanying notes 175-76 (discussing fracing fluid spills in Pennsylvania).

132. *See, e.g.,* Cass R. Sunstein, *Which Risks First?*, 1997 THE U. CHI. LEGAL F. 101, 103-105 (1997) (discussing the difficulty of determining “which risks are most serious” in the context of environmental protection, describing various approaches to risk, and proposing a new framework for governmental regulation).

133. Al Pickett, Permian Basin Oil and Gas, Hydraulic Fracturing, <http://www.pbog.com/index.php?page=article&article=108> (last visited Apr. 20, 2010) (quoting the executive vice president of the Permian Basin Petroleum Association, who argues that “[w]e have been using frac technology for 50 years with no contamination of the groundwater”); *see also supra* note 112 (discussing industry’s observations regarding low numbers of incidents associated with fracing).

134. *See supra* note 24 (describing how techniques for fracing shale were perfected in the Barnett Shale of Texas in the 1990s).

135. *See supra* notes 81-90.

small set of data to reach conclusions about the danger of the practice.¹³⁶ Unfortunately, neither of these perspectives or any of the gray area between can be fully evaluated in a meaningful way at present, given the absence of adequate studies to address risk. EPA announced in March 2010 that it will “conduct a comprehensive research study to investigate the potential adverse impact that hydraulic fracturing may have on water quality and public health,”¹³⁷ and this study will hopefully help to fill this informational gap.

Within this void of useful risk data, I attempt to take a smaller evaluative step based on a brief comparison of existing and proposed regulations of hydraulic fracturing activity. In the following subparts, I roughly describe potential risks of fracturing incidents at the surface, such as accidental spills of fracturing fluid or leakage of flowback water from pits, largely based upon the most comprehensive environmental study of fracturing that has been conducted to date—a draft Supplemental Generic Environmental Impact Statement prepared by the New State York Department of Environmental Conservation.¹³⁸ I then look to the state regulations and how these regulations address these potential incidents of surface contamination.

B. Regulation of Hydraulic Fracturing Activities in the Marcellus States

State regulations that address fracturing activities at the surface can be grouped into several conceptual categories, including: (1) well development activities at the surface; (2) the collection and disposal of flowback waters; (3) the proximity of well sites to surface and ground waters and other natural resources; and (4) information collection and reporting. Many Marcellus state regulations generally address surface well development activities, such as the construction of access roads, the preparation and grading of the well pad and impoundments, and the spill-prevention techniques that apply to the transfer of chemicals into the frac water before it is pumped into the wellbore. All Marcellus states also regulate, to varying degrees, how used fracturing fluids may be stored at the well site, as well as methods of disposing of those fluids. Further, some states

136. See, e.g., Earthworks, *supra* note 113 (describing potential threats to drinking water and possible damage to aquatic ecosystems).

137. U.S. Env'tl. Protection Agency, EPA Initiates Hydraulic Fracturing Study: Agency Seeks Input from Science Advisory Board, Mar. 18, 2010, <http://yosemite.epa.gov/opa/admpress.nsf/e77fdd4f5afd88a3852576b3005a604f/ba591ee790c58d30852576ea004ee3ad!OpenDocument> (last visited Apr. 20, 2010).

138. See *supra* note 31.

constrain the proximity of fracing sites to natural resources such as streams and wetlands in an attempt to ensure that if all other regulatory measures fail—if fracing fluid spills when being transferred, for example—humans or valued natural resources will not be harmed.¹³⁹ Finally, two Marcellus states have informational regulations that require fracing operators to disclose the composition of fracing fluids to state regulators.¹⁴⁰

1. Surface Activities Associated With Well Development

Even before a fracing operator begins to think about the prospects of drilling into the Marcellus Shale to extract the vast quantities of gas believed to be trapped beneath the earth, the operator must consider a wide range of regulations that apply to varying degrees in the states overlying the shales. At the exploration stage, where large seismic trucks smack the ground and then pick up complex signals in an attempt to gauge the productivity of the formation beneath them,¹⁴¹ some states require prior approval from a regulatory agency—in addition to the typical zoning and surface owner permission required—to conduct such tests. Maryland, for example, requires operators to submit an “Application to Conduct Seismic Operations,” which must describe the method to be used for seismic testing, whether any surface resources including “streams, rivers, wetlands, or critical areas” will be “impacted by the seismic operation,” and the projected stream crossings that may be necessary.¹⁴²

Once seismic and other testing is complete and an operator determines that drilling and fracing at a particular site will be worthwhile, the operator obtains the necessary leases and land use approvals and begins constructing the well pad¹⁴³—the site where all of the drilling and fracing activity will take place. Access roads are cleared and constructed, and a site is excavated, cleared, and

139. See, e.g., N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 8-1 (explaining that “[m]any of the potential negative impacts of oil and gas development hinge on the location chosen for the well” and that “[m]ost of the siting restrictions on the location of wells are based on environmental and/or safety considerations”).

140. See *infra* text accompanying note 277 (describing state disclosure requirements).

141. See *supra* note 28 (describing the seismic process).

142. Md. Dep't of the Env't, Application to Conduct Seismic Operations, Form No. MDE/LMA/PER.044 at 5, available at <http://mde.maryland.gov/assets/document/permit/MDE-LMA-PER044.pdf> (last visited Dec. 30, 2009).

143. See N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-5 (explaining that “[t]he first step in developing a natural gas well site is to construct the access road and well pad”).

leveled “to support the movement of heavy equipment.”¹⁴⁴ Federal regulation does not typically apply at this stage,¹⁴⁵ but all states in the Marcellus region require certain erosion and stormwater controls to be implemented during the land clearing and well pad construction process. Maryland and West Virginia require all oil and gas well applicants to submit a plan to control sediment and erosion on the surface,¹⁴⁶ and Pennsylvania requires the same for earth moving activities that disturb 5,000 or more square feet of land.¹⁴⁷ For well sites of any size, Pennsylvania also requires well operators to follow “best management practices” (“BMPs”) to “minimize the potential for accelerated erosion and sedimentation,”¹⁴⁸ and Ohio mandates that fracing operators follow nearly identical BMPs for drilling in “urbanized areas”¹⁴⁹—unincorporated areas with more than 5,000 residents;¹⁵⁰ it appears that the BMPs are not mandatory for frac sites outside of Ohio’s urbanized areas.¹⁵¹ Maryland’s and

144. *Id.* at 5-5, 5-9.

145. See 33 U.S.C. § 1342 (l)(2) (West 2010) (exempting from the Clean Water Act permit requirement “discharges of stormwater runoff from mining operations or oil and gas exploration, production, processing, or treatment operations or transmission facilities . . . which are not contaminated by contact with, or do not come into contact with, any . . . raw material, intermediate products, finished product, byproduct, or waste products located on the site of such operations”); 33 U.S.C. § 1362(24) (West 2010) (defining “oil and gas exploration, production, processing, or treatment operations or transmission facilities” to mean “all field activities or operations associated with exploration, production, processing, or treatment operations, or transmission facilities, including activities necessary to prepare a site for drilling and for the movement and placement of drilling equipment, whether or not such field activities or operations may be considered to be construction activity” (emphasis added)); *but see* Natural Resources Defense Council v. United States Environmental Protection Agency, 526 F.3d 591 (9th Cir. 2008) (vacating EPA’s regulation for stormwater discharges from oil and gas construction). This decision has left the status of some oil and gas construction sites and their need for a federal permit in limbo, but the language of the Clean Water Act exemption, in conjunction with the Energy Policy Act definition of the exempted activities, appears to omit most well pad construction from the federal permit requirement.

146. See MD. CODE REGS. 26.19.01.06 C(12)-(13) (2009) (requiring a “sediment and erosion control plan” and a “stormwater management plan”); W. VA. CODE ANN. § 22-6-6(d) (LexisNexis 2010) (requiring a “soil erosion control plan”).

147. See 25 PA. CODE § 102.2(a), 102.4(b)(2), 102.5(a) (2010) (requiring “a person proposing an earth disturbance activity that involves 5 acres (2 hectares) or more of earth disturbance” or a smaller portion in certain circumstances to “obtain a general or individual NPDES Permit for Stormwater Discharges Associated With Construction Activities prior to commencing the earth disturbance activity,” and requiring the development of a “written Erosion and Sediment Control Plan”).

148. 25 PA. CODE § 102.2(a), 102.4(a)(1) (2010).

149. OHIO ADMIN. CODE § 1501:9-1-07 (B) (2009).

150. OHIO ADMIN. CODE § 1501:9-1-01(A)(28) (2009). Population is measured by the last federal census.

151. See *id.*

Pennsylvania's BMPs recommend that operators conduct activities such as constructing culverts and surface drains to channel surface water.¹⁵² They also attempt to ensure that when erosion does occur, there are barriers in place—such as fabric fences or straw bales¹⁵³—to prevent it from migrating off site. In New York, well operators constructing a well pad must follow similar conditions in a general permit for stormwater runoff,¹⁵⁴ and New York has proposed that operators seeking permits for “high-volume”¹⁵⁵ frac jobs must meet conditions in an industrial activity stormwater permit.¹⁵⁶

During the well site construction and preparation process, minor pollution at the surface, in addition to soil erosion and sediment runoff, may occur when diesel fuel or hydraulic fluids leak from equipment.¹⁵⁷ Similar pollution incidents can potentially emerge during the next stages, when an operator brings rigs on site to begin drilling a gas well. Drilling rigs run on diesel fuel,¹⁵⁸ and large rigs sometimes require diesel tanks with more than a 10,000-gallon capacity.¹⁵⁹ The drilling process also brings “drill cuttings” to the surface—rocks that are unearthed when the wellbore is drilled.¹⁶⁰ Depending on the local geology, the drill cuttings can contain varying levels of “naturally occurring radioactive materials” or “NORM” wastes;¹⁶¹ the New York State Department of Environmental Conservation has determined that drill cuttings from the

152. Ohio Dep't of Nat. Res., Div. of Mineral Resources Mgmt., Best Management Practices for Oil and Gas Well Site Construction 9, 12 (2005), available at http://www.dnr.state.oh.us/Portals/11/publications/pdf/BMP_OIL_GAS_WELL_SITE_CONST.pdf; Pa. Dep't of Env'tl. Protection, Oil and Gas Operators' Manual, Ch. 4 at 4-41, available at <http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-48243/chap4.pdf>.

153. Ohio Dep't of Nat. Res., *supra* note 152, at 13-14; Pa. Dep't of Env'tl. Protection, *supra* note 152, at 29-31.

154. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 7-22.

155. High-volume frac jobs are those that consume 80,001 through 299,999 gallons of water and meet other specified conditions “related to water source, fracture fluid makeup, distances, water wells and fluid disposal plan” and all wells that use greater than or equal to 30,000 gallons of water. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 3-5–3-6.

156. *See id.* at 7-23. The proposed permit will be a general permit for stormwater discharges associated with industrial activity.

157. *Id.* at 6-15 (observing that “[c]onstruction equipment is a potential source of contamination from such things as hydraulic, fuel and lubricating fluids”).

158. *Id.* at 6-49.

159. *Id.* at 7-26.

160. *Id.* at 5-29.

161. *Id.* at 5-30.

Marcellus do not pose a health concern to workers or the public,¹⁶² but environmental groups in Pennsylvania are concerned that concentrated, contaminated NORM wastes transported in trucks could pose a danger to drivers.¹⁶³

The Marcellus states have several types of regulation that address these drilling-stage activities. Drill cutting disposal requirements, where they exist, typically allow for on-site land application of the cuttings, although some states have more stringent standards. Ohio and West Virginia do not directly address accepted methods of cuttings disposal in their regulations. Maryland allows operators to dispose of cuttings on the surface at the areas on the well site that have been disturbed,¹⁶⁴ transport them to an “approved disposal facility,” or follow other methods approved by the Department.¹⁶⁵ Similarly, for cuttings that have not been contaminated with substances like brines or fracturing fluids,¹⁶⁶ Pennsylvania allows “controlled land application”¹⁶⁷ of the cuttings or disposal in lined pits that have been filled in and revegetated.¹⁶⁸ These cuttings may not be disposed of within 200 feet of a water supply¹⁶⁹ or 100 feet of a “stream, body of water, or wetland.”¹⁷⁰ New York has the most stringent requirements for cuttings disposal; cuttings generated by

162. *Id.* (describing NORM wastes and concluding that in the Marcellus region, the radioactivity levels “do not indicate an exposure concern for workers or the general public”). See also generally N.Y. State Dep’t of Env’tl. Conservation, Division of Solid and Hazardous Materials, An Investigation of Naturally Occurring Radioactive Materials (NORM) in Oil and Gas Wells in New York State (Apr. 1999), available at http://www.dec.ny.gov/docs/materials_minerals_pdf/normrpt.pdf (describing the Department’s determination).

163. John Baillie, Senior Attorney, Citizens for Pennsylvania’s Future, statement at Vill. Env’tl. L.J. Symposium, “Shale” We Drill? *The Legal and Environmental Impacts of Extracting Natural Gas from the Marcellus Shale* (Jan. 30, 2010).

164. See MD. CODE REGS. 26.19.01.10 W (2009). The technique of disposing of cuttings near the surface is called land farming.

165. See MD. CODE REGS. 26.19.01.06 F(2)(g) (2009).

166. See 25 PA. CODE § 78.61(a)(2), (b)(2) (2009). The regulations differ depending on what portion of the wellbore the cuttings come from. See 25 PA. CODE § 78.61(a)-(c) (2009).

167. See 25 PA. CODE § 78.61(b) (2009); see also Pa. Dep’t of Env’tl. Protection, *supra* note 152, Chapter 4, at 77-78.

168. See 25 PA. CODE § 78.61(a)(7)-(8), (c)(1) (2009); 25 PA. CODE § 78.62(a)(18) (2009).

169. See 25 PA. CODE § 78.61(a)(4), (b)(4) (2009).

170. See 25 PA. CODE § 78.61(a)(3), (b)(3) (2009). These regulations apply to cuttings that come from above the casing seat. A waiver is permitted for the 200-foot requirement. *Id.* The same location constraints apply to the disposal of cuttings from below the casing seat, but there is no waiver permitted for the 200-foot requirement, and land application of cuttings from below the casing seat may not occur “within 1,000 feet upgradient from an uncased well or spring being used as a water supply.” See 25 PA. CODE § 78.61(c)(1) (2009); 25 PA. CODE § 78.62(a)(6)-(7) (2009); 25 PA. CODE § 78.63(a)(7)-(8) (2009).

drilling with nonwater-based mud must be disposed of in a solid waste facility for nonhazardous substances.¹⁷¹

Once a rig has finished drilling a wellbore, the fracing process begins. In preparation for this fracing stage, tanks containing fracing fluids are delivered to the site. The hazardous fracturing fluids that are transported to the site are covered by comprehensive federal hazardous transportation laws.¹⁷² Once chemicals are removed from the transport truck or container, however, and used on site, state laws become the central regulating force for fracing and drilling fluids stored and used on the well pad surface;¹⁷³ these laws are important because the fracing stage raises new risks. Once at the site, tanks or pipes can occasionally rupture or leak, and spills can occur when fluids required for the acid shale cleaning and fracing operation are transferred.¹⁷⁴ In September 2009, for example, a leaking pipe at a frac site in Dimock, Pennsylvania sent “[m]ore than six-thousand gallons of chemically tainted water into a creek” according to a news report.¹⁷⁵ Later, in December, approximately 295 gallons of hydrochloric acid leaked out of a tank at another Pennsylvania frac site, requiring state environmental officials to remove about 126 tons of contaminated soil from the site.¹⁷⁶

All of the states overlying the Marcellus shale require drilling and fracing operators to plan for possible spill events, or at least to mitigate any spills that may occur. Maryland requires operators to submit a “spill prevention, control, and countermeasures” plan with their permit to drill.¹⁷⁷ For well pads with multiple wellheads, New York has proposed that all tanks with a capacity of more than 10,000 gallons must have a special secondary containment system to

171. See N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 7-61 (describing existing requirements); *id.* at 5-118; N.Y. COMP. CODES R. & REGS. Tit. 6, § 360-1.1 (2009) (describing part 360 solid waste management facilities).

172. See N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-65-5-67 (citing the Hazardous Material Transportation Act (1975) and the Hazardous Materials Transportation Uniform Safety Act (1989)).

173. Throughout the process, of course, operators may not discharge any pollutants into waters of the United States without a permit. See 33 U.S.C. § 1342 (West 2010). This is most applicable to the fluid disposal stage of fracing operations, discussed *infra*.

174. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-69-5-70, 6-16, 7-25.

175. WBNG News, Frack Water Spill in Dimock, *available at* <http://www.wbng.com/news/local/59777742.html> (last visited Feb. 15, 2010).

176. Loewenstein, *supra* note 129.

177. Md. Dep't of the Env't, Application for Gas Exploration and Production 12, *available at* <http://www.mde.state.md.us/assets/document/permit/MDE-LMA-PER045.pdf>.

catch any escaping fluids,¹⁷⁸ as must smaller tanks that are within 500 feet of aquifers, water wells, and surface water resources.¹⁷⁹ Under New York's proposed conditions, "[t]roughs, drip pads or drip pans" that are used in fracing operations with multiple fraced wells will also have to be placed beneath the portions of the tanks that are filled if secondary containment is not used,¹⁸⁰ and all high-volume frac operations (no matter the number of wellheads) will have to follow special best management practices for spills—such as identification of spill response teams.¹⁸¹ In Ohio, spill prevention control may be maintained by the use of a dike or pit beneath activities on the surface;¹⁸² this does not require operators to prevent spills, but it provides some control in the event that they occur. Pennsylvania requires operators to develop "Preparedness, Prevention and Contingency" (or "PPC") plans to "identify all the pollutive substance and wastes. . . that will be used or generated" during an oil or gas producing operation (including fracing), to identify "the methods for control and disposal of those substances or wastes," and to plan "the actions to be taken to prevent pollution substances from reaching the waters of the Commonwealth" in the event that accidents or unexpected conditions occur.¹⁸³ West Virginia has similar but less detailed planning requirements for operators who have a poor record of past pollutant discharges,¹⁸⁴ and all operators in West Virginia must place equipment on the site in a manner that prevents spills of pollutants that will reach state waters.¹⁸⁵ Further, in certain locations, operators must use "catch-

178. See N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 7-27; N.Y. State Dep't of Envtl. Conservation, SPOTS Memo #10 Secondary Containment Systems for Aboveground Storage Tanks (Sept. 28, 1994), available at http://www.dec.ny.gov/docs/remediation_hudson_pdf/spots10.pdf [hereinafter N.Y. Dec, SPOTS Memo].

179. See N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 7-27; N.Y. DEC, SPOTS Memo (describing tank requirements).

180. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 7-27.

181. See N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 7-27 - 7-28.

182. OHIO REV. CODE ANN. § 1509.22(C)(3) (LexisNexis 2009).

183. 25 PA. CODE § 78.55 (2008) (requiring that "[p]rior to generation of waste, the well operator shall prepare and implement a plan under § 91.34 (relating to activities utilizing pollutants) for the control and disposal of fluids" and other wastes); Pa. Dep't of Envtl. Protection, *supra* note 152, Ch. 4 at 2 (providing that "[o]perators may satisfy the pollution prevention and control and disposal plan requirements specified in 25 Pa. Code §§78.55 and 91.34 by preparing and implementing a PPC [Preparedness, Prevention and Contingency] plan").

184. Any entity that has "discharged oil or other pollutant into the waters of the state in two reported discharges within any twelve month period" must submit a "spill prevention plan." W. VA. CODE R. § 35-1-9.1 (2010).

185. W. VA. CODE R. § 35-1-8.1 (2010).

ment basins or diversion structures”¹⁸⁶ to ensure that spills do not contaminate waters.

In total, state regulations cover, to varying degrees, a range of activities that occur leading up to and during the process of drilling and fracing—from preparing the site to drilling the wellbore, storing fracing fluids, and using them on site—which are potential sources of contamination of surface waters and soil. The regulatory regimes in some of the states, however, are much more comprehensive than others. The most consistent regulations apply to the construction of access roads and well sites; all five states require some form of sedimentation and erosion control,¹⁸⁷ although Ohio’s best management practices are only “mandatory” for drilling operations in urbanized areas.¹⁸⁸ Once the drilling commences, state regulations also vary substantially. New York, for example, has the most stringent requirements for the disposal of contaminated drill cuttings—requiring them to be sent to a landfill¹⁸⁹—while other states allow for land application.¹⁹⁰ For drilling and fracing fluids stored and transferred on the surface, states like New York and Pennsylvania have proposed or already implemented relatively comprehensive controls at the well site in order to prevent spills and leaks from moving beyond the site,¹⁹¹ but other Marcellus states have less detailed spill prevention requirements, or none at all for certain operators.¹⁹²

2. *Collection and Disposal of Flowback Water*

Once the drilling is completed and fracing fluid has been mixed on the surface and then pumped into the wellbore, some of the fracing fluid and proppant flows back up through the wellbore to the surface as flowback water. The quantity of fluid ultimately recovered differs substantially by well site and formation, but in the Marcellus the flowback water comprises approximately nine to thirty-five percent of the initial volume pumped into the

186. W. VA. CODE R. § 35-1-8.2 (2010).

187. *See supra* notes 146-56.

188. *See* OHIO ADMIN. CODE 1501:9-1-07 (B) (2009). Part (A) of this portion also requires generally that “[a]ll persons engaged in any phase of operation of wells shall conduct such operation or operations in a manner which will not contaminate or pollute the surface of the land, or water on the surface or in the subsurface.”

189. *See supra* note 171 and accompanying text.

190. *See supra* notes 164, 167, and accompanying text.

191. *See supra* text accompanying notes 180-81.

192. *See supra* text accompanying notes 182, 184.

wellbore.¹⁹³ With two to seven (or even nine) million gallons of water used for many Marcellus frac jobs,¹⁹⁴ as many as two million gallons of flowback water could be held on the surface at a well site before being disposed of.¹⁹⁵ Approximately one-half percent of this water (by weight)¹⁹⁶ is some form of chemical. The flowback water thus presents a risk of possible contamination at the surface, both when it is contained on site awaiting disposal¹⁹⁷ and then ultimately disposed of.¹⁹⁸ Although much of the public attention has focused on the toxic chemicals in fracing fluids, one of the primary concerns of regulators in the Marcellus is the relatively high level of “Total Dissolved Solids” (or “TDS”) in flowback waters.¹⁹⁹ TDS is a measure of water quality, which primarily includes chlorides and sulfates.²⁰⁰ Many rivers in Pennsylvania already receive high-TDS discharges from historic sources—especially drainage from old coal

193. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 55, at 5-97.

194. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 55, at 5-73 (describing the range as 2.4 to 7.8 millions of galls of water required for a “multi-stage hydraulic fracturing procedure in a 4,000-foot lateral wellbore”); CHARLES W. ABDALLA & JOY R. DROHAN, WATER WITHDRAWALS FOR DEVELOPMENT OF MARCELLUS SHALE GAS IN PENNSYLVANIA, MARCELLUS EDUCATION FACT SHEET 3, (2009) (prepared for Penn State Cooperative Extension and The Agricultural Law Resource and Reference Center), available at <http://pubs.cas.psu.edu/FreePubs/pdfs/ua460.pdf> (observing that hydraulic fracturing of a horizontal Marcellus well could require “two to nine million gallons of water”). See also Harper, *supra* note 24, at 2-11 (explaining that “[a] slick-water frac in a horizontal Marcellus well will probably use several million gallons of water. Based on information from the Barnett Shale play, a horizontal well completion might use more than 3 million gallons of water”).

195. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 5-97 (explaining that “[f]lowback water volume could be . . . 216,000 gallons to 2.7 million gallons per well”).

196. *Id.* at 5-44.

197. *Id.* at 6-16, 6-17, 6-34 (describing how “[s]pilled, leaked, or released fluids could flow to a surface water body or infiltrate the ground, reaching subsurface soils and aquifers” and explaining that “[o]pportunities for spills, leaks, operational errors, and pit or surface impoundment failures during the flowback water recovery stage are the same as they are during the prior stages with . . . additional potential releases”).

198. *Id.* at 6-39 (explaining that “[t]reatability of flowback water is a further concern. Residual fracturing chemicals and naturally-occurring constituents from the rock formation could be present in flowback water and have treatment, sludge disposal, and receiving-water impacts”).

199. Pa. Dep’t of Env’tl. Protection, Permitting Strategy for High Total Dissolved Solids (TDS) Wastewater Discharges 1 (Apr. 11, 2009), available at http://www.depweb.state.pa.us/portal/server.pt/community/marcellus_shale_wastewater_partnership/1868 (last visited Mar. 22, 2010) [hereinafter Pa. DEP, Permitting Strategy]. The author is grateful to Phillip Bender for providing this TDS information.

200. Pennsylvania’s Department of Environmental Protection, for example, is continuing to develop a new “TDS Strategy.” Pa. Dep’t of Env’tl. Protection, *supra* note 199, at 1.

mines—²⁰¹ and regulators in the Marcellus states worry that the addition of new sources of TDS, such as Marcellus flowback water that is sent to wastewater treatment plants, will compound existing water quality problems.²⁰²

No matter the particular concern of flowback water (hazardous constituents or TDS, for example), federal and state regulations apply to both the storage and disposal stages, although the balance tilts heavily toward the states. At the federal level, the Clean Water Act prohibits oil and gas operators from discharging pollutants—a broad definition that encompasses flowback water²⁰³—into waters of the United States without a permit,²⁰⁴ and waste injected underground is subject to Safe Drinking Water Act Underground Injection Control (UIC) requirements.²⁰⁵ Beyond these baseline requirements, states are left with the bulk of the regulatory work. The states shoulder this responsibility because, as discussed in Part I, hazardous waste disposal regulations do not apply to oil and gas wastes.²⁰⁶

Most state regulations do not specifically address flowback water, but all of them place some limitations on the methods of storing and disposing of the waste fluids that result from drilling and completing the well. All Marcellus states require that flowback water be contained within some sort of pit or tank on the well site, but the requirements for these structures vary widely. All of the Marcellus states with the exception of Ohio have implemented or recently proposed a specific requirement that a pit used to store flowback water maintain at least two feet of freeboard (wall space

201. *Id.* at 1.

202. *See e.g., id.* at 3. The Department has concluded that:

[t]he surveys, analyses and studies . . . establish that the extent of existing and potential pollution from TDS, sulfates and chlorides is widespread. DEP is constrained from approving any significant portion of the pending proposals and applications for new sources of discharge high-TDS wastewater, including sulfates and chlorides, and still protect the quality of Pennsylvania's streams. In addition, it is also clear that in many watersheds, existing discharges of TDS, sulfates and chlorides will have to be reduced and limited, to assure that watershed restoration is accomplished and that the purity of our streams is protected. *Id.*

203. 33 U.S.C. § 1362(6) (West 2010) (providing that “[t]he term ‘pollutant’ means . . . industrial, municipal, and agricultural waste discharged into water”).

204. 33 U.S.C. § 1342 (West 2010).

205. 42 U.S.C. § 300h(a)(1) (West 2010) (providing that “the Administrator shall publish proposed regulations for State underground injection control programs”); 42 U.S.C. § 300h(b)(1) (providing that “[r]egulations under subsection (a) of this section for State underground injection programs shall contain minimum requirements for effective programs to prevent underground injection which endangers drinking water sources”).

206. *See supra* note 91 and accompanying text.

above the top of the flowback water), to ensure that pits do not overflow.²⁰⁷ In addition to preventing pit overflow, an important component of flowback water containment is an assurance that there is a barrier between the waste stored in the pit and the soil beneath or ideally, that the flowback water is contained in a tank to best prevent the risk of soil or water contamination. Pennsylvania has detailed pit lining requirements²⁰⁸ and publishes a list of approved synthetic pit liners.²⁰⁹ Current New York regulations do not require synthetic liners, but the Department of Environmental Conservation has consistently required them,²¹⁰ and proposed New York conditions will require the use of steel tanks to contain and store flowback water onsite.²¹¹ Maryland,²¹² Ohio,²¹³ and West Virginia, on the other hand, all fail to require that pits containing flowback water have a synthetic liner, although West Virginia requires a liner if impervious soil in the pit will not prevent “seepage” or leakage.²¹⁴ A synthetic liner mandate for all pits and impoundments had been proposed in West Virginia,²¹⁵ but this change has not been implemented,²¹⁶ and Ohio’s failure to incorporate a liner requirement in its regulations was noted in a 2005 STRONGER²¹⁷ review of Ohio’s oil and gas regulations.²¹⁸

207. MD. CODE REGS. 26.19.01.10 J(2) (2009); N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 28, at 7-31; 25 PA. CODE § 78.56 (a)(2) (2009); W. VA. CODE R. § 35-4-16.4.c (proposed), *available at* http://www.wvdep.org/Docs/17404_prop35CSR4%20Oil%20and%20gas.pdf.

208. 25 PA. CODE § 78.56-78.63 (2009).

209. Pa. Dept. of Envtl. Protection, Bureau of Oil and Gas Management, Approved Alternate Pit Liners for Pits at Oil and Gas Well Sites 1, <http://www.dep.state.pa.us/dep/deputate/minres/oilgas/Standalonedocs/Approved%20Pit%20Liners.doc>.

210. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 7-29.

211. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 7-34.

212. MD. CODE REGS. 26.19.01.10 J(2)-(4) (2009) (describing pit requirements but including no liner requirement).

213. OHIO ADMIN. CODE 1501:9-3-08(A) (2009) (describing pit requirements, including a requirement that pits shall be “liquid tight,” but including no liner requirement).

214. W. VA. CODE R. § 35-4-16.4.d (2010).

215. W. VA. CODE R. § 35-4-16.4.d (proposed), *available at* http://www.wvdep.org/Docs/17404_prop35CSR4%20Oil%20and%20gas.pdf.

216. *See* W. VA. CODE R. § 35-4-16 (2010) (showing that as of March 2010, the code had not been modified to include this language).

217. *See supra* note 118, and accompanying text (discussing STRONGER review—a program wherein a nonprofit organization reviews the strengths and weaknesses of state oil and gas regulations).

218. State Review of Oil and Natural Gas Environmental Regulations, Inc. 28 (June 2005), *available at* http://www.dnr.state.oh.us/Portals/11/oil/pdf/stronger_review05.pdf (observing that “[t]he Ohio regulations do not specifically require the use of pit liners. . . . Although beyond the scope of the IOGCC criteria, the

Even where a synthetic liner or tank mandate prevents migration of the flowback water in a pit to the soil and water below, the length of time for which the flowback water may remain on the site is important; longer storage times create higher risks of a contamination incident caused by, for example, a tear in the liner or a trespasser interfering with the pit.²¹⁹ Maryland fails to specify the timing of pit closure, however.²²⁰ New York, on the other hand, requires fluids to be removed from the site within forty-five days after drilling has ended,²²¹ and it has proposed that for pits “within primary or principal aquifer areas or unfiltered water supply areas,” fluids must be removed within seven days.²²² In Pennsylvania an operator must remove fluids from a flowback water storage pit within nine months of completing the drilling process unless the operator obtains a permit stating otherwise.²²³ Ohio requires removal of salt water from pits within three months,²²⁴ and West Virginia effectively requires removal of the flowback fluid within six months by providing that pits may not “constitute a hazard” or prevent surface farming use after a six-month period.²²⁵

Once the flowback fluids in a surface pit have been removed, state disposal requirements for flowback water vary widely (beyond the basic federal requirement that all states must follow—a prohibition on the direct discharge of flowback water into waters of the United States).²²⁶ Pennsylvania and New York have the most stringent regulations. In Pennsylvania, operators may only dispose of flowback waters at publicly owned treatment works (“POTWs” or,

Review Team recommends incorporation of such criteria into regulation or guidelines”).

219. Cf. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, GENERIC ENVIRONMENTAL IMPACT STATEMENT 8-5 (1992), available at http://www.dec.ny.gov/docs/materials_minerals_pdf/dgeisvlch8.pdf (suggesting that “children, pets, and farm animals” could be endangered by a pit on a site where there was not fencing); *id.* at 9-32 – 9-33 (explaining that pit liners can “be punctured by trash and debris thrown into the pit”).

220. MD. CODE. REGS. 26.19.01.10 J(1) (2009) (providing basic requirements for pits but not providing a required time for pit closure).

221. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 7-34.

222. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 7-34–35.

223. 25 PA. CODE § 78.56 (d) (2009).

224. OHIO ADMIN. CODE 1501:9-3-08 (2010) (requiring that “[s]altwater and oil field wastes shall be drained or removed and properly disposed of periodically, at intervals not to exceed one hundred eighty days”).

225. W. VA. CODE R. § 35-4-16.4.h (2010). West Virginia has proposed that “[t]he reclamation period for pits permitted with multiple wells shall be calculated from the date the last well was drilled.” W. VA. CODE R. § 35-4-16.4.h (proposed), available at http://www.wvdep.org/Docs/17404_prop35CSR4%20Oil%20and%20gas.pdf.

226. See *supra* note 204 and accompanying text.

more generally, sewage treatment facilities) and “Centralized Waste Treatment (CWT) facilities,”²²⁷ or into seldom-used underground injection wells.²²⁸ If Pennsylvania implements its proposed regulations on the “saltiness” of the flowback water (regulations that will limit the total dissolved solid content of flowback water), POTWs will likely be unable to take the waste, and specialized mobile units and other alternative technologies will likely be used for flowback water treatment.²²⁹ In New York, permitted flowback water disposal options similarly include treatment works, injection wells, and “out-of-state industrial treatment plants.”²³⁰ Ohio does not have disposal requirements specific to flowback water, but, assuming that flowback water will fall within the definition of “brine” (the salty water that returns from the well during drilling and continued gas production), it must be disposed of in an underground injection well.²³¹ Maryland permits disposal at a POTW or in a pit or dam,²³² and West Virginia, with perhaps the most permissive disposal rules in the Marcellus region, allows for land disposal of flowback water.²³³ The West Virginia Department of Environmental Protec-

227. Pa. Dep’t of Env’tl. Protection, *supra* note 199, at 6.

228. Pa. Dep’t of Env’tl. Protection, Marcellus Shale Fact Sheet 4, *available at* <http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-77964/0100-FS-DEP4217.pdf> (requiring that “[t]he wastewater . . . [generated as part of the drilling process in the Marcellus Shale] is considered industrial wastewater Waste water (fluids) must be reused and recycled, collected and treated at a wastewater treatment facility. DEP approval is required before the receiving treatment facility can accept the wastewater for processing and/or disposal”); Scott Perry, Assistant Counsel (now Head of the Pennsylvania Dep’t of Env’tl. Protection, Bureau of Oil & Gas Mgmt.), Oil and Gas Exploration and Production of Environmental Protection, PowerPoint Presentation, *available at* http://downloads.cas.psu.edu/natural-gas/pdf/Current_Perry.pdf; Scott Perry, Oral Presentation, “Shale” We Drill? *The Legal and Environmental Impacts of Extracting Natural Gas from Marcellus Shale*, Vill. Env’tl. L.J. Symposium (Jan. 31, 2010) (explaining that there are only seven brine disposal wells in Pennsylvania).

229. The author understands this information to be true based on a conversation with Scott Perry at Pennsylvania Environmental Council & Duquesne University, Marcellus Shale Policy Conference, May 3, 2010. This information is not a direct quotation from Scott and should not be taken as such.

230. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 5-119.

231. OHIO REV. CODE ANN. § 1509.22(C)(1) (LexisNexis 2009) (requiring that “[b]rine from any well except an exempt Mississippian well shall be disposed of only by injection into an underground formation”).

232. Md. Dep’t of the Env’t, *supra* note 177, at 7.

233. *See* W. Va. Dep’t of Env’tl. Protection, Office of Oil and Gas, Well Work Permit Application Addendum, *available at* <http://www.dep.wv.gov/oil-and-gas/GI/Documents/Permit%20Addendum%20F%5B1%5D.pdf> (requiring the operator to indicate the water disposal method and to “estimate . . . [the percentage that] each facility is to receive, and listing as possible facilities “[l]and [a]pplication, “UIC” (underground injection control well), “POTW” (publicly owned wastewater treatment plant), “NPDES” (National Pollutant Discharge Elimi-

tion does not believe, however, that this disposal option will be practical for high-volume frac jobs.²³⁴ Other authorized disposal methods in West Virginia for flowback water include underground injection wells and commercial treatment works.²³⁵

Viewed collectively, as with the regulation of the surface activities during the drilling and fracturing process, states' requirements for the storage and disposal of flowback water vary. All provide for some protection from soil or water contamination while the fluid sits on the site by requiring an impermeable pit²³⁶ (even where liners are not required²³⁷) and adequate freeboard to prevent overflow.²³⁸ Most of the Marcellus states limit acceptable flowback water storage times on site, thus also narrowing the surface contamination window of risk, and they all have basic disposal requirements.²³⁹ Most allow for the flowback water to be shipped to a treatment works or to be disposed of in federally regulated underground injection wells, which, under the Safe Drinking Water Act, must not allow for the contamination of groundwater.²⁴⁰ The large volumes of waste that fracing will produce, however, may overwhelm underground injection permitting as well as the centralized treatment works. New York has proposed that an analysis must prove that a treatment works can handle the waste and the particular contaminants within the waste before it can be accepted,²⁴¹ and

nation System permit under the Clean Water Act to discharge into waters of the United States), and "[o]ther").

234. W. Va. Dep't of Env'tl. Protection, *supra* note 71, at 4 (explaining that "[w]hile land application may generally be an option . . . [i]n smaller, shallower wells, it may not be practical in dealing with the volume of water expected at these sites").

235. *Id.*

236. *See supra* notes 208-11 and accompanying text (requiring pit liners).

237. MD. CODE REGS. 26.19.01.10 J(2)-(4) (2009) (requiring pits to "[b]e impermeable" and to "[a]llow no liquid or solid discharge of any kind into the waters of the State"); OHIO ADMIN. CODE § 1501:9-3-08(A) (2009) (requiring pits to be "liquid tight").

238. *See supra* note 207 and accompanying text (discussing the freeboard requirements).

239. *See supra* text accompanying notes 227-35 (discussing state disposal requirements).

240. *See supra* note 205.

241. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 55, at 7-57 (describing existing casing requirements).

Pennsylvania²⁴² and West Virginia²⁴³ already require this. No matter where the flowback water is ultimately handled for disposal, it will be a large burden on the systems that are not accustomed to this type and volume of waste, and it presents a substantial challenge to states. Ohio has already expressed fear, for example, that Pennsylvania fracing operators will ship much of the brine from their wells to Ohio's underground injection wells due to Pennsylvania's limits on brine disposal in rivers.²⁴⁴

One immediate, though partial, solution to the disposal challenge facing the states is the reuse and recycling of flowback water, wherein fracing operators recover flowback water from one well and use it as a fracing fluid in another well. Several states encourage this type of flowback water recycling, and several fracing companies are pursuing it and are attempting to improve recycling and reuse technologies.²⁴⁵ Reuse and recycling reduces operators' need to obtain water withdrawal permits,²⁴⁶ reduces the waste that

242. Pa. Dep't of Env'tl. Protection, *supra* note 228, at 4 (explaining that "[t]he wastewater . . . [generated as part of the drilling process in the Marcellus Shale] is considered industrial wastewater," that "[w]aste water (fluids) must be reused and recycled, collected and treated at a wastewater treatment facility, and that "DEP approval is required before the receiving treatment facility can accept the wastewater for processing and/or disposal").

243. W. Va. Dep't of Env'tl. Protection, *supra* note 71, at 4.

244. Spencer Hunt, *Gas Wells' Leftovers May Wash Into Ohio: Experts Fear Brine From Pennsylvania May End Up Here*, COLUMB. DISPATCH, Jan. 10, 2010, available at http://www.dispatchpolitics.com/live/content/local_news/stories/2010/01/11/copy/PaBrine.ART_ART_01-11-10_A1_TEG89MH.html?sid=101 (last visited Feb. 16, 2010).

245. The Railroad Commission of Texas, for example, reports that in a "five-well recycling pilot project," a flowback fluid processing facility recovered "over 4.5 million barrels of reusable water." Other companies have participated in pilot projects for flowback fluid reuse approved. R.R. Comm'n of Tex., Environmental Protection, <http://www.rrc.state.tx.us/commissioners/williams/environment/producedwater.php> (last visited Feb. 15, 2010); Halliburton, Marcellus Shale, available at <http://www.halliburton.com/ps/default.aspx?navid=1616&pageid=3029> (last visited Feb. 15, 2010) (explaining that "Halliburton is actively engaged in the development of technologies that enable the re-use of water-based fracturing fluid and the use of produced water in formulating fracturing fluid"); N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 55, at 7-78 (describing how "[m]ost or all operators will recycle or reuse flowback water to reduce the need for fresh water.").

246. See, e.g., N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 7-78 (explaining that "[i]t is beneficial to the operators to implement water conservation and recycling practices because of the potential difficulties obtaining the large volumes of water needed for hydraulic fracturing."); *id.* at 7-4-7-5 (explaining that frac operators must submit an application for withdrawal of water from a public water supply); Pa. Dep't of Env'tl. Protection, Water Management Plan for Marcellus Shale Gas Well Development Example Format, Form No. 5500-PM-OG0087, available at <http://www.eibrary.dep.state.pa.us/dsweb/Get/Document-74084/5500-PM-OG0087%20Application%20Example.pdf> (requiring a well operator to list water sources, average daily quantity, maximum withdrawal rate, and

in some cases they must pay to dispose of, and may accordingly reduce operators' expenses. In the long term, however, disposal is likely to remain one of the most important environmental issues facing states with high levels of fracing activity. While recycling and reuse are an important partial alternative to disposal, the costs of recycling and reuse and the newness of the technologies suggests that disposal of large volumes of flowback water will continue through the near future.²⁴⁷

3. *Regulatory Constraints on the Proximity of Fracing to Natural Resources*

Most state regulation of the location of drilled (and now fraced) wells typically has addressed only the distance between the well and property boundaries, as well as required distances between wells.²⁴⁸ The proximity of drilling and fracing activities to natural resources, however, also matters. If a pit liner that stores fracing flowback water tears, a tank with fracing fluids leaks, or fracing fluid spills when being transferred on site, the potential damage caused will differ depending on where the release occurs. In an extreme hypothetical example, an accidental release of fracing fluid in close proximity to a municipal surface water supply could create a more important potential human exposure pathway for a chemical than, for example, a hypothetical release into soil on the site, which might have fewer effects if the soil were properly removed and disposed of and no contaminants migrated beyond the soil.²⁴⁹

other data, and referring operators to additional requirements that must be met for water withdrawals from the Susquehanna River Basin and the Delaware River Basin).

247. Reuse is costly and has not yet been perfected. *See, e.g.*, N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 55, at 5-111 (discussing "capital costs associated with treatment system"); National Energy Technology Laboratory, Oil & Gas Natural Gas Projects, Exploration and Production Technologies, http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/Environmental/Produced_Water/00975_MarcellusFlowback.html (last visited Feb. 16, 2010) (describing a research project for water reuse technology for the Marcellus region that commenced in 2009).

248. *See, e.g.*, 25 PA. CODE § 79.11 (2010) (requiring consistency with spacing orders).

249. *See, e.g.*, Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Rates, 53 Fed. Reg. 25,446, 25,455 (July 6, 1988):

The presence of constituents in concentrations exceeding health- or environmental-based standards does not necessarily mean that these wastes pose significant risks to human health and the environment. In evaluating the risks to human health and the environment, several factors beyond the toxicity of the waste should be considered. These factors include the rate of release of contaminants from different management practices,

Before the hydraulic fracturing of the Marcellus Shale commenced, some Marcellus states had begun to limit the proximity of drilling to natural resources. With the rise of fracking, these existing regulations now apply to a broader range of activity but may not cover all physical facets of the fracking process, such as impoundments. All of the Marcellus states, with the exception of Ohio, require a minimum distance between the well pad or the drilled well and private water wells. The minimum limits range from 1,000 feet in Maryland²⁵⁰ to 150 feet in New York,²⁵¹ and all Marcellus states but New York allow for a waiver of this requirement with the owner's permission.²⁵² New York allows a site to be closer than 150 feet to a well or spring if so approved after public notice and hearings.²⁵³ Maryland,²⁵⁴ New York,²⁵⁵ and Pennsyl-

the fate and transport of these contaminants in the environment, and the potential for human health or ecological exposure to the contaminants.

250. MD. CODE REGS. 26.19.01.09 G (2009) (providing that "[t]he Department may not issue a drilling and operating permit if the well location is closer than 1,000 feet to a . . . drinking water supply [or] wellhead protection area . . . unless written permission of the owners is submitted with the application and approved by the Department").

251. The New York State Department of Environmental Conservation's draft Supplemental Generic Environmental Impact Statement for high-volume hydraulic fracturing explains that the GEIS completed in 1992 proposed these distances as conditions. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 2-24, 2-25; *see also* N.Y. Dep't of Env'tl. Conservation, *supra* note 219, at 8-15 (recommending that "the minimum siting restriction on the proximity of wells and associated production facilities to permanent surface bodies of water be increased to 150 feet"); *id.* at 8-16 (recommending that "the surface water setback restriction be applied to springs which are used for a domestic water supply"). In Pennsylvania, no well may be drilled within 200 feet of existing water well or building without the consent of the owner. 58 PA. CONS. STAT. ANN. § 601.205(a) (LexisNexis 2009). In West Virginia, "[n]o oil or gas well shall be drilled nearer than two hundred feet from an existing water well or dwelling without first obtaining the written consent of the owner of such water well or dwelling." W. VA. CODE ANN. § 22-6-21 (LexisNexis 2009).

252. MD. CODE REGS. 26.19.01.09 G (2009) (allowing for waiver "with written permission of the owners"); 58 PA. CONS. STAT. ANN. § 601.205(a) (LexisNexis 2009) (allowing waiver with "the written consent of the owner" of the water well); W. VA. CODE ANN. § 22-6-21 (LexisNexis 2009). Maryland requires a waiver and the approval of the Department of Environmental Protection for the distance to vary. MD. CODE REGS. 26.19.01.09 G (2009).

253. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 219, at 8-15 (allowing for a waiver following "exception request," public notice, and hearings).

254. MD. CODE REGS. 26.19.01.09 G (2009) (providing that "[t]he Department may not issue a drilling and operating permit if the well location is closer than 1,000 feet to a school, church, drinking water supply" unless written permission is obtained).

255. N.Y. State Dep't of Env'tl. Conservation, Findings Statement (1992), *available at* http://www.dec.ny.gov/docs/materials_minerals_pdf/geisfindorig.pdf (showing that New York requires certain types of site-specific environmental assessments for oil and gas drilling permits requested less than 1,000 feet of municipal

vania²⁵⁶ also provide minimum required distances between gas wells or well sites and public water supplies, ranging from 2,000 feet in New York (unless a site-specific environmental review allows for a shorter distance²⁵⁷) to 200 feet in Pennsylvania,²⁵⁸ although Maryland²⁵⁹ and Pennsylvania²⁶⁰ allow property owner waivers for this requirement.

New York and Pennsylvania regulations also move beyond drinking water supplies; they place minimum distance requirements on the placement of a well site near surface water bodies such as streams, rivers and wetlands.²⁶¹ Several states also specifically mandate that pits used to contain wastes at well sites should not be close to certain natural resources. New York has proposed that operators must conduct a site-specific environmental review for any large, centralized impoundment pits proposed to be constructed near water wells and springs,²⁶² reservoirs,²⁶³ and surface waters,²⁶⁴ and it plans to ban centralized impoundments within the

water supply wells and between 1,000 and 2,000 feet from municipal water supply wells).

256. 58 PA. CONS. STAT. ANN. § 601.205(a) (LexisNexis 2009) (providing that “[w]ells may not be drilled within 200 feet measured horizontally from any . . . existing water well without the written consent of the owner thereof”). Scott Perry, Head of the Pennsylvania Dep’t of Env’t. Protection’s Bureau of Oil & Gas Mgmt., confirmed that the Pennsylvania Department of Environmental Protection has interpreted this to mean water supply more generally, not just private water wells. Conversation with Scott Perry (Jan. 30, 2009).

257. See *supra* note 255 (describing the site-specific review required).

258. See *supra* note 256 (prohibiting the drilling of wells within 200 feet of water wells).

259. MD. CODE REGS. 26.19.01.09 G (2009). Maryland requires a waiver and the approval of the Department of Environmental Protection for the distance to vary. *Id.*

260. 58 PA. CONS. STAT. ANN. § 601.205(a) (LexisNexis 2009) (allowing for waiver with written consent of the water well owner).

261. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 7-69 (describing existing conditions limiting surface locations of oil and gas wells to more than 150 feet from a “public stream, river or other body of water”); *id.* at 7-70 (describing an existing requirement for a special “Freshwater Wetlands Permits” in a “wetland or 100-foot buffer zone”); 58 PA. CONS. STAT. ANN. § 601.205(b) (LexisNexis 2009) (providing that “[n]o well site may be prepared or well drilled within 100 feet measured horizontally from any stream, spring or body of water . . . or within 100 feet of any wetlands greater than 1 acre in size”).

262. See N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 7-69 (proposing a requirement of site-specific environmental review for “any proposed centralized surface flowback impoundment within 300 feet of a private water well or domestic-use spring”).

263. See *id.* at 7-72 (proposing that site-specific review be required for any centralized flowback impoundment within 1,000 feet of a reservoir).

264. See *id.* at 7-72 (proposing that site-specific review be required for any centralized flowback impoundment within “500 feet of a perennial or intermittent stream, wetland, drain, lake or pond”).

boundaries of important aquifers and New York City's water supply.²⁶⁵ Ohio does not specify a minimum required distance between pits and surface waters, but it provides that pits "shall not be used in an area which is subject to flooding by streams, rivers, lakes, or drainage ditches, unless so constructed that the pits would not normally be affected by flooding."²⁶⁶ West Virginia has proposed a similar rule to avoid the flooding of pits,²⁶⁷ although this rule has not yet been enacted.²⁶⁸

These regulations, which in some states limit the proximity between drilling and pits and natural resources, may help to ensure that when accidents occur—as they did in Bradford County and Dimock, Pennsylvania in 2009²⁶⁹—contaminants do not damage valuable natural resources or water supplies. Currently, however, the regulations vary widely. Some apply only to the location of the drilling operation, while others, such as New York's proposed regulations, specifically address the location of pits.²⁷⁰ Further, some states address the proximity of drilling to more types of resources than do others—protecting wetlands and streams,²⁷¹ for example, in addition to water wells.

4. *Required Information Disclosure to Agencies and the Public*

Beyond formal regulation of well drilling and waste disposal activities, as well as the location of these activities, some Marcellus state regulations also require the disclosure of information related to the fracturing process. Through a permitting process, an operator applies to the relevant state agency for a permit to drill before com-

265. *See id.* at 7-51 (explaining that "the Department will not approve use of centralized flowback water surface impoundments within the boundaries of primary and principal aquifers or unfiltered water supplies").

266. OHIO ADMIN. CODE 1501:9-3-08(A) (2009).

267. *See* W. VA. CODE R. § 35-4-21.1 (proposed), available at http://www.wvdep.org/Docs/17404_prop35CSR4%20Oil%20and%20gas.pdf (proposing that "[a]ll pits and impoundments used in association with oil and gas operation . . . shall be constructed only in locations appropriate for the storage of water, including wastewater, and shall be designed, constructed, located, maintained, and used . . . in such a manner as to minimize adverse environmental impacts and assure safety to the public").

268. *See* W. VA. CODE R. §§ 35-4-20, 35-5-1 (2010) (showing that as of March 2010, the code had not been modified to include a section beyond "19" in the 35-4 set of rules).

269. Loewenstein, *supra* note 129; WBNG News, *supra* note 175 (describing Pennsylvania accidents).

270. *See supra* notes 262-64 and accompanying text (describing constraints on location of pits near water wells, springs, reservoirs, surface waters, and aquifers).

271. *See supra* note 261 and accompanying text (describing how New York and Pennsylvania limit gas well proximities to wetlands and streams).

mencing drilling and production activity. The Marcellus states all require operators applying for a permit to drill to submit a plan that indicates how the operator will dispose of the waste created by drilling (and, impliedly, by the associated fracing), or at least to provide a basic indication of planned disposal.²⁷² All of these states also require disclosure of the distance between the proposed well site or wellbore and certain surface waters,²⁷³ although West Vir-

272. Md. Dep't of the Env't, *supra* note 177, at 7 (requiring an operator to "[n]ame the location of all treatment facility(s) where all wastewater, including drilling and fracing water will be taken for disposal"); N.Y. COMP. CODES R. & REGS. Tit. 6, § 554.1(c)(1) (2009) (requiring that "[p]rior to the issuance of a well-drilling permit for any operation in which the probability exists that brine. . . or other polluting fluids will be produced or obtained during drilling operations in sufficient quantities to be deleterious to the surrounding environment, the operator must submit and receive approval for a plan for the environmentally safe and proper ultimate disposal of such fluids"); OHIO ADMIN. CODE 1501:9-1-02 (A)(3) (2009) (requiring a "plan for disposal of water and other waste substances resulting from, obtained, or produced in connection with exploration, drilling, or production of oil or gas"); 25 PA. CODE § 78.55 (2009) (requiring that "[p]rior to generation of waste, the well operator shall prepare and implement a plan under § 91.34 (relating to activities utilizing pollutants) for the control and disposal of fluids" and other pollutants); Pa. Dep't of Env'tl. Protection, *supra* note 152, Ch. 4 at 2 (providing that "[o]perators may satisfy the pollution prevention and control and disposal plan requirements specified in 25 Pa. Code §§78.55 and 91.34 by preparing and implementing a PPC [Preparedness, Prevention and Contingency] plan"); W. Va. Dep't of Env'tl. Protection, *supra* note 71, at 4 (requiring operators that are considering disposing of their flowback water at a wastewater treatment plant to notify several state agencies and departments that this option is being considered); W. Va. Dep't of Env'tl. Protection, Office of Oil and Gas, Construction and Reclamation Plan and Site Registration Application Form, General Permit for Oil and Gas Pit Waste Discharge, Form No. WW-9, *available at* <http://www.dep.wv.gov/oil-and-gas/GI/Documents/permit%20forms.pdf> (scroll to p. 7) (requiring operator to indicate whether operator plans to use land application, underground injection, reuse, offsite disposal, or "other," to dispose of pit wastes); Md. Dep't of the Env't, *supra* note 177, at 6, (requiring a description of "how the free liquid fraction and contaminated liquids will be treated and disposed of").

273. Md. Dep't of the Env't, *supra* note 177, at 3 (requiring a yes, no, or N/A answer to the question of whether the "drilling operation will be located within . . . 25 feet from wetlands"); MD. CODE REGS. 26.19.01.06 E(2)(c)(iv) (2009) (requiring the submittal of a plat showing "[a]ny part of the Chesapeake Bay Critical Area, 100 year floodplain, non-tidal wetlands, tidal wetlands, streams, or other bodies of water within 200 feet of well site"); MD. CODE ANN., [ENVIR.] § 14-104 (West 2010) (requiring an environmental assessment); N. Y. State Dep't of Env'tl. Conservation, *supra* note 77 (requiring a yes, no, or "not known" answer to whether "any part of the well site or access road" is located "[w]ithin 150 feet of a lake, stream, or other public surface water body"); N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 3-8 (proposing further disclosure conditions as part of an "Environmental Assessment Form Addendum" (EAF) proposed as part of draft sGEIS); N.Y. State Dep't of Env'tl. Conservation, *supra* note 31, at Appendix 6 (proposed EAF addendum will require disclosure of the "[d]istance from closest edge of well pad to" "[a]ny perennial or intermittent stream, wetland, storm drain, lake or pond within 660 feet"); OHIO ADMIN. CODE 1501:9-1-02(A)(5)(d) (2009) (requiring disclosure of "[t]he location of all . . . streams within two hundred (200) feet of the proposed well site"); Pa. Dep't of Env'tl. Protection, Permit Application for

ginia only requires general disclosure of “streams,” without any specification of distance;²⁷⁴ all, with the exception of Ohio, require or have proposed to require disclosure of the anticipated distance between the well site or the well itself and private water wells;²⁷⁵ and all, with the exception of Ohio and West Virginia, mandate that drilling applicants show the anticipated distance to public water supplies.²⁷⁶

Although the Marcellus states all have these basic disclosure requirements, only New York and Pennsylvania expressly require that fracing operators disclose the chemical constituents of fracturing fluids.²⁷⁷ Maryland’s regulations may require this disclosure, but only if the requirement of disclosing “drilling additives and

Drilling or Altering a Well, Form 5500-PM-OG0001 at 1, *available at* <http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-79067/02%205500-PM-OG0001%20Form.pdf> (requiring a yes or no answer to the question of whether the “well site” will “be within 100 feet (measured horizontally) or a stream, spring, or body of water” and whether the “well site” will be “within 100 feet or a wetland or in a wetland”).

274. W. VA. CODE R. § 35-4-9.2.m.3 (2010) (requiring submittal of a plat showing “streams”).

275. Md. Dep’t of the Env’t, *supra* note 277, at 3 (requiring disclosure of whether the “drilling operation” will be “located within . . . 1,000 feet from a drinking water supply”); Md. CODE REGS. 26.19.01.06 E(2)(c)(ii) (2009) (requiring a plat showing “[w]ater wells within 2,640 feet of the proposed well location”); N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 3-8 (proposing further disclosure conditions as part of an “Environmental Assessment Form Addendum” (EAF) proposed as part of draft sGEIS); N.Y. State Dep’t of Envtl. Conservation, *supra* note 31, at Appendix 6 (proposed EAF addendum will require disclosure of “[e]vidence of diligent efforts by the well operator to determine the existence of public or private water wells and domestic-supply springs within half a mile (2,640 feet) of any proposed drilling location or centralized flowback water impoundment”); Pa. Dep’t of Envtl. Protection, *supra* note 273, at 1 (requiring a yes or no answer to the question of whether the “well will be drilled within 200 feet (horizontally) from any existing building or an existing water supply”); W. VA. CODE R. § 35-4-9.2.m.1 (2010) (requiring submittal of a plat showing “[w]ater wells within two hundred (200) feet of the well” for which a permit is being sought”).

276. Md. Dep’t of the Env’t, *supra* note 277, at 3 (requiring a yes, no, or N/A answer to whether the “drilling operation” will be “located within . . . 1,000 feet from a drinking water supply”); N.Y. STATE DEPT. OF ENVTL. CONSERVATION, *supra* note 77 (requiring a yes, no, or “unknown” answer to whether “any part of the well site or access road” will be located “[w]ithin 150 feet of a surface municipal water supply”); N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 3-8 (proposing further disclosure conditions as part of an “Environmental Assessment Form Addendum” (EAF) proposed as part of draft sGEIS); N.Y. State Dep’t of Envtl. Conservation, *supra* note 31, at Appendix 6 (proposed EAF addendum will require disclosure of the “[d]istance from closest edge of well pad to” “[a]ny water supply reservoir within 1,320 feet”); Pa. Dep’t of Envtl. Protection, *supra* note 273, at 1 (requiring a yes or no answer to whether the well will be “drilled within 200 feet (horizontally) from any existing building or any existing water supply”).

277. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 3-9; *supra* note 272 (referencing Pennsylvania’s required “PPC” plan, which requires the disclosure of chemicals).

their toxicity”²⁷⁸ is interpreted to include fracing fluid additives. Ohio and West Virginia have no regulations requiring such disclosure. These states’ environmental agencies could potentially mandate this type of disclosure as part and parcel of the disposal or reclamation plans that all operators must submit,²⁷⁹ but the regulations as written do not require disclosure.

5. *Enforcement Activity*

A final consideration in measuring the strength of state regulations, as roughly measured by their ability to adequately lower the risk of environmental damage and harm to human health from hydraulic fracturing,²⁸⁰ is the extent to which the regulations on the books are enforced. One can attempt to estimate the level of enforcement of fracing activities by investigating the number of wells drilled, the number of enforcement staff within agencies’ oil, gas, and mineral divisions, and the reports within occasional newspaper articles that mention an enforcement event. But these numbers would be inadequate. Some agencies with high staffing numbers may not do much enforcement work; their reporting requirements may not allow them to effectively determine when violations occur, for example, or they may not have the physical resources, such as vehicles and testing equipment, which would allow their staff to make effective site visits. In some states, however, these types of statistics are transparent. Official enforcement reports by agencies, such as workload reports published by the Pennsylvania Department of Environmental Protection, describe the number of investigations conducted, the number of violations identified, and the number of enforcement actions taken. The DEP’s 2009 end-of-year workload report, for example, shows that for Marcellus wells, staff made a total of 2,094 inspections, inspected 874 wells, found 638 violations, and made 173 “enforcements.”²⁸¹ In late January 2010, Pennsylvania’s Governor Rendell also directed the Department to hire sixty-eight new enforcement personnel, suggesting that enforcement efforts will continue and potentially increase.²⁸²

278. Md. Dep’t of the Env’t, *supra* note 277, at 5 (asking operator to describe “[w]hat drilling additives will be used” and to “[p]rovide description of toxicity”).

279. *See supra* note 272 (describing required disposal plans).

280. *See* Part IIIA for a description of this rough metric.

281. Pa. Dep’t of Env’tl. Protection, Regional Year to Date Workload Report – 01/01/2009 to 12/31/2009, *available at* <http://www.dep.state.pa.us/dep/dep/dupe/minres/oilgas/2009%20Year%20End%20Report-WEBSITE.pdf>.

282. Pa. Dep’t of Env’tl. Protection, News Release (Jan. 28, 2010), *available at* <http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=3115&typeid=1> (last visited Feb. 12, 2009).

In addition to tracking permitting and resulting inspection and enforcement activity, at least one Marcellus state is also taking steps to avoid compliance problems in the first instance. The Pennsylvania Department of Environmental Protection, for example, has developed a regular training program for fracing operators and others involved in the industry. This program discusses methods to protect streams and wetlands, spill reporting requirements, impoundment requirements, chemical analysis and residual waste (including flowback water) handling, erosion and sediment control permitting, BMPs, and implementation, among other measures.²⁸³ This type of training helps to ensure that regulations do not only exist on the books; those who must follow the regulations are fully informed of them prior to the commencement of fracing activity.

Regardless of the ultimate level of enforcement of state regulations, the existing and recently-proposed rules in the Marcellus states show that states in the Appalachian region are responding to recent changes in drilling methods and frequency within their territory, although some more quickly and comprehensively than others.

IV. STATES' ADAPTATION AND FUTURE NEEDS

The discussion in Part III of state regulation of hydraulic fracturing in the Marcellus region highlights the non-uniformity of the regulations in some areas. Some of this variation could potentially be explained by the rate of fracturing to-date (which has been high in Pennsylvania, for example, but is only beginning in West Virginia²⁸⁴), as well as differing local conditions. But it also suggests that some states—especially those that will soon experience a high level of fracing activity and have not yet updated their oil and gas regulations to accommodate this change—need to adapt. This Part argues, following the metric described in Part IIIA, that state regulations in the hydraulic fracturing area are not consistently filling in federal regulatory gaps, particularly with respect to hazardous wastes and potential contamination incidents at the surface. It also

283. See, e.g., Pa. Dep't of Envtl. Protection, Regulatory Requirements Training Seminar for Marcellus Shale, Agenda, Feb. 10, 2010, http://www.dep.state.pa.us/dep/deputate/minres/oilgas/new_forms/marcellus/Training/February%20%202010%20Training%20Agenda.doc (last visited Mar. 3, 2010); see also Pa. Dep't of Envtl. Protection, 2010 Marcellus Shale Training, http://www.dep.state.pa.us/dep/deputate/minres/oilgas/new_forms/marcellus/2010%20MarcellusTraining.htm (last visited Mar. 3, 2010) (showing current training information).

284. See *supra* text accompanying notes 66 and 71-73 (describing well permits issued and proposed).

argues that the regulations in some states fail to require the production of information that will be necessary to inform future, improved analysis of regulatory needs with respect to fracing. After identifying these deficiencies, it suggests solutions at the state level and briefly explores the possibility of an additional federal regulatory floor.

A. State Regulatory Deficiencies

When gas wells in Appalachia are fractured with millions of gallons of fresh water mixed with (potentially) several thousand gallons of chemicals,²⁸⁵ state regulations nearly exclusively govern several stages of the process, including the handling and transfer of fracing fluids on site, the containment of used fluids on the surface, and the ultimate disposal of the fluids.²⁸⁶ As discussed in Part II, the extent to which Marcellus states regulate these activities varies widely. Some states require pits that contain flowback water from the fractured well to have a synthetic liner to prevent the seepage of the waste into any water or soils below;²⁸⁷ others do not.²⁸⁸ Some require that flowback pits and other waste impoundments be a minimum distance from surface waters and other natural resources;²⁸⁹ others do not.²⁹⁰ One Marcellus state allows for land application of flowback water at the well site²⁹¹—a practice that would not likely be permitted if flowback water were subject to federal hazardous waste disposal regulation²⁹²—while others require disposal at a was-

285. See *supra* notes 50, 194, and accompanying text (describing reported statistics on volumes and concentrations).

286. See *supra* text accompanying notes 79-80, 84, 91-93 (describing state regulations that govern, to varying degrees, a range of fracing-related activities).

287. See *supra* text accompanying notes 209-11 (describing synthetic liner requirements).

288. See *supra* text accompanying notes 212-15 (describing how Maryland, Ohio, and West Virginia do not require a synthetic liner).

289. See *supra* notes 261-64 (showing that New York specifically limits pits' proximity to natural resources and that Pennsylvania limits the proximity of a "well site"—which would likely include the pit—to certain natural resources).

290. See *supra* notes 251, 254 (showing that states like West Virginia and Maryland limit the proximity of the well location—not the well site or well pit—to natural resources).

291. See *supra* text accompanying note 233 (describing how West Virginia allows land application of flowback water). *But see supra* text accompanying note 234 (describing how West Virginia's environmental agency has suggested that land application will not be practical for Marcellus wells).

292. See 42 U.S.C. § 6924(d)(1) (West 2010) (prohibiting the "land disposal of hazardous wastes," with several exceptions); 42 U.S.C. § 6924(c) (West 2010) (prohibiting "the placement of bulk or noncontainerized liquid hazardous waste or free liquids contained in hazardous wastes . . . in any landfill").

tewater treatment plant or similar facility.²⁹³ Three of the Marcellus states fail to require the disclosure of chemicals used in the fracturing fluid,²⁹⁴ and the length of time for which flowback water (the used fluid) may be stored in a pit on site varies from forty-five days to nine months—with one state failing to specify the time for pit closure.²⁹⁵

From the perspective of the handling and disposal of potentially hazardous substances, it appears from this melange of regulation that not all states have lived up to EPA's expectations for improved regulation, which the agency voiced when it exempted oil and gas wastes from federal hazardous waste regulation in 1988. EPA observed during that time that "some [s]tates do not have adequate requirements controlling roadspreading or landspreading of large-volume wastes, design or maintenance rules for reserve pits, or have insufficient management specifications for centralized and commercial disposal facilities."²⁹⁶ In some cases, these deficiencies have not changed. The fracturing fluids used in Marcellus fracturing operations often contain familiar household chemicals,²⁹⁷ but some also contain hazardous components. And the concentrations of certain hazardous chemicals in flowback water, such as concen-

293. See *supra* text accompanying notes 227-30 (describing Pennsylvania's requirement for POTWs and New York's requirement for POTWs or injection wells). *But see* text accompanying note 229 (explaining how alternative means of disposal will likely be necessary when and if Pennsylvania implements total dissolved solids limits on flowback water).

294. See *supra* text accompanying notes 278-79 (explaining that only New York (under its proposed regulations) and Pennsylvania (under its existing regulations) require disclosure of fracturing chemicals).

295. See *supra* text accompanying notes 220-25 (describing how New York requires removal within forty-five days, whereas Pennsylvania allows nine months and how Maryland does not specify timing for pit closure).

296. *Supra* note 114.

297. GROUND WATER PROTECTION COUNCIL, *supra* note 33, at 62; N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-62 (explaining that "[g]lycols occur in several fracturing fluid additives" and are "used as an additive in food, cosmetic and drug products").

trations of methanol,²⁹⁸ propargyl alcohol,²⁹⁹ and ethylene glycol,³⁰⁰ appear to exceed EPA risk-based concentrations for federal tapwater. Flowback water, which in all Marcellus states is stored in impoundments or tanks on the surface before being disposed of, is produced in high volumes³⁰¹ and may also contain several toxic chemicals. Selected samples of flowback water from Pennsylvania and West Virginia contained all of the toxic constituents of oil and gas wastes that EPA mentioned in its 1988 oil and gas hazardous waste report as occurring in relatively high concentrations:³⁰² arsenic, barium, benzene, boron, cadmium, chromium, fluoride, and lead.³⁰³ Further, the median concentration of these constituents in the flowback water sampled in Pennsylvania and West Virginia appear to exceed EPA maximum contaminant levels (MCLs) allowed in drinking water for each of these constituents with the exception of boron, which lacks an established MCL.³⁰⁴ The sampled

298. Pa. Dep't of Envtl. Protection, Table 1 Summary of Hydraulic Fracture Solutions – Marcellus Shale, *available at* <http://www.dep.state.pa.us/dep/deputate/minres/oilgas/FractListing.pdf> (showing in product “XLW-32” a concentration of methanol in the frac solution of 176.79 parts per million (ppm) and an EPA risk-based concentration for residential tapwater of 18 ppm). Note that the table does not specify whether “Concentration in Frac Solution” refers to the concentration of the hazardous component of a product or the concentration of a product. The author assumes that the “Concentration in Frac Solution” refers to the concentration of the hazardous component in the frac solution, since previous columns describe the hazardous component, but this assumption may be incorrect.

299. *Id.* (showing in product Cl-14 a concentration of propargyl alcohol in frac solution of 0.23 ppm and an EPA risk-based concentration for residential tapwater of 0.073 ppm).

300. *Id.* (showing in product Unilink 8.5 a concentration of ethylene glycol in frac solution of 123.19 ppm and an EPA risk-based concentration for residential tapwater of 73 ppm).

301. *See supra* notes 50, 194, 195, and accompanying text (explaining that each frac site can generate as many as 2.7 million gallons of water, based on a maximum estimate of some frac jobs requiring as many as seven million gallons of water and a flowback rate of approximately thirty percent); *see also* R.R. Comm'n of Tex., *supra* note 30 (explaining that horizontal slickwater frac jobs “can use over 3.5 million gallons (over 83,000 barrels) of water”); R. Timothy Weston, Development of the Marcellus Shale—Water Resource Challenges 1, *available at* <http://www.wvoro.org/resources/marcellus/Weston.pdf> (explaining that slickwater frac techniques in the Barnett have used “as much as 500,000 to 1,000,000 gallons of fluid in each of five to seven stages”) and estimating that similarly large quantities may be required in the Marcellus.

302. *See supra* note 96 (describing constituents occurring in relatively high concentrations in oil and gas wastes).

303. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-104-5-106 (listing toxic constituents in flowback water samples).

304. U.S. Envtl. Protection Agency, Drinking Water Contaminants, List of Contaminants & Their MCLs, *available at* <http://www.epa.gov/ogwdw000/contaminants/index.html#2> (last visited May 7, 2010) (showing permissible maximum contaminant levels in drinking water of 0.010 mg/L for arsenic, 2 mg/L for bar-

flowback water also contained high concentrations (as compared to acceptable drinking water concentrations) of chemicals not described by EPA in its 1988 report, such as antimony and thallium.³⁰⁵

The presence of these toxic chemicals in fracturing fluid and fracturing flowback water suggests that, absent EPA's 1988 determination to exempt oil and gas wastes from federal hazardous waste regulation, fracturing flowback water might count as a "hazardous waste" and might be federally regulated. Several of the more than 250 chemical constituents potentially found in fracturing flowback water in Pennsylvania and New York are chemicals that are listed as hazardous under the Resource Conservation and Recovery Act,³⁰⁶ and professors from Cornell University have pointed to the hazardous nature of several additional components of some frac solutions, discussing their potentially carcinogenic qualities and their highly volatile nature as well as identifying one "known carcinogen" and an "extremely potent mutagen" mentioned in New York's State's description of fracturing fluids and flowback water.³⁰⁷ Further, the New York State Department of Environmental Conservation has identified several fracturing products with potentially hazardous effects. Aromatic hydrocarbons such as benzene, toluene, ethylbenzene, and xylene ("BTEX"), for example, which are sometimes contained within frac products, "are associated with adverse effects on the nervous system, liver, kidneys and blood-cell-forming tissues," and some glycol ethers "can affect the male reproductive

ium, 0.005 mg/L for benzene, 0.005 mg/L for cadmium, 0.1 mg/L for chromium, 4.0 mg/L for fluoride, and an 0.015 mg/L action level for lead; N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-104-5-105 (showing median concentrations of flowback constituents "based on limited samples" from Pennsylvania and West Virginia, which were 0.1065 mg/L for arsenic, 661.5 mg/L for barium, 479.5 micrograms/L (0.4795 mg/L) for benzene, 0.032 mg/L for cadmium, 5 mg/L for chromium, 392.615 mg/L for fluoride, and 0.24 mg/L for lead).

305. U.S. Envtl. Protection Agency, *supra* note 304 (showing maximum contaminant levels in drinking water of 0.006 mg/L for antimony and 0.002 mg/L for thallium); N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-104-5-105 (showing median concentrations of flowback constituents "based on limited samples" from Pennsylvania and New York as 0.26 mg/L for antimony and 0.1 mg/L for thallium). The selenium concentrations in flowback water samples only slightly exceeded the maximum contaminant level: the median concentration of selenium in flowback was 0.058 mg/L, and the maximum contaminant level is 0.05 mg/L. U.S. Envtl. Protection Agency, Drinking Water Contaminants, *supra* note 304; N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-105.

306. 40 C.F.R. §§ 261.30-33 & App. VIII (West 2010); Pa. Dep't of Envtl. Protection, *supra* note 298 (listing propargyl alcohol, methanol, and acetic acid as hazardous components of fracture solutions).

307. Susan Riha et al., Comments on Draft sGEIS on the Oil, Gas and Solution Mining Regulatory Program, *available at* <http://blogs.cornell.edu/nyswri/files/2010/01/Comments-on-draft-sGEIS-for-Marcellus-Shale.pdf>.

system and red blood cell formation in laboratory animals at high exposure levels."³⁰⁸ Whether fracing fluids would ultimately be deemed "hazardous" under federal hazardous waste regulation absent the oil and exemption, however, would depend on concentrations and characteristics of the waste.³⁰⁹

While describing the potentially hazardous nature of some of the chemicals in fracing flowback water, it is also important to note that the initial concentrations of the toxic constituents in flowback water vary widely,³¹⁰ and the concentration of toxic constituents in flowback water would also be diluted if flowback water escaped from a pit through a leak, overflow, or interference by a trespasser and entered fresh surface water, groundwater, or soil.³¹¹ Professors at Cornell, however, are concerned that "[e]ven if one considers a dilution or attenuation factor. . . of as much as 100, it is possible that mishandling of flowback water could contaminate nearby aquifers. . . at levels that could exceed a . . . [maximum contaminant level] established by the EPA."³¹² Some constituents will break down when mixed with certain media, although New York City's Department of Environmental Protection is concerned that fracing chemicals like 2,2-Dibromo-3-Nitrilopropionamide are "highly toxic" and do not "readily evaporate, volatalize, or adsorb to soil particles."³¹³

What remains is the basic fact that flowback water, which sometimes contains toxic constituents, is in some states being stored at the wellsite surface in unlined pits for several months without requirements for minimum distances between pits and surface water, and in West Virginia the flowback water may technically be applied

308. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-62.

309. *See, e.g., supra* note 125 (showing that some listed wastes are only associated with certain types of industrial processes).

310. N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 5-104-5-105 (showing ranges of 0.09 mg/L-0.123 mg/L for arsenic, 0.553 mg/L-15700 mg/L for barium, 15.7 micrograms/L-1950 micrograms/L for benzene, 0.009 mg/L-1.2 mg/L for cadmium, 0.122-5.0 mg/L for chromium, and 0.02 mg/L-0.46 mg/L for lead in flowback water samples from Pennsylvania and West Virginia).

311. *But see* N.Y. City Dep't of Envtl. Protection, New York City Comments on: Draft Supplemental Generic Environmental Impact Statement (dSGEIS) on the Oil, Gas and Solution Mining Regulatory Program 20 (Dec. 22, 2009), *available at* <http://www.tcgasmap.org/media/NYC%20DEP%20Draft%20SGEIS%20Comments.pdf> (noting, in the context of concerns about spills entering reservoirs, that "[c]omplete mixing in reservoirs with volumes as large as NYC's reservoir is not a reasonable assumption under most circumstances").

312. Riha et al., *supra* note 307.

313. N.Y. City Dep't of Envtl. Protection, *supra* note 311, at 21.

to the surface of the well site.³¹⁴ On-site storage creates the possibility that the flowback water could migrate to soil or water sources on the surface³¹⁵ if a “non-routine” event occurred.³¹⁶ This could be of particular concern in the 1,077 square miles of unprotected land in the watershed for New York City’s unfiltered drinking water supply. EPA, in commenting on New York’s analysis of the environmental effects of high-volume fracing and proposed conditions for fracing operations, indicated:

EPA is particularly concerned about the potential risks associated with gas drilling activities in the New York City watershed and the reservoirs that collect drinking water for nine million people. . . . EPA has serious reservations about whether gas drilling in the New York City watershed is consistent with the vision of long-term maintenance of a high quality unfiltered water supply.³¹⁷

In addition to concerns about the adequacy of state regulations for the containment of fracing fluid and flowback water on the well site, Marcellus states are struggling with the ultimate disposal of flowback water. As discussed in Part III, states like New York and Pennsylvania expressly require analyses of sewage treatment facilities prior to the disposal of flowback water at these facilities, and Pennsylvania has proposed more stringent regulations for allowed concentrations of barium, strontium, and other pollutants called “total dissolved solids” in flowback water.³¹⁸ Other states are further behind and have not specified the type of analysis that must be conducted when the wastes are sent to a treatment plant. Regardless of the requirements that states impose for the disposal of flowback water, even where more stringent requirements like Pennsylvania’s have been imposed, it is not clear that fracing operators or treatment plants have developed the technology necessary to treat millions of gallons of this waste. Considered in total, it ap-

314. See *supra* text accompanying note 233; but see *supra* text accompanying note 234.

315. N.Y. City Dep’t of Env’tl. Protection, *supra* note 311, at 21 (expressing concern about chemical spills contaminating reservoirs and worrying that the “spills in proximity to inlet structures must also be taken into consideration”).

316. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 5-61 (explaining that “exposure to fracing additives would require a failure of operational controls such as an accident, a spill, or other non-routine incident”).

317. U.S. Env’tl. Protection Agency, *supra* note 124, at 2.

318. 30 PA. BULL. 6467 (Nov. 7, 2009), available at <http://www.pabulletin.com/secure/data/vol39/39-45/2065.html> (last visited Feb. 15, 2010) (proposing changes to 25 PA. CODE § 95.10(c)).

pears that regulatory gaps remain at several stages of the fracing process.

B. Solutions for State Adaptation

For Marcellus states to better adapt to the flood of fracing permit applications that have arrived or soon will, states should take several actions in the near term. As the Ground Water Protection Council has observed, recent developments like shale gas extraction have “resulted in the use of formation treatment practices such as fracturing that are now returning large amounts of fluids to the surface,” and “regulations. . . may not yet reflect. . . [recent activity such as fracing] with respect to surface storage and management of treatment fluids.”³¹⁹ In most cases, at least one state within the Marcellus region has addressed some of the regulatory gaps identified in this Article. New York, for example, has proposed that fracing operators must follow a general stormwater permit for industrial users,³²⁰ and it has recommended that flowback water be stored in steel tanks rather than pits;³²¹ Pennsylvania has a slightly less stringent requirement of synthetic pit lines.³²² Further, to address concerns about impacts to surface waters, Pennsylvania prohibits a well site from being prepared within 100 feet of streams, wetlands, springs, or other bodies of water,³²³ and New York has proposed similar 300- and 150-foot requirements.³²⁴

States that lack similar requirements should look to other Marcellus states’ regulations and adapt the substance of their regulation to fit their specific circumstances. For example, Marcellus states that do not require a synthetic pit liner for the storage of flowback water, with specifications for the strength of the liner and acceptable materials, should add this requirement or otherwise ensure that permitted pit linings are truly impermeable; ideally, states would follow New York’s lead and consider requiring steel tanks for flowback water storage. States should also consider reducing the length of time during which flowback water may be stored on site. Finally, spill prevention and planning, response, and remediation

319. GROUND WATER PROTECTION COUNCIL, *supra* note 39, at 37.

320. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 7-70.

321. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 7-34.

322. 25 PA. CODE § 78.56 (a)(2),(4) (2009).

323. 58 PA. CONS. STAT. ANN. § 601.205(b) (LexisNexis 2009).

324. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 7-71 (describing a proposed requirement of site-specific review for any well pad proposed within 300 feet “of a reservoir stem or controlled lake” or within 150 feet of a “watercourse, perennial or intermittent stream, storm drain, lake or pond”).

are ripe for upgrading in some states. States that do not require operators to follow basic spill prevention and control practices and to submit a plan for prevention and containment of spills, for instance, should do so. And in the event that spills do occur despite control measures, or impoundments fail, states should also modify constraints on the location of fracing and impoundments relative to surface water, ground water, and other important natural resources.³²⁵

In addition to modifying regulation of fracing practices such as pit storage and spill prevention, Marcellus states should also immediately require disclosure of the chemical constituents that a fracing operator plans to use in fracing fluids when an operator applies to drill a well, as Pennsylvania already does³²⁶ and New York has proposed to do.³²⁷ Following the completion of the fracing operation, the states should additionally require reporting of the types and quantities of chemicals actually used.³²⁸ If contamination of a site is discovered in the future, this will allow for more effective clean up. In addition to assisting response efforts in the event of an accident,³²⁹ disclosure of the chemical constituents in fracing fluids may allay public concerns about their toxicity; with full and accurate information about the fluids, individuals could ask a local lab or scientist to explain the hazards of the chemicals rather than having to guess. Indeed, industry is not uniformly opposed to this type of disclosure; several prominent natural gas companies—Chesapeake, Range Resources, and Schlumberger—have called for voluntary disclosure of fracing chemicals.³³⁰

325. The Ground Water Protection Council has made similar suggestions that can provide a useful guide—proposing, for example, that states should “review current regulations in several programmatic areas to determine whether or not they meet an appropriate level of specificity.” GROUND WATER PROTECTION COUNCIL, *supra* note 39, at 7.

326. *See supra* note 183.

327. N.Y. STATE DEP’T OF ENVTL. CONSERVATION, *supra* note 31, at 3-9.

328. Many states already require the completion of “well treatment reports.” *See* GROUND WATER PROTECTION COUNCIL, *supra* note 39, at 25. These reporting forms could be revised to require the disclosure of chemicals used.

329. *See supra* text accompanying note 129 (discussing soil clean-up); *see, e.g., Jim Moscou, A Toxic Spew?: Officials Worry About Impact of ‘Fracking’ of Oil and Gas*, NEWSWEEK Web Exclusive, Aug. 20, 2008, available at <http://www.newsweek.com/id/154394> (last visited Feb. 15, 2010) (describing an emergency room response to a frac site worker’s exposure to a chemical).

330. Abrahm Lustgarten, *Gas Execs Call for Disclosure of Chemicals Used in Hydraulic Fracturing*, PROPUBLICA, Oct. 2, 2009, available at <http://www.propublica.org/feature/gas-execs-call-for-disclosure-of-chemicals-used-in-hydraulic-fracturing-102>; David Wethe, *Schlumberger Presses for Shale-Gas Openness as Regulation Looms*, BLOOMBERG, Sept. 29, 2009, <http://www.bloomberg.com/apps/news?pid=20601072&sid=acwzglfw6Re8>.

Marcellus states that have not done so should also consider implementing other disclosure requirements as part of the permit to drill application; states that have not yet done so could require disclosure, for example, of the distance of the proposed well pad from surface water and other natural resources.³³¹ This will allow members of the public, environmental groups, and other state agencies to comment on the permit and express any concerns about drilling in a particular location. In order for effective regulatory adaptation to occur, states must know about unique local circumstances, and the public can assist in this quest. On the other side of the spectrum, federal assistance in producing solid, unbiased, scientific information on the typical concentrations of chemical constituents in fracking fluids, their likely exposure routes, and the level of risk posed by various fracking chemicals is also important. As Daniel Esty has argued, "While in some cases, competing federal and state analyses would be useful, in most circumstances, intergovernmental competition on technical issues is likely to consume resources without yielding commensurate benefits."³³² Federal entities embarking upon studies could benefit from information generated as a result of state disclosure requirements.

Finally, as states collect information and write new or modified regulations, they should simultaneously ensure that these regulations are effectively implemented. This will require at least two steps. First, states should hire enforcement staff if drilling permit application rates increase and should equip staff with the physical equipment necessary to do effective testing and monitoring. Recognizing the challenges that state budgets are facing in the region, these states will likely need to evaluate budgeting priorities to fund sufficient staff and resources; some states have used permitting fee increases to help fund regulatory staff.³³³ As part of the staffing process, they should also, as Pennsylvania already does,³³⁴ regularly report enforcement activities so that the public may see the level to which fracking regulations are implemented and enforced.

As a second step toward effective implementation of both existing and "adapted" fracking regulations, states should provide

331. Most of the Marcellus states already require this disclosure to varying degrees (*see supra* notes 273-76), but more disclosure would be useful.

332. Daniel C. Esty, *Toward Optimal Environmental Governance*, 74 N.Y.U. L. REV. 1495, 1562 (1999).

333. This information was provided by Phillip Bender of K&L Gates in March 2010.

334. *See supra* text accompanying note 281 (describing Pennsylvania's regular workload reports).

clear, understandable information to fracing operators of the regulations and any changes to the regulations—informing them of the rules that must be followed and the penalties that may be enforced in the absence of compliance. Regulations are already confusing and complex, and clarification and guidance will be essential as the regulations change. The training similar to that provided by Pennsylvania—as discussed in Part III.E. above—is crucial to ensuring that operators' on-the-ground personnel understand and effectively implement the varied regulatory controls intended to protect surface waters and natural resources. The other Marcellus states should consider including this type of training in their regulatory programs.

There is no formula for an ideal regulatory adaptation process, but some general principles are clear. Some state regulations need updating; this has been shown both by the holes identified in the EPA's 1988 analysis of state management of oil and gas waste—some of which still have not been filled—as well as by the substantial variation among states in some regulatory areas. In this updating process, several general principles will hold true. Where the greatest variation exists, as with pit liner and spill control requirements, states should look to their unique circumstances and determine whether this variation is justified by these circumstances or rather by a failure to address fracing, a recently-introduced activity within the states. Further, states should focus on better information gathering; with improved information, any changes to regulation will be better informed. And finally, states should revisit their enforcement practices and should consider improvements to their system of recording and publicizing enforcement. These basic principles, if followed, will help to ensure that as the Marcellus states adapt to a rush of new extraction activity, so too will the effectiveness of their regulations.

C. Contemplating a Federal Floor

If states adopt the solutions for regulatory adaptation suggested in this Article (or, ideally, find even better solutions), state regulation of hydraulic fracturing might sufficiently limit the potential environmental and human-health risks associated with fracing. As this article has emphasized, however, more information is needed to effectively and more fully understand these risks and thus to determine regulatory adequacy.³³⁵ And if states fail to adapt

335. Some attempts at producing information about the risks of hydraulic fracturing have been made. EPA in 2004, for example, completed an analysis of

as fracing expands, or if further study shows higher risks, Congress may need to reconsider the exemption of hydraulic fracturing from several aspects of federal regulation.

Any suggestion of federal regulation tends to invoke strong responses from states, industry, and other actors;³³⁶ federal regulation is seen as onerous, costly, and bureaucratic³³⁷ and is often opposed.³³⁸ I do not attempt to devise a federal solution here or to suggest that flowback water should immediately lose its exemption

hydraulic fracturing in coalbeds, but this analysis failed to address shales and had many other flaws. See Wiseman, *supra* note 29, at 176-80 (highlighting some of the deficiencies in the report). In 2009, the Department of Energy published a report, written by the Ground Water Protection Council, which it describes as a “fact-based dialogue on how shale gas development can proceed in an environmentally responsible manner under the auspices of state regulatory programs.” GROUND WATER PROTECTION COUNCIL, *supra* note 33 (Foreword). The report, however, sometimes relies upon general conclusions about risk (pointing out, for example, that “[e]ven chemicals that go into our food and drinking water can be hazardous”), and does not purport to fully conduct a scientific, risk-based analysis. *Id.* at 62. New York’s Department of Environmental Conservation has conducted the most thorough analysis of the potential effects of hydraulic fracturing to-date in its draft Supplemental Generic Environmental Impact Statement released in 2009. See generally *supra* note 31. More documents similar to this impact statement would be useful for future dialogue on the risk posed to the environment and human health by hydraulic fracturing.

336. See, e.g., Am. Petroleum Inst., Duplicative Hydraulic Fracturing Rules Could Imperil U.S. Economy, <http://www.api.org/Newsroom/hf-rules-usecon.cfm> (last visited Apr. 19, 2010) (quoting API’s president, who argues that “[u]nnecessary additional regulation of . . . [hydraulic fracturing] would only hurt the nation’s energy security and threaten our economy” and concluding that “[a]dditional federal oversight of hydraulic fracturing is not necessary”); Cal. Indep. Petroleum Ass’n, Hydraulic Fracturing, <http://www.cipa.org/i4a/pages/index.cfm?pageID=597> (last visited Apr. 19, 2010) (arguing that the proposed federal FRAC Act would “would institute a vast, unnecessary financial burden on a single small-business industry: American oil and natural gas producers, as well the state agencies without any environmental benefit”); Ground Water Protection Council, Resolution Requesting Legislative Clarification of the Definition of “Underground Injection” in the Safe Drinking Water Act, available at <http://www.gwpc.org/advocacy/documents/resolutions/res00-7.htm> (last visited Apr. 19, 2010) (supporting the position that hydraulic fracturing is not “underground injection” under the Safe Drinking Water Act and that the controversy over whether fracing should be included within this definition “is not serving the goals of protecting drinking water supplies in the United States”); GROUND WATER PROTECTION COUNCIL, *supra* note 39, at 7 (concluding that “[s]tate oil and gas regulations are adequately designed to directly protect water resources”); Statement of Scott Kell on Behalf of the Ground Water Protection Council before the House Committee on Natural Resources, June 4, 2009, available at <http://www.gwpc.org/e-library/documents/general/Kell%20House%20Testimony%206-4-2009.pdf> (arguing that a “one-size-fits-all federal program is not the most effective way to regulate” hydraulic fracturing); Williams, *supra* note 124 (describing a Colorado administrator’s objection to federal regulation of fracing under the Safe Drinking Water Act).

337. See, e.g., *supra* notes 105 and 106, and accompanying text (discussing EPA’s view, expressed in 1988, of RCRA subtitle C as complex and burdensome).

338. See *supra* note 336.

from federal hazardous waste regulation. As has been shown with other high-volume substances with constituents that have hazardous properties, such as coal ash,³³⁹ attempts at federal regulation are not easy.³⁴⁰ The technology to handle the new waste must be developed, and certain federal restrictions, if not written properly, could negatively interfere with industry's ability to recycle a pollutant.³⁴¹ But the possibility of developing a federal regulatory floor to ensure minimum standards of environmental and human health protection—whether under the Safe Drinking Water Act to address concerns about the quality of underground sources of drinking water, under RCRA, or a new federal act—should not be immediately rejected.

EPA, in exempting oil and gas wastes from federal regulation under RCRA, explained that its deference to the states in this area arises from several considerations. Oil and gas extraction are economically important activities,³⁴² and EPA believed in 1988 that the hazardous wastes generated by these activities could be effectively managed by state regulations, provided that some of those regulations improved.³⁴³ The tendency toward deference to the states in

339. U.S. Env'tl. Protection Agency, Fact Sheet: Coal Combustion Residues – Surface Impoundments with High Hazard Potential Ratings, <http://www.epa.gov/osw/nonhaz/industrial/special/fossil/ccrs-fs/> (last visited Apr. 21, 2010) (explaining that coal combustion residues “contain a broad range of metals, for example, arsenic, selenium, cadmium, lead, and mercury, but the concentrations of these are generally low. However, if not properly managed, (for example, in lined units), CCRs may cause a risk to human health and the environment and, in fact, EPA has documented cases of environmental damage”). The “hazard potential” in the title of this document does not refer to the hazardousness of the various components of the residue but rather to the safety or lack thereof of the impoundments that hold the residue (as measured by National Dam Safety Program criteria).

340. Following the Kingston, Tennessee coal ash spill, EPA announced that it anticipated “having a proposed rule [relating to fly ash] ready for public comment” by the end of 2009. Env'tl. Protection Agency, EPA Announces New Action to Prevent Coal Ash Releases, <http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/b2856087389fb82485257574007409c1!OpenDocument> (last visited Sept. 15, 2009). In late December 2009, the Obama administration announced that it would “delay the release” of the new rules. Ken Ward, Jr., EPA Delays New Rules on Coal Ash, CHARLESTON GAZETTE, Dec. 17, 2009, available at <http://wvgazette.com/News/MiningtheMountains/200912170559> (last visited Apr. 19, 2010).

341. See, e.g., Patrick Reis, *Is Coal Ash Hazardous?*, SCI. AM., Jan. 13, 2010, available at <http://www.scientificamerican.com/article.cfm?id=coal-ash-waste-hazardous-standard-regulation> (describing industry's fears that “hazardous designation would kill an ash-recycling enterprise”).

342. See *supra* note 102 and accompanying text (describing EPA's view, in 1988, of the importance of oil and gas extraction and the economic impact of regulation).

343. See *supra* note 103 and accompanying text.

oil and gas regulation may also be attributed, in part, to the fact that the practice of extracting resources from beneath the ground is inherently tied up in local geography.³⁴⁴ Precipitation varies, for example, and flowback water stored in a pit might pose a higher contamination potential in a state prone to flooding.³⁴⁵

All of this said, many other important economic activities, such as power generation, face comprehensive federal regulations based on concerns about public health and the state of America's air and water.³⁴⁶ And the impacts of these federally regulated activities also vary greatly depending on local circumstances. A coal ash impoundment at a coal-fired power plant in one area of the country might be subject to a higher risk of flooding and overflow than a similar impoundment in an area with different local weather conditions.³⁴⁷ This, however, has not stopped EPA from declaring its intention to regulate these impoundments. The impoundments are not currently regulated as hazardous wastes under RCRA but face impending federal rules.³⁴⁸

Analysis of the need for federal regulatory standards in the area of fracing should consider traditional metrics within environmental federalism analysis. Further investigation is needed to determine whether fracing leads to economic and pollution-based "spillovers" and regulatory races to the bottom, for example,³⁴⁹ and whether state and even local regulations are "working" from the perspective of internalizing the costs of regulation or the lack

344. Cf. GROUND WATER PROTECTION COUNCIL, *supra* note 39, at 7 (referring to the "specific conditions" of individual states).

345. Cf. GROUND WATER PROTECTION COUNCIL, *supra* note 39, at 39 (arguing that "[p]its designed as evaporation pits should not be allowed in regions where average annual precipitation exceeds average annual evaporation").

346. Power plants face numerous regulations under the Clean Air Act and Clean Water Act. See, e.g., HAROLD R. FRIEDANI & KIMBERLY MASTERS EVANS, POWER PLANT PERMITTING 5-6 (1996) (describing, for example, national ambient air quality standards that power plants must meet and permits that they must obtain under the Clean Air Act and national pollutant discharge elimination system permits and water quality based effluent limits that power plants must meet under the Clean Water Act).

347. Differing local conditions, of course, are not the only explanatory factor. Safety considerations—such as the engineering of the impoundment—also affect impoundment safety, as shown by EPA's identification of "high hazard potential units" in August 2009. Env'tl. Protection Agency, Coal Combustion Residues (CCR) – Surface Impoundments with High Hazard Potential Ratings, <http://www.epa.gov/osw/nonhaz/industrial/special/fossil/ccrs-fs/> (last visited Apr. 19, 2010).

348. See *supra* note 340.

349. See Richard B. Stewart, *Pyramids of Sacrifice? Problems of Federalism in Mandating State Implementation of National Environmental Policy*, 86 YALE L. J. 1196, 1215 (1977).

thereof.³⁵⁰ The variation in certain fracing regulations among different regions of the United States³⁵¹ could possibly suggest a race to the bottom. The Ground Water Protection Council, a coalition of state regulators, disagrees. It highlights, for example, well casing requirements designed to protect ground water in all of the fracing states,³⁵² as well as other regulations related to pit permitting, well plugging, and other drilling and fracing-related activities,³⁵³ and believes that “state regulations are adequately designed to protect water resources.”³⁵⁴ But there are also substantial differences among some state fracing regulations.³⁵⁵ Texas, for example, does not at the state level have any restrictions on the proximity of drilling (and hence fracing) to natural resources.³⁵⁶ It also does not require liners in completion/workover pits (a definition that appears to include flowback water impoundments³⁵⁷), nor does it require a permit for the operation of such pits.³⁵⁸ These regulations differ markedly from some of the Marcellus regulations described in Part III of this Article, although some local governments in Texas have addressed environmental and nuisance-based concerns through their own municipal regulation. Fort Worth, for example, requires a “closed-loop” system wherein wastes from drilling and

350. See, e.g., David E. Adelman & Kirsten H. Engel, *Adaptive Federalism: The Case Against Reallocating Environmental Regulatory Authority*, 92 MINN. L. REV. 1796, 1803 (2008) (discussing the “simple insight” of environmental federalism literature that “regulation would be inefficient if its costs and benefits were not fully internalized by the regulating authority”).

351. See *infra* text accompanying notes 356-58 and *supra* text accompanying note 30. Even among the Marcellus states, some types of regulations differ substantially, as discussed in Part III; these differences might partially be explained by the newness of fracing in some of these states.

352. GROUND WATER PROTECTION COUNCIL, *supra* note 39, at 18-21.

353. *Id.* at 25-31.

354. *Id.* at 7.

355. The Ground Water Protection Council recognizes that regulations differ but believes, as did the EPA in exempting oil and gas wastes from federal hazardous waste regulation, that any deficiencies can and should be cured by the states, not the federal government. See GROUND WATER PROTECTION COUNCIL, *supra* note 39, at 19 (describing percentages of states that require certain types of casing). The report makes similar comparisons about well plugging, completion reports, pit and tank requirements, and other fracing-related regulations throughout its report). See e.g., *id.* at 7 (arguing that “[s]tates should review current regulations in several programmatic areas to determine whether or not they meet an appropriate level of specificity”).

356. See *supra* note 30 (describing how Texas only has spacing requirements for wells).

357. See *supra* note 30 (describing how flowback water appears to fall within the definition of “completion/workover pit” in 16 TEX. ADMIN. CODE § 3.8(a)(4) and how the Railroad Commission has described fracturing jobs as “completions”).

358. See *supra* note 30.

fracing are stored within tanks, although it allows earthen lined pits for operations that are on open space of at least 25 acres and not within 1,000 feet of a "protected use."³⁵⁹ Arlington requires a similar closed loop system with above-ground steel tanks for waste for all gas drilling operations unless the Texas Railroad Commission provides a different directive.³⁶⁰

In light of the interesting and complex array of state and local fracing-related regulations and the continued inadequacy of data about fracing risks, the federal/state question will continue to be an important one. In the meantime, as states continue to do much of the regulatory work in the area of hydraulic fracturing, their actions require immediate attention.

CONCLUSION

Hydraulic fracturing is an essential component of modern gas extraction, and it has allowed America to increase natural gas production from unconventional reserves while the country continues its slow transition to a sustainable energy base. The challenge, however, is to effectively regulate this practice—which is new to regions like Appalachia—in a manner that ensures production of an important fuel resource and the simultaneous protection of natural resources and human health.

This challenge is a familiar one to environmental regulators and industry, but the many stages of the fracing process, the new technologies that it has introduced, and its rapid expansion to new regions have all increased the challenge. A well site and access road must be constructed, presenting opportunities for erosion and sedimentation. A wellbore must be drilled, and fracing fluids must be transported to, stored, and then used on the site, creating the potential for accidental spills and leaks.³⁶¹ Some of these fracing fluids, once used, then flow back to the surface, where they must be stored, managed, and ultimately disposed of. Storage and disposal

359. Fort Worth, Texas, Ordinance No. 18449-02-2009 § 15-42 A.2 (2009), available at http://www.fortworthgov.org/uploadedFiles/Gas_Wells/090120_gas_drilling_final.pdf.

360. Arlington, Texas, Ordinance No. 07-074 § 7.01 A.29 (2007), available at http://www.marcellus-shale.us/pdf/Gas-Drill-Ord_Arlington-TX.pdf.

361. See N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 6-16 (explaining that "contamination of surface water bodies and groundwater resources during well stimulation could occur as a result of . . . ineffective site management and surface and subsurface fluid containment practices . . . or accidental spills and releases").

also create opportunities for potential contamination of natural resources on the surface.³⁶²

As this Article has shown, the lack of federal regulation in some areas has left to the states much of the responsibility for meeting this challenge and states, to varying degrees, have stepped up to the plate. Some have modified their regulations to address the newly-introduced extraction practices, and many existing state regulations apply to most stages of the fracing process. The regulations in some areas differ substantially, however, and some fail to fill federal regulatory gaps. With respect to transferring fracing chemicals on site, for example, some Marcellus states lack a comprehensive spill prevention and control program.³⁶³ Others do not constrain the location of a well pad or fracing facilities with respect to nearby surface waters,³⁶⁴ and still others have relatively lax requirements for the lining of impoundments and pits.³⁶⁵

This Article has suggested several basic guiding principles that might help to fill these potential gaps, such as changing certain regulations to address some of the inconsistencies, strengthening information disclosure requirements, training regulated entities to inform them of regulations (particularly as they move from state-to-state to conduct new fracing operations), and providing adequate resources for enforcement. It has also raised the possibility of considering a federal floor, as more and better information is developed concerning the risks of fracing. If Congress continues to leave the bulk of regulation to the states, it is imperative that states modify and continue to update their regulations as more fracing activity and information about the activity emerges. Ideally, states will work together to complete this task.

With better collaboration, state regulators will be able to better adapt to changing production practices within their states. If states implement improved, updated regulations that address fracing, while using more information produced as a result of required dis-

362. See N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 31, at 7-30 (discussing "the potential for releases associated with the on-site reserve pit"); *id.* at 6-129 (describing "[p]otential soil, wetland, surface water, and groundwater contamination from spills, leaks or other failure of the impoundment to effectively contain fluid").

363. See *supra* text accompanying notes 182, 185 (describing basic state requirements for spill prevention that do not require operators to follow a detailed plan).

364. See *supra* text accompanying notes 266-67 (describing how, in some states, only drilling near water wells is constrained, and in others only the location of drilling itself—not the well pad and the impoundments—is limited).

365. See *supra* text accompanying notes 212-15 (describing the lack of a synthetic liner requirement).

closure, they will better fill the regulatory gaps and help to prevent contamination of valuable surface resources. At the same time, they will address legitimate public concerns that have been raised about the potential environmental and human health effects of portions of the fracking process.³⁶⁶ Several states have already begun the adaptation process, and other states should follow this example.

Americans need energy, and all energy production has consequences that we all must weigh, whether those consequences arise from wind turbines that interrupt an ocean view or a drilling rig that casts a shadow on a pastoral scene. Beyond the aesthetic level, the potential consequences of energy production expand to concerns such as contamination of natural resources³⁶⁷ and fragmentation of valuable habitat.³⁶⁸ Energy production need not charge forward blindly while ignoring these consequences. Rather than embark upon a panicked race toward the extraction or capturing of fuels such as gas, oil, sun, and wind, we can and should continue to explore, produce, and capture these necessary fuels while simultaneously weighing, addressing, and remedying the consequences. In the area of hydraulic fracturing, as the trucks and tankers wind through the roads of Appalachia, improved regulations will hopefully follow close behind, or even precede them. And with better regulation, a bridge fuel can truly serve as the clean transition to a more sustainable future that it is intended to be.

366. *See supra* text accompanying notes 307, 308, 313, and 317 (describing EPA's, Cornell University's, and the New York City Department of Environmental Protection's concerns).

367. *See, e.g., supra* notes 361-62.

368. *See, e.g.,* Oregon Department of Fish and Wildlife, Classification Under Oregon Department of Fish and Wildlife's Fish and Wildlife Habitat Mitigation Policy, Aug. 7, 2009, available at http://www.dfw.state.or.us/conservationstrategy/docs/Sage-Grouse_Habitat_Mitigation_Recommendations_FINAL%208-7-9.pdf (worrying that "the rapid rate of a wind energy development may mean more rapid declines in sage-grouse populations").