FRACKING PATENTS: THE EMERGENCE OF PATENTS AS INFORMATION-CONTAINMENT TOOLS IN SHALE DRILLING

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The advantages of new sources of energy must be weighed against environmental, health, and safety concerns related to new production technology. The rapid development of unconventional oil and gas fields, such as the Barnett and Marcellus Shales, provide an excellent context for these contrasting goals. Information about extraction hazards is an extremely important issue. In general, patents are viewed as a positive force in this regard, providing a vehicle for disseminating information in exchange for a limited property right over an invention. However, by limiting the evaluation of an invention by third parties, patents might also be used to control the creation of new information. Such control is more likely in situations where third-party use and assessment may produce information damaging to the patent owner.

This Article explores the relationship between patents and information control in the context of natural gas extraction. Understanding the role of a patent as an information-control mechanism is critical to the safe employment of new technology. If patents substantially limit information creation or disclosure, government intervention may be necessary to permit non-patentee experimental use along with environmental, health, and safety testing. Before patent rights are encumbered, however, options that exist under current law should be considered.

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Introduction

The recent boom in natural gas extraction presents a classic information problem. To assess the benefits of this emerging energy source, one needs to fully understand the risks of using invasive drilling techniques. But that information has not always been easily accessible. In February 2010, the U.S. House of Representatives Committee on Energy and Commerce launched an investigation into the chemicals used in hydraulic fracturing fluids and the potential impact of industry practices on the environment and human health.[1] Even though hydraulic fracturing has become a common practice in the oil and gas industry since fracturing was commercialized in the late 1940s, it has recently become quite visible and controversial in ways not previously experienced.[2] During the course of its investigation, the Committee asked fourteen leading oil and gas service companies to disclose the types and volumes of the products they used in their fluids between 2005 and 2009, along with the chemical contents of those products.[3] The resulting analysis was described in a press release as "the first comprehensive national inventory of chemicals used by hydraulic fracturing companies during the drilling process."[4] The responses revealed that the surveyed companies had used 780 million gallons of some 2,500 different products, which collectively contained over 750 identifiable chemicals and other components.[5] According to the Committee, "[s]ome of the components used in the hydraulic fracturing products were common and generally harmless, such as salt and citric acid, whereas others were unexpected, such as instant coffee and walnut hulls."[6] Of greater concern, a number of the components identified were extremely toxic, such as benzene and lead, while still other components could not be

1. On February 18, 2010, Henry A. Waxman, Chairman of the Energy and Commerce Committee, and Edward J. Markey, Chairman of the Energy and Environment Subcommittee, sent letters to eight oil and gas services companies. *See* Memorandum from Rep. Henry A. Waxman & Rep. Edward J. Markey to Members of the Subcomm. on Energy and Environment (Feb. 18, 2010) [hereinafter Feb. 18 Memo], *available at* http://democrats.energycommerce.house.gov/Press_111/20100218/hydraulic_fracturing_memo.pdf. In May 2010, they expanded the scope of their investigation to include six more service companies. Memorandum from Henry A. Waxman & Edward J. Markey to Members of the Subcomm. on Energy and Environment (Jul. 19, 2010), *available at* http://democrats.energycommerce.house.gov/documents/20100719/Memo.Hydraulic.Fracturing.07.19.2010.pdf. The roots of this investigation trace back to 2007 when as Chairman of the Oversight and Government Reform Committee, Rep. Waxman requested similar information from the three largest oil and gas service companies Halliburton, Schlumberger and BJ Services (since acquired by Baker Hughes). *See* Feb. 18 Memo, *supra*, at 7.

2. Starting in the 1990s, so-called slickwater hydraulic fracturing was first applied to the Barnett Shale, a formation that underlies the city of Fort Worth, Texas, and at least 17 surrounding counties. Since then, similar practices have been applied to an increasing number of so-called "unconventional" shale formations throughout the United States. The scale and scope of hydraulic fracturing operations is now larger than ever, and these operations are now often taking place in more populated regions unfamiliar with oil and gas development.

3. H.R. Comm. on Energy & Commerce, Chemicals Used in Hydraulic Fracturing (2011) [hereinafter Hydraulic Fracturing Report], *available at* http://democrats.energycommerce.house.gov/sites/default/files/documents/Hydraulic-Fracturing-Chemicals-2011-4-18.pdf.

4. Press Release, H.R. Comm. on Energy & Commerce, Committee Democrats Release New Report Detailing Hydraulic Fracturing Products (Apr. 16, 2011), *available at* http://democrats.energycommerce.house.gov/index.php?q=news/committee-democrats-release-new-report-detailing-hydraulic-fracturing-products.

5. Hydraulic Fracturing Report, *supra* note 3, at 1.

6. *Id.*

identified because they were withheld as proprietary or trade secrets.[7] Despite these information limitations, the Committee concluded that more than 650 hydraulic fracturing products contained known carcinogens, chemicals regulated under the Safe Drinking Water Act, or hazardous air pollutants.[8]

The growing concern over the use of dangerous chemicals in hydraulic fracturing has led to a call for greater disclosure. Companies may soon be required to produce public lists of chemicals used, even when trade secrets are involved.[9] But this may not solve the information problem. A complete understanding of the impact of hydraulic fracturing chemicals cannot be gained from a mere list of the compounds used. It is just as important to understand how they interact with each other as well as how they act in the real world. As with agricultural technologies such as genetically modified crops, simply knowing the structure of the chemicals or the steps in a method of use is not sufficient. Field and laboratory experimentation is necessary to fully capture how the exploitation of shale gasses impacts the environment. Normally, third parties such as NGOs and universities would be able to fill this information gap by conducting experiments, but patents may play a new and surprising role in limiting this important source of information production.

The patent system is generally viewed as a means for disseminating information as much as providing an incentive to innovate.[10] Rapid information disclosure is part of the bargain with the patentee. However, patent disclosure relates only to the invention itself, as opposed to its impact on the world. When reproduction or use of the patented invention is necessary to understand how it impacts the rest of the world, patent rights can actually serve as a barrier. The lack of an effective non-patentee experimental use exception in patent law means that there is little immunity for one's research in exploring patent impacts. Moreover, recent changes to U.S. patent law in the America Invents Act have expanded the benefits of keeping an invention secret, thereby reducing the need for a patent race in order to preserve use of

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7. *Id.*

8. *Id.* at 8.

9. Currently, federal law regarding disclosure is somewhat limited, with only releases of hazardous chemicals as defined by the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA") subject to mandatory disclosure. Rebecca J. Reser & David T. Ritter, *State and Federal Regulation of Hydraulic Fracturing*, 57 ADVOC. (TEX.) 31, 32–33 (2011). However, new regulations have been proposed. Additionally, states such as Pennsylvania and Texas have disclosure rules in place. *Id.* at 33; Michael Dillon, *Water Scarcity and Hydraulic Fracturing in Pennsylvania: Examining Pennsylvania Water Law and Water Shortage Issues*, 84 TEMP. L. REV. 201, 208 n.65 (2011).

10. *See, e.g.*, Seymour v. Osborne, 78 U.S. (11 Wall.) 516, 533 (1870) ("Letters patent are . . . public franchises . . . tending to promote the progress of science and the useful arts, and as matter of compensation to the inventors for their labor, toil, and expense in making the inventions, and reducing the same to practice for the public benefit . . . .").

the technology.[11] Overall, the U.S. may be experiencing an unexpected emergence of patents as information-containment tools while the disclosure function of patents has been weakened.

Empirical data in the context of hydraulic fracturing supports this shift in the relationship between patents and information. As a complement to the discussion on patent rights, this Article presents data on patent activity in the oil and gas industry derived from the U.S. Patent and Trademark Office ("USPTO"). Our analysis reveals that at the very moment when the use of hydraulic fracturing was becoming more widespread, visible, and controversial, patenting activity related to the practice began to rise. As the questions and controversies surrounding hydraulic fracturing multiply, so do the number of issued and pending patents. This Article posits a novel perspective on this data. Simply put, given the demand for disclosure, companies could be paradoxically pursuing patenting in part as a means of information containment. This argument runs counter to the dominant view of patents as mechanisms for disclosure.

This Article considers patents as information-containment tools by comprehensively investigating their role in hydraulic fracturing and predicting their future applicability. Part I describes the history of hydraulic fracturing and the related significance of patents. Part II explains how patents can legally function as a tool to prevent information disclosure, particularly in view of the limited experimental use exception. Part III demonstrates how patents are likely to be used to impact information specific to hydraulic fracturing technology. Finally, Part IV provides some possible solutions, highlighting the role of the public university.

I. The Historic Development of Hydraulic Fracturing as a Technology and Its Capture Through Patents

The commercial development of hydraulic fracturing dates back to the late 1940s. Its evolution as a technology is a story of creativity, experimentation and, ultimately, definition through property rights. The latter is critical as a means of extending innovation impacts beyond market control.

A. *Evolving Science in Fluid and Pressure*

The first hydraulic fracturing experiment was performed in July 1947 in Hugoton, Kansas, when Stanolind Oil & Gas Company (later Amoco and then BP) attempted to stimulate production on its Kelpper No. 1 well.[12] Although well performance did not improve much, the technology showed

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11. Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 5, 125 Stat. 284, 297–99 (2011).

12. George C. Howard & C. Robert Fast, Hydraulic Fracturing 8 (1970).

some promise.[13] Five other hydraulic fracturing treatments were performed that year in Rangley, Colorado, and all were considered failures.[14]

The oil and gas industry first learned of these developments in October 1948, when J. B. Clark of Stanolind presented a paper on the "hydrafrac" process as a technique for improving the productivity of existing oil and gas wells.[15] Included in the paper were the results of thirty-two treatments on twenty-three wells in seven fields, of which eleven wells showed production increases. As originally described, the process consisted of two steps: injecting a viscous liquid containing a granular material under high hydraulic pressure to fracture and prop open the formation, and then changing the liquid's viscosity from high to low so that it could be displaced from the formation.

During the late 1940s and early 1950s, hydraulic fracturing technologies proliferated. For instance, Moore analyzed nearly 6,000 fracture treatments performed in the eastern United States between 1949 and 1954, and assigned them to three categories: gel fracs (the original hydrafrac process), sand fracs (also called sandoil fracs), and acid fracs.[16] Related to these developments, Dow Chemical Company registered Sandfrac and Stratafrac as trademarks in 1951.[17] Just seven years after the first hydraulic fracturing treatment, considerable progress had been made "in the art of hydraulically fracturing formations . . . for the purposes of stimulating oil and gas production."[18]

One early improvement to the hydraulic fracturing process was the introduction of water as a fracturing fluid.[19] Starting in the mid-1950s, Dowell (later Schlumberger) began offering "waterfrac" and "riverfrac" treatments.[20] In 1956, Dowell completed what it described as the "biggest frac

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13. Jack R. Jones & Larry K. Britt, Design and Appraisal of Hydraulic Fractures 1 (2009); Recent Advances in Hydraulic Fracturing 1 (John L. Gidley, Stephen A. Holditch, Dale E. Nierode & Ralph W. Veatch, Jr. eds., 1989).

14. John. M. Bagzis, *Refracturing Pays off in Rangley Field*, 209 World Oil 39, 39–40 (1989).

15. According to the paper, other Stanolind researchers involved included Riley F. Farris, C. Robert Fast, George. And C. Howard. *See* J.B. Clark, *A Hydraulic Process for Increasing the Productivity of Wells*, 186 Petroleum Transac. 1 (1949).

16. Wendell S. Moore, *Fracturing in Eastern United States*, Drilling & Production Prac. 379 (1955).

17. U.S. Patent No. 584,015 (filed Nov. 26, 1952) (issued Dec. 22, 1953) (amended Feb. 23, 1971); U.S. Patent No. 1,050,945 (filed Nov. 14, 1975) (issued Oct. 19, 1976).

18. Roscoe C. Clark, et al., *Application of Hydraulic Fracturing to the Stimulation of Oil and Gas Production*, 1953 Drilling & Production Prac. 113.

19. F. J. Shell & O. K. Bodine, *Economics of Hydraulic Fracturing Using Wall-Building Additives*, 1960 Drilling & Production Prac. 145.

20. The Dowell Division of Dow Chemical was formed in 1932 to provide well acidizing services, and later, well completion services (e.g., cementing, hydraulic fracturing) throughout the United States and Canada. *See* Leonard Kalfayan, Production Enhancement with Acid Stimulation 6–7 (2d ed. 2008). By the mid–1950s, Dowell offered a menu of HF treatments. *See* Dowell, *Eight Basic Ways Dowell Fractures Wells*, Petroleum Wk. 46

job in history," consisting of 250,000 gallons of fresh water, 200,000 pounds of sand and 4,500 hydraulic horsepower of pumping.[21] The following year a 500,000 gallon waterfrac was completed, with expectations that "the first million-gallon treatment may soon be performed."[22]

Over the second half of the twentieth century, hydraulic fracturing technologies continued to evolve. By 1997, Mitchell Energy had been "experimenting" in the Barnett Shale for some 16 years, but had yet to figure out how to economically recover gas there.[23] It was at this point that Mitchell Energy tried so-called slickwater hydraulic fracturing treatments.[24] They found that well performance was somewhat better than the crosslinked jobs, but stimulation costs were reduced by approximately 65%.[25] By the end of 1998, it seemed the company had finally achieved its breakthrough.[26] In particular, waterfracs were significantly cheaper than massive hydraulic fracture ("MHF") treatments with no loss of performance.[27] The stimulation cost reductions allowed Mitchell to complete fracturing in the Upper Barnett Shale in Denton and Wise Counties as well as the Lower Barnett Shale, increasing expected ultimate recoveries ("EURs") by roughly 20% to 25%.[28]

In 2001, Devon Energy CEO Larry Nichols noticed a sudden surge in gas supply from the Barnett Shale area. "If fracking was not working, why was Mitchell's output going up?"[29] Suspecting that Mitchell Energy had finally cracked the code to the Barnett Shale, in August 2001 Devon reached agreement on a $3.5 billion acquisition of Mitchell.[30] According to Nichols, "At that time, absolutely no one believed that shale drilling worked, other than Mitchell and us."[31]

At the time of its acquisition, Mitchell Energy had drilled about 400 wells in the Barnett, and executives had publicly announced the potential for

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(1956). In 1960, Dow Chemical and Schlumberger established Dowell Schlumberger, a 50/50 joint venture offering well completion services outside the United States and Canada. In 1984, Schlumberger paid $440 million to acquire a half interest in the Dowell Division, which was then integrated into Dowell Schlumberger. In 1993, Schlumberger acquired Dow's remaining 50% interest in the company. *See* PAUL OREFFICE, ONLY IN AMERICA 225–27 (2006).

21. *Biggest Fracture Job*, 3 PETROLEUM WK. 17 (1956).

22. Anthony Gibbon, *Fresh Water Is Becoming Favorite Fracturing Fluid*, WORLD OIL 76, 77 (1957).

23. George Waters et al., *Use of Horizontal Well Image Tools to Optimize Barnett Shale Reservoir Exploitation* 1 (Soc'y of Petroleum Eng'rs, SPE 103202, 2006), *available at* http://www.onepetro.org/mslib/servlet/onepetropreview?id=SPE-103202-MS; *see also* DANIEL YERGIN, THE QUEST: ENERGY, SECURITY, AND THE REMAKING OF THE MODERN WORLD ch. 16 (2011).

24. Waters et al., *supra* note 23.

25. *Id.*

26. YERGIN, *supra* note 23.

27. Waters et al., *supra* note 23.

28. *Id.*

29. YERGIN, *supra* note 23.

30. *Id.*

31. *Id.*

1,200 more.[32] By then, Mitchell had become quite proficient at slickwater hydraulic fracturing. For its part, Devon Energy had its own specialty: horizontal drilling. In 2002, Devon combined Mitchell's expertise in slickwater fracking with its own expertise in horizontal drilling, earning the distinction as the first company to combine horizontal drilling and hydraulic fracturing to release hydrocarbons trapped in shale plays.[33] "That was the 'aha' moment. At that point, it was this worldwide breakthrough."[34] It completed seven horizontal wells in 2002 and another fifty-five wells in 2003.[35]

Somewhat parallel with these developments, Range Resources had acquired a considerable amount of acreage in southwestern Pennsylvania.[36] By the time Range drilled the Renz No. 1 well in May 2003, the company had already invested $6 million in the project.[37] By December 2003, Range treated the Lockport and Salina formations with acid, and the Oriskany formation with a 13,000 gallon gelled acid treatment, but the results were disappointing.[38] According to Bill Zagorski, a longtime Range Resources geologist, the well "was on its way to becoming a pretty expensive dry hole."[39]

In the midst of these struggles, Zagorski happened to visit a friend and fellow geologist who was studying recent developments in the Barnett Shale underlying the Dallas-Fort Worth region in Texas.[40] During the visit, Zagorski realized that the same hydraulic fracturing techniques being applied there might also work in Pennsylvania.

Upon returning from Texas, Zagorski and his team made an audacious proposal: spend another $2 million on the Renz No. 1 well.[41] Aware of the Barnett Shale developments, Jeffrey Ventura, Range's new president and chief operating officer, authorized the plan. In October 2004, Range Re-

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32. Jack Smith, *Devon Energy's Barnett Shale Bet Pays Off*, Fort Worth Star-Telegram, Aug. 14, 2011, at D, *available at* http://oil-and-gas-post.blogspot.com/2011/08/devon-energys-barnett-shale-bet-pays.html.

33. Phaedra Friend Troy, *Devon Energy Pioneers Shale Drilling and Production*, Penn Energy (Aug. 2008), http://www.pennenergy.com/index/blogs/all-energy-all-the-time/2011/08/devon-energy-pioneers-shale-drilling-and-production.html.

34. Jonathan D. Silver, *The Marcellus Boom Origins: The Story of a Professor, a Gas Driller, and Wall Street*, Pitt. Post-Gazette (Mar. 29, 2012, 11:05 PM), http://www.post-gazette.com/stories/local/marcellusshale/the-marcellus-boom-origins-the-story-of-a-professor-a-gas-driller-and-wall-street-288098/.

35. Yergin, *supra* note 23.

36. Silver, *supra* note 34.

37. Penn. Dep't of Envtl. Prot., *Renz 1 SPUD Report*, http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Oil_Gas/Spud_External_Data (enter "05/31/2003" for both the start date and the end date, then click "View Report"). On the costs of development, see Silver, *supra* note 34.

38. Penn. Dep't of Envtl. Prot., *Well Record and Completion Report for Permit #125-22074*, *available at* http://www.marcellus.psu.edu/resources/PDFs/DCNR.pdf.

39. Silver, *supra* note 34.

40. *Id.*

41. *Id.*

sources translated unconventional slickwater hydraulic-fracturing techniques from Texas to its Marcellus Shale well, pumping a 942,970-gallon treatment with 370,000 pounds of sand.[42] When the well began producing gas in 2005, it yielded 5.5 Mmcfe in 31 days (enough to meet the needs of about 5,500 US homes for one year).[43] These were reasonable results, and Range initiated a pilot horizontal drilling program.[44] But the results of the first couple of wells were still unremarkable. As Mitchell found in the Barnett, "The question was, 'How do we crack the code?' "[45]

By August 2007, Range had spent more than $150 million on what it described to investors as its "Appalachian Basin Devonian shale gas play"—a sizeable investment for a company that had a market capitalization of $400 million.[46] However, when the company's fourth horizontal well, the Gulla No. 9, went online, it was "just like a Barnett well."[47] As it relates to the commercial development of the Marcellus Formation, the Gulla No. 9 well was the second most historic well after the initial Renz No. 1 well, one that turned the company's Devonian project into "a game changer."[48] The first time the company referred to the "Marcellus Shale play" was in a December press release announcing that "At the end of the third quarter, two wells had been placed online at rates of 1.4 and 3.2 Mmcfe per day. Since then, three additional horizontal wells have been drilled, completed and tested at initial rates of 3.7, 4.3 and 4.7 Mmcfe per day."[49] The announcement set off a massive land rush in Pennsylvania.

B. *Innovation and Controversy*

The world's growing appetite for oil and gas has pushed exploration and production companies to expand the scale and scope of their operations in ways scarcely imaginable several decades ago.[50] As the quest for hydrocarbons has intensified, the use of hydraulic fracturing has become nearly ubiq-

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42. Penn. Dep't of Envtl. Prot., *supra* note 38.

43. Kristin M. Carter et al., *Unconventional Natural Gas Resources in Pennsylvania: The Backstory of the Modern Marcellus Shale Play*, 18 Envtl. Geosci. 217, 237 (2011).

44. *Id.*

45. Silver, *supra* note 34.

46. *Id.*

47. *Id.*

48. Christine Campbell, *Well . . . That Does It*, Observer-Reporter, Jan. 21, 2011, at A1.

49. Press Release, Range Res. Corp., Range Expands Barnett Shale Holdings and Provides Operations Update (Dec. 10, 2007), *available at* http://www.reuters.com/article/2007/12/10/idUS100341+10-Dec-2007+BW20071210.

50. For instance, oil production in the United States has climbed from 4.95 million barrels per day in 2008 to 5.7 million barrels per day by the end of 2011. *See* Clifford Krauss & Eric Lipton, *U.S. Inches Toward Goal of Energy Independence*, N.Y. Times, Mar. 23, 2012, at A1, A20.

uitous, especially in unconventional oil and gas fields.[51] According to the American Petroleum Industry, "Recent innovations combining [hydraulic fracturing] technology with horizontal drilling in shale formations [have] unlocked vast new supplies of natural gas, allowing the nation to get to the energy it needs today, and transforming our energy future."[52] As the industry has honed its techniques, hydraulic fracturing operations have become more complex, requiring the use of more water and chemicals—millions of gallons per well, rather than the tens of thousands of gallons used in the past.[53]

While remarkable technical achievements, hydraulic fracturing innovations have sparked heated controversy over the tradeoffs between increasing energy demands and the potential environmental, health, and safety hazards associated with these innovations. At a 2011 hearing, Benjamin L. Cardin (D-Md.), chairman of the U.S. Senate's Water and Wildlife Subcommittee said, "The industry has failed to meet minimally acceptable performance levels for protecting human health and the environment. That is both an industry failure, and a failure of the regulatory agencies."[54] Republicans disagreed, with John Cornyn (R-Tex.) saying at the same hearing that existing regulations "could put many independent producers out of business and their employees out of work."[55]

Practices taken for granted in communities that are financially dependent on the oil and gas industry have been translated into areas not familiar with oil and gas development, raising new questions and concerns, including air quality, wastewater disposal, and wildlife encroachment.[56] In the case of

51. More than 2.5 million HF treatments have been performed worldwide, adding 9 billion barrels of oil and more than 700 trillion cubic feet of gas to U.S. reserves since 1949. *See* Carl T. Montgomery & Michael B. Smith, *Hydraulic Fracturing: History of an Enduring Technology*, 62 J. Petroleum Tech. 26, 27 (2010), *available at* http://www.spe.org/jpt/print/archives/2010/12/10Hydraulic.pdf.

52. Am. Petroleum Inst., Freeing Up Energy, Hydraulic Fracturing: Unlocking America's Natural Gas Resources (July 19, 2010), *available at* http://api.org/policy/exploration/hydraulicfracturing/upload/HYDRAULIC_FRACTURING_PRIMER.pdf; *see also* Carter et al., *supra* note 43, at 237.

53. *See, e.g.*, Carter et al., *supra* note 43, at 242 (calculating that between 2005 and 2009, completion of an average horizontal Marcellus well required 2.9 million gallons).

54. Nick Snow, *Strong State Programs Key to Safe Shale Gas Activity, Senators Told*, Oil & Gas J., Apr. 18, 2011, at 18, 19.

55. *Id.*

56. *See* Susan Williams, Sustainable Investments Institute, Discovering Shale Gas: An Investor Guide to Hydraulic Fracturing (2012), *available at* http://si2news.files.wordpress.com/2012/03/discovering-shale-gas-an-investor-guide-to-hydraulic-fracturing.pdf; Jeremy Holtsclaw et al., *Environmentally Focused Crosslinked-Gel System Results in High Retained Proppant-Pack Conductivity* 1 (Soc'y of Petroleum Eng'rs, SPE 146832, 2011); Krauss & Lipton, *supra* note 50 at A20.

the Marcellus region, there is "no history of activity like this in the modern age."[57]

C. *Hydraulic Fracturing and Patents*

Starting in 1948, Stanolind applied for several U.S. patents related to hydraulic fracturing.[58] Around this same time, Stanolind granted Halliburton Oil Well Cementing Company a license to the process, and the two companies completed the first commercial treatments on March 17, 1949.[59] Under the terms of the agreement, Stanolind was to receive a $100 royalty for each hydraulic fracturing job performed. For its part, Halliburton could attain an exclusive license if, by March 1951, the royalties payable to Stanolind totaled $300,000. However, "within a comparatively short time the demand of the oil and gas industry for the use of the process exceeded all expectations. This demand became so great that Halliburton was unable to manufacture equipment and train personnel sufficient to meet requests for the service."[60]

Confronted with these challenges, in June 1953 an agreement was reached under which Halliburton was given a non-exclusive license, as well as one-third of any royalties Stanolind received from licenses granted to third parties. In 1955, these royalties totaled more than $400,000. Beyond royalties, the demand for hydraulic fracturing services was evident in Halliburton's annual revenues, which increased from $57.2 million in 1949 to $69.3 million in 1950 and $92.6 million in 1951.

Given the huge financial stakes, it did not take long for patent litigation to emerge. For instance, in February 1955, Stanolind filed a patent infringement lawsuit against Magnolia Petroleum Company, a subsidiary of Socony Mobil. According to the complaint, Magnolia was "the first company to openly defy Stanolind's claims to royalties in fracturing."[61] Eighteen months later the two parties settled, with Magnolia agreeing to the first "paid-up" license covering hydraulic fracturing of wells.[62]

Recently, patents related to hydraulic fracturing have become more prominent. From 1981 to 2003, according to J. Steven Rutt, the USPTO steadily issued about fifty hydraulic fracturing patents per year, with a high

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57. Boyd Huls, *Maximizing the Marcellus Gold Rush While Minimizing Negative Impacts*, Canadian Unconventional Resources and International Petroleum Conference, 1, October 19–21, (2010).

58. *See, e.g.*, U.S. Patent No. 2,596,844 (filed May 28, 1948) (issued May 13, 1952); U.S. Patent No. 2,667,224 (filed June 29, 1949) (issued Jan. 26, 1954); U.S. Patent No. 2,596,843 (filed Dec. 31, 1949) (issued May 13, 1952).

59. Moore, *supra* note 16, at 379; John E. Smith, *Design of Hydraulic Fracture Treatments* 1 (Soc'y of Petroleum Eng'rs, SPE 1286, 1965).

60. Wiseman v. Haliburton Oil Well Cementing Co., 301 F.2d 654 (10th Cir. 1962).

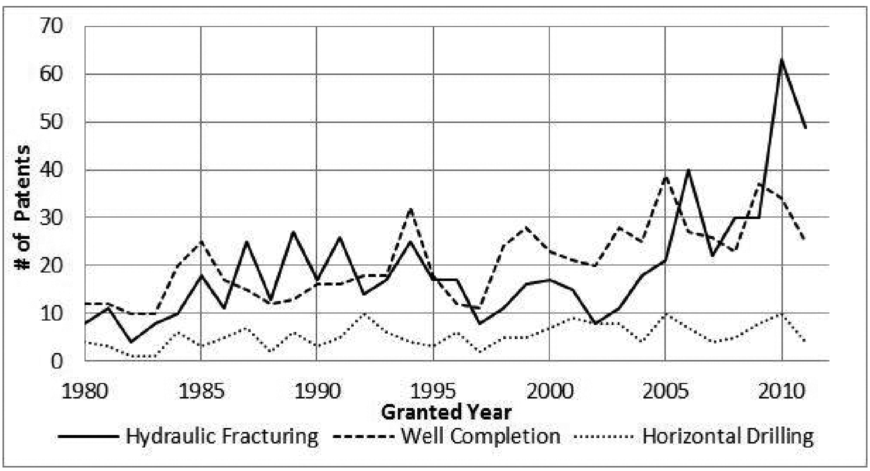
61. *'Paid-Up' Frac License Granted*, PETROLEUM WK., Aug. 31, 1956, at 15.

62. *Id.*

of seventy-three in 1993 and a low of twenty-five in 1982.[63] Then, suddenly, from 2004 to 2010, the USPTO issued an average of more than 150 patents a year—more than tripling the patenting output of the preceding two decades.[64] Of note, more than seventy patents issued during this period stemmed from research funded by the federal government, including the Department of Energy.[65] In 2010 and 2011, the USPTO issued 257 and 224 hydraulic fracturing patents respectively; never before had more than 200 patents related to hydraulic fracturing been issued in a single year.[66]

Our own empirical data also show that the number of hydraulic fracturing patents has increased dramatically over the last twenty years, and particularly over the most recent ten years. We can establish this increase through a search of the USPTO-issued patent database using search strings designed to capture patents related to hydraulic fracturing. This search shows a significant increase from 2000 to 2010 (see Figure 1 below).

FIGURE 1. U.S. PATENTS RELATED TO HYDRAULIC FRACTURING ISSUED BETWEEN 1980 AND 2010.[67]



63. J. Steven Rutt, *U.S. Patent Explosion for Hydraulic Fracturing Technology: Impact on Marcellus Shale*, FOLEY & LARDNER CLEANTECH & NANO (Mar. 20, 2011), http://www.nanocleantechblog.com/2011/03/20/u-s-patent-explosion-for-hydraulic-fracturing-technology-impact-on-marcellus-shale/.

64. *Id.*

65. *Id.*

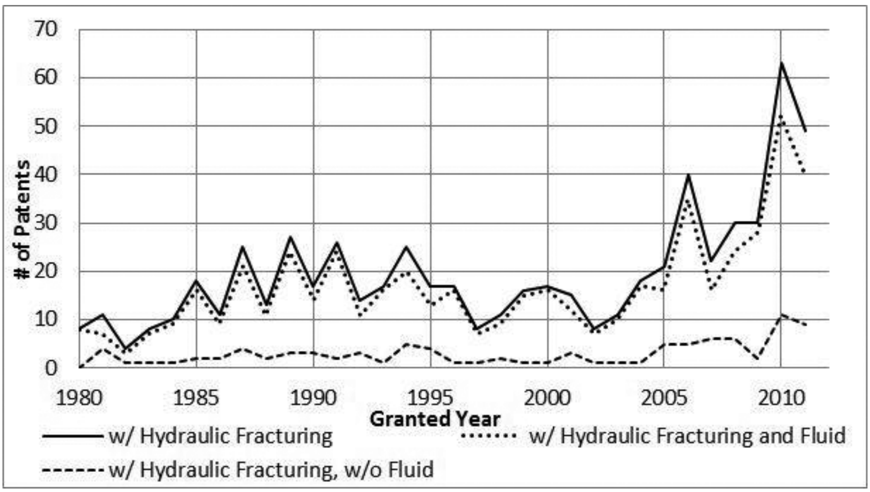
66. J. Steven Rutt, *Recent Hydraulic Fracturing Patenting Shows Connections with Cleantech and Nanotech*, FOLEY & LARDNER CLEANTECH & NANO (Feb. 26, 2012), http://www.nanocleantechblog.com/2012/02/26/recent-hydraulic-fracturing-patenting-shows-connections-with-cleantech-and-nanotech/.

67. We identified US patents that related to these three technologies by keyword-searching in titles, abstracts, and claims of the US patent database in Thomson Innovation. Specifically, we identify US patents whose titles, abstracts, or claims contain "hydraulic fracturing," "horizontal drilling," and "well completion" as patents in the three technologies, respectively. The patent search was conducted in February 2012.

Moreover, the increase in hydraulic fracturing patents occurs in contrast to other technologies employed in gas extraction with broader applications. Patents related to well completion have increased only moderately, and patents related to horizontal drilling have remained nearly flat, with few issuing per year.

At a more granular level, fracturing fluids are the apparent reason for the increase in patent activity in the gas extraction industry. A search for terms designed to distinguish fracturing generally from fracturing fluids shows that most of the increase is related to fluid patents. One can infer that companies involved in unconventional drilling—the most prominent and controversial form of gas extraction—are the ones that are creating most of the intellectual property ("IP") in this industry.

FIGURE 2. SIGNIFICANCE OF FLUID TECHNOLOGY IN U.S. PATENTS RELATED TO HYDRAULIC FRACTURING ISSUED BETWEEN 1980 AND 2010.



The increase in patent rights means that the field of patents for gas extraction is more populated. However, it does not necessarily prove that it is more constrained by ownership. It is possible that the increase in patents represents an expansion of innovation in gas extraction. Moreover, it is also possible that many of the patents cover unusual or exotic materials unrelated to those used in industry. A mere count of the number of rights is not fully revealing. Only a patent-by-patent analysis can establish that the rights relate to materials currently in use. Nonetheless, the trend is a potential signal of rights capture and should not be ignored.

Although it is somewhat surprising and counterintuitive, during the late 1990s and early 2000s, neither Mitchell nor Devon pursued patent protection for their respective innovations in slickwater hydraulic fracturing and horizontal drilling. Perhaps owing to this lack of intellectual property barriers, a gold-rush mentality ensued, with companies racing to capitalize on innovative, yet unpatented techniques in other geographies (e.g., Haynesville, Marcellus, etc.).[68] A detail of initial patent assignees provides an indication of the diverse ownership environment that evolved over the last thirty years. As more and more players got involved, the possibility of mistakes multiplied.

Table 1. Top Ten Initial Assignees of U.S. Hydraulic Fracturing Patents Issued Between 1980 and 2010.[69]

	Number of Patents	*Percentage*
Schlumberger	99	15.7%
Exxon Mobil	60	9.5%
Halliburton	58	9.3%
Atlantic Richfield Co.	33	5.2%
Baker Hughes Inc.	31	4.9%
BJ Services Co.	26	4.1%
DuPont	20	3.2%
Union Oil Co.	15	2.4%
Conoco Phillips	14	2.2%
GeoSierra LLC	11	1.7%

Thus, on one hand, the lack of IP protection facilitated the emergence of controversies related to hydraulic fracturing. On the other hand, these same controversies have prompted calls for greater disclosure and transparency, and IP is being used to circumvent these requirements.

II. Patents as an Information-Limitation Tool

Patents are important rights in the context of new technology, and they are often referred to as monopolies.[70] There is a negative connotation with that characterization that is largely undeserved. Rather than a naked government grant of market exclusivity, patents actually represent a societal bargain. In exchange for limited monopoly over an invention, a patent applicant

68. Silver, *supra* note 34.

69. Patents collected according to methods described in Figure 1. A total of 632 patents are in this collection.

70. Edmund W. Kitch, *Elementary and Persistent Errors in the Economic Analysis of Intellectual Property Law*, 53 Vand. L. Rev. 1727, 1730–31 (2000) (noting that whether patents provide monopoly power depends on the market).

agrees to disclose the invention to the world.[71] Scholars, including Landes and Posner, note that the likely outcome of a world without patents would be more secrecy, as inventors would work to foil free riders by cloaking their ideas for as long as possible.[72] Patent exclusivity eliminates the need for secrecy and forced disclosure prevents opportunists from trying to have it both ways.

However, the disclosure framework only operates to provide access to information related to the nature of the actual invention. Follow-on information regarding patented products is not necessarily so free flowing. In fact, through the use of restrictions in patent licensing, it may be possible to use the putative disclosure device to inhibit information creation and dissemination. The nature of patents as information inhibitors has been historically overlooked,[73] but it may be one of the most important issues on the technology horizon.

A. *The Patent's Traditional Role in Information Disclosure*

At the very core of the modern patent right is the concept that an invention will be revealed to the world and eventually will be available for others to exploit.[74] The term "patent" is derived from open communications ("letters patent" or "literae patentes") issued from a monarch to his subjects.[75] The declarations, which eventually encompassed exclusive rights to inventions in addition to land patents, were meant to be public and accessible. In a sense, the dissemination of information is more historically attached to patents than the demonstration of new inventions.[76]

Functionally, modern patents are designed to continue the tradition of information disclosure. Although initially pursued in secret, patent applications become open documents unless abandonment occurs early on in the process. In part, this is due to the fact that issued patents are published, and

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71. *See, e.g.*, Bonito Boats, Inc. v. Thunder Craft Boats, Inc., 489 U.S. 141, 151 (1989) ("In consideration of its disclosure and the consequent benefit to the community, the patent is granted.").

72. William M. Landes & Richard A. Posner, The Economic Structure of Intellectual Property Law 326–29 (2003).

73. *But see generally* Brenda M. Simon, *Patent Cover-Up*, 47 Hous. L. Rev. 1299 (2011) (for a recently published, general discussion of the issue).

74. Jeanne C. Fromer, *Patent Disclosure*, 94 Iowa L. Rev. 539, 546–54 (2009); Daniel R. Cahoy, *An Incrementalist Approach to Patent Reform Policy*, 9 N.Y.U. J. Legis. & Pub. Pol'y 587, 610–21 (2006).

75. Adam Goodman, *The Origins of the Modern Patent in the Doctrine of Restraint of Trade*, 19 Intell. Prop. J. 297, 309 (2006).

76. *See* Adam Mossoff, *Rethinking the Development of Patents: An Intellectual History, 1550–1800*, 52 Hastings L.J. 1255, 1261–62 (2001) (stating that patents issued under early European monarchies were essentially privileges for monopoly rights over existing goods and services, rather than rights to inventions).

always have been.[77] Additionally, communications between the USPTO and the applicant are publicly available. Indeed, these documents, known as the file wrapper, are considered to be a part of the patent and may play a role in interpreting the claimed invention or characterizing the integrity of the prosecution.[78] More recently, information from non-issued patents has been made available. As a result of revisions to the law in 1999 requiring applications to be published after eighteen months (except in a relatively narrow range of cases), patent applications and file wrappers are open to the public.[79] And, not surprisingly, all of these materials are available online through the USPTO and various private providers.[80]

Importantly, the public nature of modern patents extends beyond information accessibility; it also relates to information quality. A patent applicant is required to disclose a sufficient amount of information to enable others to practice the invention.[81] No secret step or ingredients can exist that will foil copiers. Until recently, that enablement requirement included the need to disclose a "best mode" of practicing an invention, if one is known to the applicant.[82] The 2011 America Invents Act ("AIA") weakened this requirement, eliminating the failure to disclose the best mode as a means for invalidating a patent.[83] Still, patent disclosures must be detailed and accurate, commensurate with the claims.

Against the pro-disclosure rules of the patent system, some aspects of the recent AIA reforms will result in an increased preference for secrecy in some cases. On its face, the new law seems to compel earlier disclosure by transitioning the United States into what is often referred to as a "first inventor to file" system.[84] Part of this mechanism is the law's recognition of an inventor's preapplication disclosure as invalidating later filers, but not their own. In other words, there is a built-in incentive to disclose one's invention early to knock out competing applicants.[85] Tempering this early disclosure

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77. *See* Edward C. Walterscheid, *Charting a Novel Course: The Creation of the Patent Act of 1790*, 25 AIPLA Q.J. 445, 473 (1997) (noting that the earliest iterations of U.S. patent law contained a requirement for a specification that disclosed the invention to the public).

78. Phillips v. AWH Corp., 415 F.3d 1303, 1317 (Fed. Cir. 2005) ("In addition to consulting the specification, we have held that a court 'should also consider the patent's prosecution history, if it is in evidence.'").

79. 35 U.S.C. § 122(b) (2011).

80. *Public Pair*, U.S. Pat. & Trademark Off., http://portal.uspto.gov/external/portal/pair (last visited Feb. 28, 2013).

81. *See* 35 U.S.C. § 112 (2011); Fromer, *supra* note 74, at 546–47.

82. 35 U.S.C. § 112 (2011).

83. Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011).

84. Donald S. Chisum, Priority Among Competing Patent Applicants Under the American Invents Act (Dec. 5, 2011) (unpublished manuscript), *available at* http://ssrn.com/abstract=1969592.

85. Jason Rantanen, *The Effects of the America Invents Act on Technological Disclosure*, Patently-O (Sept. 8, 2011), http://www.patentlyo.com/patent/2011/09/the-effects-of-the-america-invents-act-on-technological-disclosure.html.

benefit is the AIA's newly expanded protection for prior users.[86] This rule permits prior users to avoid infringement liability if they used the invention internally and commercially more than one year before the patent was filed or the invention was disclosed.[87] As a result of this rule, prior users can keep an invention secret without worrying that competitors will patent it and preclude its use. Because of the prior user defense, at least some inventions will now likely remain secret instead of entering the patent system.

Philosophically, information disclosure is considered to be an important part of an efficient patent system. To minimize the deadweight losses inherent in a limited monopoly grant, the public disclosure of inventive information permits others to fully utilize the invention as soon as the patent expires.[88] In addition, the disclosure of the invention while the patent is in force should allow others to design around and create new ways of accomplishing the same ends.[89] The hope is that patents enrich the innovation environment by bringing forward those ideas that benefit from the limited monopoly protection.

Despite the powerful disclosure incentives inherent in patents, the scope of information involved is, in practice, still limited. Functional details related to the invention are covered, but additional aspects of a product embodying the invention, including its safety profile and other applied know-how, may not be evident from the compelled disclosure. This is why, for example, patented pharmaceutical compounds must undergo years of testing to obtain FDA approval; the patent process may not address safety and effectiveness. There may be other means of obtaining this information, but such efforts may be thwarted if the power of a patent is utilized to control information production.

B. *Patents Can Be Used to Limit Information*

Although a limited property right, a patent permits a great deal of control over an invention during the term of enforceability. The right allows its owner to exclude another from making, using, selling or importing the invention for essentially any reason.[90] The purpose is to forestall competition and enable monopoly profit taking for a period sufficient to induce innova-

86. Leahy-Smith America Invents Act, § 5, Pub. L. No. 112-29, 125 Stat. 284–341 (2011) (codified at 35 U.S.C. § 273).

87. *Id.*

88. *See* Katherine J. Strandburg, *What Does the Public Get? Experimental Use and the Patent Bargain*, 2004 Wis. L. Rev. 81, 105–07 (describing the rationale for compelling disclosure in patents and noting that it is most important in the context on non-self-disclosing inventions).

89. *See* Fromer, *supra* note 74, at 546–47.

90. 35 U.S.C. § 271 (2011).

tive behavior.[91] Given the information disclosure requirements described above, that right is not a direct barrier to information dissemination, as long as concerns only relate to the nature of an invention itself. But when there is a need for information on products or processes related to the invention (i.e., information that can be generated only by impacting one of the patent owner's restrictive rights), a patent can severely impact the availability of information.

1. Blocking Information from Follow-On Discovery

One of the most obvious ways in which patents can restrict information is when they limit follow-on research that can lead to further discovery and extension of a field. Innovation is a cumulative process, and the absence of foundational or enabling technology can mean that some amount of third-party basic research does not occur. Information production is depressed as the research field fails to grow to its full potential.

Professors Murray and Stern demonstrated the depression effect empirically by looking at citation rates for papers associated with patented inventions.[92] They found that there was a significant decrease in citations to initial papers that were associated with patents, suggesting that third-party researchers may be avoiding the technology.[93]

A recent and controversial application of this form of blocking was asserted in *AMP v. USPTO*,[94] a case concerning patents for DNA that are useful in the detection of breast cancer. Most of the debate has related to whether such compounds should be patentable at all or be part of the public domain. However, underlying this litigation is a basic question of information control.[95]

In *AMP*, Myriad Genetics and others were sued for a declaratory judgment that Myriad's patents covering the BRCA1 and BRCA2 genes were invalid.[96] Motivating the litigation were allegations that Myriad had used its patents to stop cancer research by those who had not purchased the right to use the genes from Myriad.[97] According to the plaintiffs, the issuance of patents that could convey such power was wrong for at least two reasons. The primary reason, and eventual core of the case, was that unmodified

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91. William D. Nordhaus, Invention, Growth, and Welfare: A Theoretical Treatment of Technological Change 70 (1969) (stating patents create incentives by conferring monopoly power for a limited period of time).

92. Fiona Murray & Scott Stern, *Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge? An Empirical Test of the Anti-Commons Hypothesis*, 63 J. Econ. Behavior & Org. 648 (2007).

93. *Id.* at 683. However, the authors note that alternate explanations for the results may be possible. *Id.*

94. Ass'n for Molecular Pathology v. USPTO, 702 F. Supp. 2d 181 (S.D.N.Y. 2010).

95. Simon, *supra* note 73, at 1308–10.

96. *Ass'n for Molecular Pathology*, 702 F. Supp. 2d at 181.

97. *Id.* at 204–06.

DNA does not qualify as patentable subject matter.[98] An additional argument was that the patents constitute an unconstitutional limitation on speech.[99]

The district court dismissed the speech argument early on, but ruled for the plaintiffs on the subject matter case.[100] On appeal, the Federal Circuit reversed the subject matter issue and found the patents to be not invalid.[101] As a result, the court conceded that Myriad's enforcement behavior was within its patent grant, despite the impact such enforcement behavior may have on the creation of medical knowledge.

At this point, *AMP* is still in play. The Supreme Court vacated the Federal Circuit's 2011 ruling in view of the Supreme Court's decision in *Mayo Collaborative Services v. Prometheus Laboratories, Inc*.[102] In 2012, the Federal Circuit reconsidered *AMP*, found little impact from *Prometheus*, and largely mirrored the earlier determination.[103] The case was subsequently granted certiorari to the Supreme Court and will be decided in 2013.[104]

In the end, the negative impact of patents on knowledge creation in follow-on discovery could be viewed as a necessary consequence of intellectual property rights. If society grants temporary ownership over a fundamental invention, one would expect to see less exploitation by others, particularly competitors. More of a concern is the impact of patent rights on understanding the invention itself. This is a less studied and likely less acceptable form of information reduction.

2. Restricting a Full Understanding of the Invention Itself

In essence, by giving owners broad powers of exclusion, patents can be used to lock down just about any third-party use, even if unrelated to competition in the marketplace. That includes testing or other analysis.[105] The reason for this is that, outside of medical products,[106] experimental use of patents is allowed only by a common law exception in the United States.[107]

The concept of free space for experimental use has been part of American patent law for some time. The exception was originally articulated in an 1813 case, *Whittemore v. Cutter*, in which Justice Story stated that the law should not punish one's use for "philosophical experiments" or "the suffi-

98. *Id.* at 220.
99. *Id.* at 237–38 (articulating and dismissing constitutional claims).
100. *Id.*
101. Ass'n for Molecular Pathology v. USPTO, 653 F.3d 1329 (Fed. Cir. 2011).
102. Ass'n for Molecular Pathology v. USPTO, 467 Fed. App'x 890 (Fed. Cir. 2012).
103. *See* Ass'n for Molecular Pathology v. USPTO, 689 F.3d 1303 (Fed. Cir. 2012).
104. Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 133 S. Ct. 694 (2012).
105. Simon, *supra* note 73, at 1337–42.
106. A rather broad exception exists for uses of patented inventions that are reasonably related to the development and submission of information under Federal drug and biologic regulatory law. 35 U.S.C. § 271(e)(1) (2011).
107. *See* Timothy R. Holbrook, *Possession in Patent Law*, 59 SMU L. REV. 123, 139–40 (2006) (noting that the Federal Circuit has eviscerated the experimental use exception).

ciency of a machine to produce its described effects."[108] The exception remains as a limitation on the rights of a patent owner, justified in part by the requirement to disclose,[109] but also by the small impact on the economic power of patents. Such a limitation could play a very significant role in setting patent boundaries—similar to fair use in copyright law—but it has not to date been utilized to a great degree. Since its initial articulation, the exception has appeared in only a few cases, always in a noncommercial context.[110]

While there has always been some ambiguity about the extent of the experimental use exception—with the general notion that it is limited to uses for "amusement, idle curiosity . . . or philosophical inquiry"[111]—recent case law has rendered it nearly irrelevant. This is primarily a result of the Federal Circuit decision in *Madey v. Duke*,[112] which found that a university's unauthorized use of a patented laser constituted infringement. The court determined that even experimentation within the confines of a university is commercial, because research is an institution's business.[113] After *Madey*, patent scholars question what, if any, use would be noncommercial.[114] Indeed, there have been apparently no successful applications of the common law experimental use exception since the *Madey* decision at the Federal Circuit.[115]

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108. Whittemore v. Cutter, 29 F. Cas. 1120, 1121 (C.C.D. Mass. 1813) (No. 17,600).

109. Andrew S. Baluch, Note, *Relating the Two Experimental Uses in Patent Law: Inventor's Negation and Infringer's Defense*, 87 B.U. L. Rev. 213, 226–27 (2007).

110. *See, e.g.*, *id.* at 220–25 (surveying historic cases involving common law experimental use); Maureen E. Boyle, *Leaving Room for Research: The Historical Treatment of the Common Law Research Exemption in Congress and the Courts, and Its Relationship to Biotech Law and Policy*, 12 Yale J.L. & Tech. 269, 278–80 (2009) (describing the post-*Whittemore* treatment of the exception prior to the *Madey* case).

111. Embrex, Inc. v. Serv. Eng'g Corp., 216 F.3d 1343, 1349 (Fed. Cir. 2000) (citing Roche Prods., Inc. v. Bolar Pharm. Co., 733 F.2d 858, 863 (Fed.Cir.1984)); Simon, *supra* note 73, at 1339.

112. Madey v. Duke Univ., 307 F.3d 1351 (Fed. Cir. 2002).

113. *Id.* at 1362.

114. Strandburg, *supra* note 88, at 99 ("With Madey's disqualification of experimental use in keeping with the 'legitimate business' of a nonprofit research institution, the Federal Circuit's reading of the experimental-use exemption was confirmed to be 'very narrow' indeed.").

115. At least four cases have considered the common law experimental use defense after *Madey*, and all rejected it. Soitec, S.A. v. Silicon Genesis Corp., 81 Fed. App'x 734, 737 (Fed. Cir. 2003) (declaring that early stages of product development were non-experimental and infringed a patent for process for production of thin semiconductor metal films); Athena Feminine Techs. Inc. v. Wilkes, No. C 10-04868, 2011 WL 4079927, at *4 (N.D. Cal. Sept. 13, 2011) (stating that defendant could not establish that testing a patented "pelvic muscle trainer" was the only purpose for importation); Monsanto Co. v. E.I. Dupont de Nemours & Co., No. 4:09CV00686, 2010 WL 3039210, at *10 (E.D. Mo. July 30, 2010) (ruling that defendant's use of a patented RR gene had commercial implications and aligned with its legitimate business operations in manufacturing seed products); Third Wave Techs., Inc. v. Stratagene Corp., 381 F. Supp. 2d 891, 911–12 (W.D. Wis. 2005) (stating that defendant's testing for purposes

The effect of *Madey* and subsequent cases is that patent owners have the ability to exclude uses of an invention that might generate harmful information or negative publicity. This can be achieved in one of two ways depending on how the invention is made available to the public. If the patent rights relate to an article or process that is held closely by the owner, simply suing for infringement can prevent third-party use. Although there can be a question of whether a third party is actually using the invention, enforcement is facilitated when a good faith belief of infringement[116] is coupled with the rather broad discovery process in the United States.

Somewhat more complicated is the case where a patent owner sells an article embodying an invention to the public. The doctrine of exhaustion operates to limit a patentee's control over a sold product.[117] Theoretically, a purchaser could then use the invention in any manner desired, so long as the invention was not remade or copied in the process. However, it has been generally accepted that patent owners can limit subsequent use through contracts.[118] In essence, a sale can be transformed into a license that may prevent experimentation or other data creation outside of limited parameters.[119]

In a recent article, Professor Simon describes the power of patents to limit investigation into the "quality" of a patented invention.[120] She notes that quality assessments are not clearly exempted under current law, and implies that the use of the invention by a putative tester would result in infringement.[121] Professor Simon provides examples in the context of RFID technology, genetic testing, and agricultural biotechnology as support for the need to understand technology quality.[122] She calls for a new quality assessment defense to address the problem.[123]

Prescriptions related to quality may not go far enough to address the full extent of information needs, as patent-based restriction of critical knowledge is broader. Fundamental questions of safety are also impacted. When use of the invention is necessary to understand its impact in context, the current intellectual property regime provides no relief. The use of an invention in the real world may present dangers that are impossible to understand in the

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of developing its own diagnostic essays was not exempted as its intent to obtain FDA approval demonstrated commercial motivation).

116. *See, e.g.*, Superior Fireplace Co. v. Majestic Prods. Co., 270 F.3d 1358, 1377 (Fed. Cir. 2001) (assessing whether to award attorney fees because the plaintiff did not have a good faith belief in defendant's infringement).

117. Quanta Computer, Inc. v. LG Elecs., Inc., 553 U.S. 617, 625 (2008) (articulating the doctrine of patent exhaustion).

118. *See, e.g.*, Mallinckrodt, Inc. v. Medipart, Inc., 976 F.2d 700, 708–09 (Fed. Cir. 1992) (stating that restriction within scope of patent grant is enforceable).

119. Simon, *supra* note 73, at 1328–31 (discussing the limitations of patent exhaustion).

120. *See generally id.*

121. *Id.* at 1327.

122. *Id.* at 1304–14.

123. *Id.* at 1342–45.

lab—spillovers and externalities—that exist even if the invention is functioning exactly as intended. This need to understand safety through testing is the rationale behind government pharmaceutical-approval systems,[124] and the potential for patents to interfere is the reason behind the specific statutory infringement exemption.[125]

As restricted as the patent environment is in the US, it is possible that there may be more international flexibility.[126] Although not required by international agreements such as the Agreement on Trade-Related Aspects of Intellectual Property Agreement ("TRIPS"),[127] many countries have an explicit experimental use exception whether articulated through statute or common law.[128] The boundaries of permitted use may be wider.[129] Still, it is not entirely clear that the exceptions in other nations extend to safety testing. And while the exception for pharmaceutical experimentation is relatively established globally,[130] it is extremely limited in context and cannot provide the flexibility necessary to address safety concerns.

Through a combination of litigation and tight licensing, patent owners can control a great deal of information. With no relief valve available, it then becomes more important to assess patent accumulation in fields of great public concern. Because an understanding of the impact of patents on natural gas technology is still emerging, it is helpful to look to other contexts for a view of what may come to pass.

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124. *See, e.g.*, 21 U.S.C. § 355 (2011); *Conducting Clinical Trials*, U.S. Food & Drug Admin., http://www.fda.gov/Drugs/DevelopmentApprovalProcess/ConductingClinicalTrials/default.htm (last updated June 22, 2012).

125. *See* 35 U.S.C. § 271(e) (2011); Merck KGAA v. Integra Lifesciences I, Ltd., 545 U.S. 321, 202–04 (2005) (describing the pharmaceutical research exemption and the need to evaluate information from a wide range of testing).

126. *See, e.g.*, Norman Siebrasse & Keith Culver, *The Experimental Use Defence to Patent Infringement: A Comparative Assessment*, 56 U. Toronto L.J. 333, 338–40 (2006) (comparing the U.S. regime with the European approach, and concluding that Europe has a broader exception).

127. TRIPS permits limited exceptions so long as they "do not unreasonably conflict with a normal conflict with a normal exploitation of the patent and do not unreasonably prejudice the legitimate interests of the patent owner." Agreement on Trade-Related Aspects of Intellectual Property Rights, Art. 31, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299, 33 I.L.M. 1197 (1994). However, there is no positive requirement for such an exception, and certainly nothing specific to experimental use.

128. *See, e.g.*, Austl. Gov't Advisory Council on Intell. Prop., Patents and Experimental Use 38–44 (2005) [hereinafter Australian Study], *available at* http://www.acip.gov.au/library/acip%20patents%20&%20experimental%20use%20final%20report%20final.pdf (reviewing the experimental use provisions of the U.S., the U.K, Germany, Japan, Canada, and New Zealand); Centre for Intell. Prop. Policy & Health Law Inst., The Research or Experimental Use Exception: A Comparative Analysis 7–38 (2004), *available at* http://www.cipp.mcgill.ca/data/newsletters/00000050.pdf (comparing the experimental use provisions of Australia, the U.S., Germany, the U.K, and France).

129. *See* Siebrasse & Culver, *supra* note 126, at 338.

130. Australian Study, *supra* note 128, at 44–45.

C. *An Analogous Case of Patent Information Control in Agricultural Biotechnology*

The issue of information control through patents is more than just theoretical; in at least one context, such as agricultural biotechnology, patents have been alleged to cause substantial public harm by limiting experimental use. The experience gained in this battle is therefore informative for assessing similar issues in natural gas production.

Genetically modified seeds have become dominant in several crops in the United States, particularly corn and soybeans.[131] In general, multiple utility patents protect these modifications.[132] Farmers obtain seeds subject to a license rather than an outright sale,[133] and the license contains restrictive terms related to seed saving and other planting restrictions, as well as to distributing the seeds to others.[134] Researchers may also obtain seeds, but such purchases are often on significantly different terms from the typical farming license. This restrictive environment has the potential to significantly impact information flow.

The problem with seed licensing practices is that contract terms can prevent basic research on issues such as plant safety profiles, drift between fields, mutations, and resistance. Researchers must negotiate for the use of seeds in particular contexts, and there is always the possibility that confidentiality conditions may apply to the results. The restrictions make sense for the seed producers; negative information can damage sales by raising safety and comparative efficacy issues that would otherwise be unknown. Widely publicized risks could also bring additional regulatory scrutiny. Coupled with the already fragile reputation of genetically modified crops, this additional negative information could be devastating for producers.

The legal legitimacy of restrictive seed licenses has been upheld. Most prominently, in *Monsanto v. McFarling*, the Court of Appeals for the Federal Circuit upheld Monsanto's breach of contract claim and rejected McFarling's claims of patent misuse.[135] According to the court, Monsanto was within its rights as a patentee in restricting the saving and replanting of

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131. Jorge Fernandez-Conejo & William D. McBride, U.S. Dep't of Agric., Adoption of Bioengineered Crops 4 (2002), *available at* http://www.ers.usda.gov/publications/aer-agricultural-economic-report/aer810.aspx#.UVn74I6RMz0 (GM soybeans constituted 60% of U.S. crop in 2001).

132. John H. Barton & Peter Berger, *Patenting Agriculture*, 17 Issues Sci. & Tech. 43, 44–45 (2001).

133. *See, e.g.*, *Technology Use Guides*, Monsanto, http://www.monsanto.com/products/Pages/technology-use-guides.aspx (last visited Mar. 1, 2013) ("Growers wishing to purchase or plant seed with Monsanto technologies are required to have a current Monsanto Technology/Stewardship Agreemnt (MTSA)—version 2010 or later."). A copy of the Monsanto MTSA can be found at http://thefarmerslife.files.wordpress.com/2012/02/scan_doc0004.pdf.

134. *2011 Monsanto Technology/Stewardship Agreement*, Farmer's Life § 4, http://thefarmerslife.files.wordpress.com/2012/02/scan_doc0004.pdf (last visited Mar. 1, 2013).

135. Monsanto Co. v. McFarling, 363 F.3d 1336, 1341–43 (Fed. Cir. 2004).

seeds through its license, as the terms read on the same invention articulated in the claims.[136] This case followed on the court's earlier decision in *Mallinckrodt, Inc. v. Medipart, Inc.*, in which the court upheld a label license's restriction on the reuse of a medical device.[137] Although the Supreme Court had an opportunity to reign in the power of licenses to prevent exhaustion of patent claims, it passed, implying that the practice is legitimate.[138]

Because of these seed-licensing systems, at least some basic safety research on the patented products is not being carried out. Additionally, the research that *is* performed may be subject to disclosure limitations.[139] To the extent that genetically modified seeds pose hidden dangers, patent rights may prevent this information from seeing the light of day.

III. Information Limitation Is a Particular Problem in Gas Extraction

While proponents claim that hydraulic fracturing is safe and proven, "less than 2% of the well fractures since the 1940s have used the high-volume technology necessary to get gas from shale, almost all of these in the past ten years."[140] The result has been a proliferation of involvement by concerned stakeholders.[141] Our analysis of the impact of this proliferation points to information limitation as a particular problem in gas extraction. Far from mitigating stakeholder concerns, we conclude that increased patenting activity related to hydraulic fracturing appears likely to exacerbate the problem of information control.

A. *Hydraulic Fracturing Information Has Raised Concerns*

A wide variety of chemical products are required during well drilling, completion, and workover operations.[142] The oilfield products and services

136. *Id.*

137. Mallinckrodt, Inc. v. Medipart, Inc., 976 F.2d 700 (Fed. Cir. 1992).

138. Quanta Computer, Inc. v. LG Electronics, Inc., 553 U.S. 617, 636–37 (2008) (noting that "[e]xhaustion is triggered only by a sale authorized by the patent holder" and implying that a properly conditioned license may limit exhaustion).

139. *See*, Bruce Stutz, *Companies Put Restrictions on Research into GM Crops*, Yale Env't 360 (May 13, 2010), http://e360.yale.edu/feature/companies_put_restrictions_on_research_into_gm_crops/2273/.

140. Robert W. Howarth & Anthony Ingraffea, *Should Fracking Stop?*, 477 Nature 271, 272 (2011).

141. Harold D. Brannon et al., *Progression Toward Implementation of Environmentally Responsible Fracturing Processes* 1, (Soc'y of Petroleum Eng'rs, SPE 147534, 2011), *available at* http://www.spe.org/atce/2011/pages/schedule/tech_program/documents/spe147534%201.pdf; *see also* Hannah Wiseman, *Trade Secrets, Disclosure, and Dissent in a Fracturing Energy Revolution*, 111 Colum. L. Rev. Sidebar 1 (2011).

142. Johnny Sanders et al., *Are Your Chemical Products Green? A Chemical Hazard Scoring System* 1 (Soc'y of Petroleum Eng'rs, SPE 126451, 2010), *available at* http://www.onepetro.org/mslib/servlet/onepetropreview?id=SPE-126451-MS#; *see also* Hydraulic Fracturing Report, *supra* note 3.

required for the exploitation of shale and other unconventional gas reservoirs bring with them a spectrum of distinct and significant environmental and health hazards.[143] "From the first day the drill bit is inserted into the ground until the well is completed, toxic materials are introduced into the borehole and returned to the surface along with produced water and other extraction liquids."[144] Along the way, each well produces hundreds of tons of drill cuttings and thousands of gallons of slops, much of it highly toxic.[145] For instance, "many of the fracking additives are toxic, carcinogenic or mutagenic."[146] Similarly, "current fracture diagnostic technology uses radioactive materials which can pose a high risk from a health, safety and environment perspective . . . . [T]he potential to cause pollution or long term detrimental health problems are great."[147] There are also considerable land use changes such as drilling pads, pipelines and compressor stations, along with numerous other potential community impacts such as truck traffic, temporary workers, and stresses related to drilling and fracking.[148] Given the breadth and complexity of these issues, stakeholders have raised numerous questions about potential environmental, safety, and health hazards.[149]

First, environmental hazards include issues such as acute and chronic aquatic toxicity, bioaccumulation, biodegradation, endocrine disruption, ozone depletion, volatile organic compounds ("VOCs"), and the use of chemicals considered "priority pollutants" by the Environmental Protection Agency ("EPA").[150] Despite the fact that many of these chemicals are "highly toxic," such additives are "critical to the success of hydraulic water-

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143. Williams, *supra* note 56, at 9; Andy Jordan et al., *Quantitative Ranking Measures Oil Field Chemicals Environmental Impact* 1 (Soc'y of Petroleum Eng'rs, SPE 135517, 2010), *available at* http://www.spe.org/atce/2010/pages/schedule/tech_program/documents/spe1355171.pdf; Sanders et al., *supra* note 142, at 1–3.

144. Theo Colborn et al., *Natural Gas Operations from a Public Health Perspective*, 17 Hum. & Ecological Risk Assessment 1039, 1053 (2011).

145. Pete Morrison, *Meeting the Environmental Challenge with Technology* 1 (Soc'y of Petroleum Eng'rs, SPE 143837, 2011), *available at* http://www.onepetro.org/mslib/servlet/onepetropreview?id=SPE-143837-MS.

146. Howarth & Ingraffea, *supra* note 140, at 477.

147. Mark Mulkern et al., *A Green Alternative for Determination of Frac Height and Proppant Distribution* 1 (Soc'y of Petroleum Eng'rs, SPE 138500, 2010), *available at* http://www.onepetro.org/mslib/servlet/onepetropreview?id=SPE-138500-MS.

148. Williams, *supra* note 56, at 10, 14–16; Roxanna Witter et al., Potential Exposure-Related Human Health Effects of Oil and Gas Development: A White Paper 13–15 (Sept. 15, 2008), *available at* http://docs.nrdc.org/health/files/hea_08091702a.pdf.

149. Daniel J. Soeder, *The Marcellus Shale: Resources and Reservations*, 91 Eos 277, 278 (2010).

150. Brannon et al., *supra* note 141, at 3; Harold D. Brannon et al., *The Quest to Exclusive Use of Environmentally Responsible Fracturing Products and Systems* 3 (Soc'y of Petroleum Eng'rs, SPE 152068, 2012), *available at* http://www.onepetro.org/mslib/servlet/onepetropreview?id=SPE-152068-MS; Jordan et al., *supra* note 143 at 1, 3; Sanders et al., *supra* note 142, at 3. Currently, the EPA regulates and has developed analytical test methods for 126 Priority Pollutants. 40 C.F.R. § 423 app. A (2012).

based fracturing."[151] In particular, hydraulic fracturing typically involves a complex cocktail of chemicals from different functional categories, including acids, biocides, breakers, clay stabilizers, corrosion inhibitors, crosslinkers, defoamers, friction reducers, gellants, pH buffers, proppants, scale inhibitors, and surfactants.[152]

Very few crosslinkers are "environmentally acceptable," and for some applications none of the available products are environmentally suitable.[153] Choline chloride, an ammonium salt compound, and tetramethyl ammonium chloride ("TMAC"), a quanternary ammonium salt, are the two most common clay stabilizers. Both are toxic—especially TMAC.[154] The most commonly used surfactants "often contain chemicals that are deemed environmentally unacceptable."[155] One conventional demulsifying solvent is known to be genetically, reproductively, and developmentally toxic.[156] Similarly, existing corrosion inhibitors are "very poisonous and strongly polluting," but currently there are no "acceptable environmental alternatives."[157] Until recently, one of the "big three" service companies has consumed over fourteen-million gallons of diesel oil per year in various fracturing products.[158] Notably, diesel fuel contains benzene, toluene, ethylbenzene, and xylenes ("BTEX"), all of which are VOCs known to be harmful to the central nervous system.

Another one of the "most visible" environmental issues associated with hydraulic fracturing is the disposal of flowback fluids, or produced water, which can be especially problematic "because of their high concentrations of total dissolved solids ("TDS")."[159] "The volume of water produced from

151. John J. Wylde & Bill O'Neil, *Environmentally-Acceptable Replacement of 2-Butoxyethanol: A High Performance Alternative for Fracturing Applications* 2 (Soc'y of Petroleum Eng'rs, SPE 141099, 2011), *available at* http://www.onepetro.org/mslib/servlet/onepetropreview?id=SPE-141099-MS.

152. Colborn et al., *supra* note 144, at 1039, 1053; U.S. Envtl. Prot. Agency, 816-R-04-003, Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs, at 4–9 & tbl. 4-1, 4–10 (2004); *id.* at 4–8.

153. Julio Gomez, *Developing Environmentally Compliant Materials for Cementing and Stimulation Operations* 1 (Soc'y of Petroleum Eng'rs, SPE 127196, 2010), *available at* http://www.onepetro.org/mslib/servlet/onepetropreview?id=SPE-127196-MS.

154. I.A. El-Monier & H.A. Nasr-El-Din, *A Study of Several Environmentally Friendly Clay Stabilizers* 1–2 (Soc'y of Petroleum Eng'rs, SPE 142755, 2011), *available at* http://www.onepetro.org/mslib/servlet/onepetropreview?id=SPE-142755-MS.

155. Hui Zhou et al., *Development of More Environmentally Friendly Demulsifiers* 1 (Soc'y of Petroleum Eng'rs, SPE 15182, 2012), *available at* http://www.onepetro.org/mslib/app/Preview.do?paperNumber=SPE-151852-MS&societyCode=SPE.

156. *Id.* at 3.

157. Gomez, *supra* note 153, at 6.

158. Brannon et al., *supra* note 141, at 11.

159. Soeder, *supra* note 149, at 277–78. Similarly, according to Michael L. Godec & Robin L. Petrusak, the disposal of produced water is a significant environmental concern, in large part because of the tremendous volumes involved. Michael L. Godec & Robin L. Pe-

America's oil and gas wells is many times the volume of hydrocarbons produced each day."[160] One recent study of the Pennsylvania Brine Treatment ("PBT") Josephine Facility, which only accepts wastewater from the oil and gas industry, found barium levels had a mean concentration in effluent of 27.3 ppm, approximately fourteen times the EPA maximum concentration limit of 2 ppm for drinking water; mean strontium levels of 2981.1 ppm, over 745 times higher than the EPA recommended limit for finished municipal drinking water of 4 ppm; mean bromide levels of 1068.8 ppm, more than 10,000 times higher than the 100 ppb level at which authorities become concerned; and elevated levels of other contaminants.[161] This study concluded that downstream populations served by the Freeport water authority and other water authorities downstream of Freeport, were at risk of contamination owing to these contaminants as well as others that were not sampled as part of the study.[162] Others are concerned about "fugitive emissions that occur at multiple points during fracking and production."[163] Hydraulic fracturing also "can have impacts on local water resources."[164] Meanwhile, petroleum engineers have cautioned that "the more obvious risks posed by well treatment chemicals on the surface have been largely ignored by both the environmental interest groups and governmental authorities," suggesting that if anything, the range of potential environmental hazards has yet to be fully enumerated.[165]

Second, in addition to their possible environmental hazards, "drilling and fracturing activities may use and produce hazardous materials which could threaten human health."[166] "The work does have inherent dangers."[167] These include safety hazards related to explosives, flammability, oxidizers, and corrosives.[168] For instance, "spills of chemical additives during transport or well site operations could pose far greater risks because the concentrations of as received additives are two to three orders of magnitude greater than they are after blending with water to formulate the fracturing fluid."[169] The chemicals involved in hydraulic fracturing may contain hydrochloric

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trusak, *The Answer to Increasing Environmental Compliance Costs: Regulatory Reform or Technological Advance?* 3 (Soc'y of Petroleum Eng'rs, SPE 56495, 1999), *available at* http://www.onepetro.org/mslib/app/Preview.do?paperNumber=00056495&societyCode=SPE.

160. *Produced Water*, Interstate Oil & Gas Compact Comm'n, http://www.iogcc.state.ok.us/produced-water (last visited Mar. 1, 2013).

161. U.S. Envtl. Prot. Agency, EPA/600/R-11/047, Proceedings of the Technical Workshops for the Hydraulic Fracturing Study: Fate and Transport, at 11 (2011).

162. *Id.* at 13.

163. David Kramer, *Shale-Gas Extraction Faces Growing Public and Regulatory Challenges*, Phys. Today, July 2011, at 23, 24.

164. Soeder, *supra* note 149, at 277–78.

165. Brannon et al., *supra* note 141, at 2.

166. Witter et al., *supra* note 148, at 3.

167. Huls, *supra* note 57, at 2.

168. Brannon et al., *supra* note 141, at 3–4; Jordan et al., *supra* note 143, at 3.

169. Brannon et al., *supra* note 141, at 2.

acid; muriatic acid; hydroxyethyl cellulose; glutaraldehyde; petroleum distillate; ammonium bisulfate; 2-hydroxy-1,2,3-propanetricaboxylic acid; N,N-dimethylformamide; ethylene glycol; 2-butoxyethanol; fluorocarbons; naphthalene; butanol; or formaldehyde.[170] Following hydraulic fracturing, some of these chemicals are returned to the surface, potentially contaminating soil, air, and water, whereas other chemicals are left underground, potentially contaminating subsurface aquifers. Other potential causes of health hazards include improper handling of drilling sludge and produced water, chemical and waste spills, and fugitive gas emissions.[171]

One fracturing product, 2-butoxyethanol ("EGBE"), has come under increased scrutiny recently.[172] EGBE is used ubiquitously and in high volumes in fracturing operations, preflushes, acid washes, and surfactant formulations.[173] The fourteen largest oil and gas service companies injected 21.9 million gallons of products containing EGBE between 2005 and 2009.[174] EGBE is absorbed and rapidly distributed in humans following inhalation, ingestion, or dermal exposure.[175] Numerous toxicity concerns are associated with EGBE, including nose and eye irritations, headaches, vomiting, breathing problems, low blood pressure, lowered levels of hemoglobin, blood in urine, and metabolic acidosis.

As oil and gas exploration and production activities move closer to human populations, these associated hazards "are more likely to have a direct effect on the health of those living, working and going to school in proximity."[176] Indeed, the few existing studies available show that exposure to air pollutants, toxic chemicals, metals, radiation, noise and light pollution cause a range of diseases, illnesses, and health problems.[177] As a result, those living in close proximity to oil and gas activities may be at increased risk for a variety of health problems affecting the skin, eyes, and other sensory organs; brain and nervous system; gastrointestinal tract, liver, and kidneys; and the immune system.[178] Negative health outcomes such as cancer, cardiovascular disease, blood disorders, endocrine disruption, respiratory problems,

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170. David M. Kargbo et al., *Natural Gas Plays in the Marcellus Shale: Challenges and Potential Opportunities*, 44 Envtl. Sci. Tech. 5679, 5681 (2010).

171. Witter et al., *supra* note 148, at 3.

172. Wylde & O'Neil, *supra* note 151, at 1.

173. *Id.* at 2; Press Release, Clariant, Clariant Oil Services Named Finalist in 2011 World Oil Awards, at 1 (Sept. 20, 2011).

174. Hydraulic Fracturing Report, *supra* note 3, at 7.

175. For a review of the toxicology of EGBE, see U.S. Envtl. Prot. Agency, EPA/635/R-08/006F, Toxicological Review of Ethylene Glycol Monobutyl Ether (EGBE) (CAS No. 111-76-2), at 4 (2010); U.S. Dep't of Health & Hum. Servs., Toxicological Profile for 2-Butoxyethanol and 2-Butoxyethanol Acetate (1998).

176. Witter et al., *supra* note 148, at 5.

177. *Id.* at 7.

178. *Id.*

and asthma, as well as genetic, reproductive, and developmental toxicity have been linked to oil and gas activities.[179]

B. *Information Necessary for Assessment Is Limited*

Despite the many questions stakeholders have posed about hydraulic fracturing and related oilfield products and services, those who have attempted to assess these issues have reported that necessary information is often not available. For instance, the types and quantities of chemicals involved are often not readily disclosed.[180] The exact reasons for these information shortages are not entirely clear. For instance, some have noted that even though the chemical formulations of hydraulic fracturing fluids are "highly researched," they are also "closely guarded."[181] Others maintain that "because shale-gas development is so new, scientific information on the environmental costs is scarce."[182] Another possible difficulty is that drilling companies have historically not been legally required to list the chemicals used in hydraulic fracturing, making it "difficult to assess the full scope of the contents of fracking fluids."[183] A lack of standards may also be a culprit. For instance, even within a single area such as the Marcellus Shale, "there are no basin-wide standards for brine analysis, so it is difficult to compare the small amounts of data that do exist."[184] Finally, "ever-present concerns of compromising supplier proprietary information" make obtaining the necessary information difficult, even for industry insiders willing to sign confidentiality agreements and utilize third-party intermediaries.[185] Despite these different information barriers, "many in industry agree that there is a need for accurate, thorough, and unbiased scientific data on the possible environmental impacts of shale gas drilling and production."[186]

The quantification of potential environmental, safety, and health hazards is further complicated by that fact that "evaluating and communicating the hazards of chemicals is done in a highly variable manner across the world."[187] Simply gathering data on oilfield products is challenging. For instance, it is not uncommon for a given Material Safety Data Sheet ("MSDS") to be "fraught with gaps in information about the formulation of

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179. Brannon et al., *supra* note 141, at 3; Brannon et al., *supra* note 150, at 3; Colborn et al., *supra* note 144, at 1039, 1045; Kargbo et al., *supra* note 170, at 5670, 5681; Witter et al., *supra* note 148, at 7.

180. Colborn et al., *supra* note 144, at 1039–40.

181. Kargbo et al., *supra* note 170, at 5679, 5681.

182. Howarth & Ingraffea, *supra* note 140, at 271–72.

183. Madelon L. Finkel & Adam Law, *The Rush to Drill for Natural Gas: A Public Health Cautionary Tale*, 101 AMER. J. PUB. HEALTH, 784 (2011).

184. Soeder, *supra* note 149, at 277–78.

185. Brannon et al., *supra* note 141, at 3.

186. Soeder, *supra* note 149, at 277–78.

187. Jordan et al., *supra* note 143, at 4.

the products."[188] The problems stem in part from the fact that the Occupational Safety and Health Administration ("OSHA") "provides only general guidance about the format and content of material safety data sheets."[189] It is not uncommon for an MSDS to omit the chemical composition of a product, to report on only a fraction of the total composition (sometimes less than 0.1%), or to provide only a general description of a product (such as plasticizer).[190] Even in cases where information is provided, Chemical Abstract Service ("CAS") numbers are often not provided.[191] "We have health data on only a small percentage of the chemicals in use because CAS numbers are often not provided on MSDSs and without a CAS number it is difficult to search for health data."[192] Reflecting on these problems, the U.S. General Accounting Office (renamed "Government Accountability Office" in 2004) concluded bluntly that "many MSDSs contain inaccurate or incomplete information" and OSHA "lacks an effective process for detecting inaccuracies."[193]

Moreover, even "a fully compliant OSHA-mandated [MSDS] in the US is likely to have significant gaps in the data needed to assess its environmental, safety and health hazards."[194] For one thing, an OSHA MSDS "requires no environmental information."[195] Additionally, in cases where OSHA classifies all the components of a particular product as non-hazardous, manufacturers are not required to identify any of the product's specific substances. However, OSHA's "non-hazardous" classification "does not account for potential environmental hazards" and if a substance is not identified on an MSDS "no database searching can be accomplished for environmental data."[196] In other cases, oilfield products were mixed together before use, but "little data was available for most of the mixtures," requiring interested stakeholders to make their own judgments by combining the profiles of individual components based on their weighted contribution to the overall mixture. Finally, "much of the necessary but missing data (including the names of specific constituent chemicals) was considered proprietary or trade secret by the chemical supplier."[197]

To the extent these basic information challenges can be overcome, interpreting the results can still be complicated. For instance, even if the inherent environmental, safety, and health hazards of particular chemicals can be de-

188. Colborn et al., *supra* note 144, at 1039, 1044.
189. U.S. Gen. Acct. Off., HRD-92-8, OSHA Action Needed to Improve Compliance with Hazard Communication Standard 28 (1991).
190. Colborn et al., *supra* note 144, at 1039, 1044.
191. *Id.*; Jordan et al., *supra* note 143, at 4.
192. Colborn et al., *supra* note 144, at 1039, 1054.
193. U.S. Gen. Acct. Off., *supra* note 189, at 28, 31.
194. Jordan et al., *supra* note 143, at 4.
195. *Id.*
196. *Id.*
197. *Id.* (internal quotation marks omitted).

termined, these individual product hazards do not "account for use conditions or exposure scenarios."[198] For instance, hydraulically fracturing a horizontal shale well requires three to seven million gallons of water per well, but it is only by making basin-wide evaluations that the cumulative impacts of such withdrawals and their concomitant disposals can be evaluated.[199] In the case of water, such holistic assessments have concluded that hydraulic fracturing is a consumptive use, meaning that the water is permanently removed from the hydrological cycle.[200] But without better information on the quantities, timing, and locations of such water withdrawals and disposals, it is difficult to assess their overall impacts. The applicability of isolated product assessments can also be misleading in other ways. For instance, on their own, silica-based proppants are considered inorganic substances, and appear to have low environmental, safety, and health hazards, but such an assessment "is totally unrelated to the product's ultimate and long-term use underground in a hydraulic fracture."[201]

Although interested stakeholders have identified numerous potential health hazards associated with hydraulic fracturing and related oilfield products and services, further assessment of these hazards depends on access to sufficient information. However, the "data necessary to completely assess the health and social impacts of the oil and gas industry are missing in all areas, including population demographics, health status, psychological status, social measures, worker health, and environmental exposure."[202] Timely and unbiased environmental monitoring is not readily available to the public. In other cases, the studies that have been submitted to the EPA are not publicly available because they are considered proprietary to the industry.[203]

In one study, a list was compiled of 944 products used during natural gas operations.[204] Working from the associated MSDSs, the authors were able to identify 95% or more of the ingredients for just 131 (14%) of the products. Conversely, for 407 (43%) of the products, the authors were able to identify less than 1% of the total composition. Ultimately, just 632 chemicals were identified, and of those they were only able to locate CAS numbers for 353 (56%). After analyzing the potential health effects of the subset of oilfield chemicals that they were able to identify, the authors concluded

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198. *Id.*

199. James Daniel Arthur & Bobbi Jo Coughlin, *Cumulative Impacts of Shale-Gas Water Management: Considerations and Challenges* 3 (Soc'y of Petroleum Eng'rs, SPE 142234, 2011), *available at* http://www.spe.org/events/hsse/2011/pages/schedule/tech_program/documents/142234_Arthur.pdf.

200. Charles W. Abdalla & Joy R. Drohan, *Water Withdrawals for Development of Marcellus Shale Gas in Pennsylvania* 2 (Penn. State Coll. of Ag. Sci., Publ'n No. UA460, 2010); Huls, *supra* note 57, at 1.

201. Jordan et al., *supra* note 143, at 5.

202. Witter et al., *supra* note 148, at 2.

203. Colborn et al., *supra* note 144, at 1044.

204. *Id.* at 1039, 1045.

that "it was difficult to arrive at a 'short list' of chemicals that would be informative for water quality monitoring because of the vast array of products constantly being developed, and the wide selection of chemicals used in those products."[205] Others have reached similar conclusions: "Because of the lack of disclosure by the drilling companies of the individual chemicals with their unique CAS registry numbers used in fracking fluids, it is difficult to truly assess their potential adverse effects, and so the cumulative exposure impact is not known."[206]

In another study, the New York State Department of Environmental Conservation ("NYDEC") analyzed 235 hydraulic fracturing products from six oilfield service companies and fifteen chemical suppliers.[207] It could only determine the complete composition of 167 products.[208] Among the products, 322 unique chemicals with CAS numbers were identified.[209] Part of the difficulty was that "a significant number of product compositions have been properly justified as trade secrets within the coverage of disclosure exceptions of the Freedom of Information Law," however, the NYDEC "considers MSDSs to be public information ineligible for exception from disclosure as trade secrets or confidential business information."[210] As a further difficulty, the NYDEC found that "compound-specific toxicity data are very limited for many chemical additives to fracturing fluids."[211] As a result, it was forced to limit its assessment to "qualitative hazard information."[212]

In sum, given the widespread absence of necessary data, "it has been scientifically difficult to establish causal relationships between oil and gas activity and health effects."[213] Nonetheless, the lack of specific evidence "does not negate the fact that oil and gas operations use and produce toxic contaminants that adversely affect human health, nor does it negate the potential health effects of the large-scale socio-demographic and economic changes often associated with such projects."[214] In place of answers, there are "many uncertainties" regarding the health effects of the oil and gas industry.[215]

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205. *Id.* at 1049.
206. Finkel & Law, *supra* note 183, at 785.
207. N.Y. State Dep't of Envtl. Conserv., Revised Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program 5-41 (2011).
208. *Id.*
209. *Id.*
210. *Id.* at 5-63.
211. *Id.*
212. *Id.* at 5-74.
213. Witter et al., *supra* note 148, at 5.
214. *Id.* at 7.
215. *Id.* at 28.

C. *Availability of Government Information Is Limited*

In addition to the many independent assessment efforts described above, federal and state regulators face similar limitations. For one thing, "the speed at which the resource is being developed often forces regulatory agencies to make policy decisions based on little data."[216] Complicating matters is the fact that oil and gas exploration and service companies have traditionally been "secretive about additives in the fluids used for hydraulic fracturing and the volumes of water recovered after each treatment."[217] According to some, "even the EPA does not know what proprietary chemicals are contained in fracking fluids."[218]

As evidence of these limitations accumulates, a growing number of stakeholders are concluding that part of the information problem may be the result of inadequate regulatory oversight of oil and gas.[219] For instance, the oil and gas industry is exempt from several major federal regulations that would otherwise require important disclosures, or restrict some of the industry's most controversial practices, including exemptions from the Comprehensive Environmental Response, Compensation, and Liability Act; Resource Conservation and Recovery Act; Safe Drinking Water Act; Clean Water Act; Clean Air Act; National Environmental Policy Act; and Emergency Planning and Community Right-to-Know Act.[220]

The Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA") of 1980 regulates the cleanup of hazardous substances released into any part of the environment, including air, water and land.[221] All petroleum products contain benzene, toluene, ethylbenzene, or xylenes, and these substances are explicitly covered under CERCLA. And yet, as currently enacted, CERCLA considers these and any other hazardous substances contained in crude oil and petroleum products to be exempt from regulation.[222] Petroleum facilities and abandoned well sites are similarly exempt from CERCLA regulation.[223]

Under the Resource Conservation and Recovery Act ("RCRA") of 1976, the EPA was given authority for determining the specific characteristics of hazardous waste and promulgating lists of such wastes.[224] Before the EPA could finish its rulemaking, Congress enacted the Solid Waste Disposal Act, exempting oilfield wastes from regulation under the requirements of RCRA

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216. Soeder, *supra* note 149, at 277–78.

217. *Id.*

218. Jerald L. Schnoor, *Regulate, Baby, Regulate*, 44 Envtl. Sci. & Tech., 6524 (2010).

219. *See* Williams, *supra* note 56, at 5; Renee Lewis Kosnik, The Oil and Gas Industry's Exclusions and Exemptions to Major Environmental Statutes, Oil & Gas Accountability Project 2 (2007).

220. Kosnik, *supra* note 219, at 2.

221. 42 U.S.C. §§ 9601–9675 (2011).

222. *See* Kosnik, *supra* note 219, at 4–6; *see also* 42 U.S.C. § 9601(14).

223. *See* Kosnik, *supra* note 219, at 4–6.

224. *See id.* at 6–8; *see also* 42 U.S.C. § 6903–6992.

Subtitle C until the EPA could prove these wastes were a danger to human health and the environment.[225] In 1988, the EPA concluded that existing state and federal regulations provided adequate oversight of oilfield wastes.[226] As a practical matter, these exemptions allow for the ready disposal of numerous known hazardous pollutants.[227]

The Safe Drinking Water Act ("SDWA") of 1974 protects all surface and subsurface waters actually or potentially used for drinking.[228] However, the Energy Policy Act of 2005 ("EPAct of 2005") amended the SWDA in three ways by: (a) completely exempting hydraulic fracturing operations, (b) asking for the voluntary discontinuance of diesel fuel in hydraulic fracturing rather than banning it, and (c) redefining underground injection related to oil and gas operations as outside the EPA's jurisdiction unless diesel fuel is involved.[229] Collectively, these changes have had the effect of codifying the deregulation of hydraulic fracturing except when diesel fuels are used, and even then, regulation by the EPA is discretionary.[230]

The regulations commonly known as the Clean Water Act ("CWA") were passed in 1972 and 1977.[231] Under the CWA, the EPA was given authority to implement pollution control programs and to set water quality standards for all surface waters. The CWA also made it unlawful to discharge any pollutant from a point source into navigable waters, without first obtaining a permit.[232] From 1987 until 2005, the CWA exempted oil, gas, and mining operations from obtaining runoff permits, provided that the runoff was not contaminated by contact with raw materials or wastes.[233] However, in 1990, the EPA promulgated a rule stating that construction activities disturbing five or more acres of land required a permit.[234] In 1999, the EPA expanded the permitting requirement to encompass construction activities disturbing one to five acres of land,[235] but deferred its implementation.[236] Before the deferral expired, the EPAct of 2005 amended the CWA to specif-

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225. *See* Kosnik, *supra* note 219, at 6.
226. *Id.*
227. *Id.* at 7–8; Godec & Petrusak, *supra* note 159, at 3.
228. Pub. L. No. 93-523, 88 Stat. 1660 (1974) (codified as amended at 42 U.S.C. §§ 300h to 300h-8); Bruce M. Kramer, *Federal Legislative and Administrative Regulation of Hydraulic Fracturing Operations*, 44 Tex. Tech. L. Rev. 837, 840 (2012).
229. *See* Kosnik, *supra* note 219, at 8; Kramer, *supra* note 228, at 855–56.
230. *See* Kosnik, *supra* note 219, at 9.
231. Federal Water Pollution Control Act Amendments of 1972, Pub. L. No. 92-500, 86 Stat. 816 (codified at 33 U.S.C. §§ 1251–1376); Clean Water Act of 1977, Pub. L. No. 95-217, 91 Stat. 1566.
232. *See* Kosnik, *supra* note 219, at 10.
233. *See id.*; *see also* 33 U.S.C. § 1342(1)(2) (2011).
234. 55 Fed. Reg. 47990 (Nov. 16, 1990).
235. 64 Fed. Reg. 68,722 (Dec. 8, 1999).
236. 67 Fed. Reg. 79,828 (Dec. 30, 2002).

ically include sediment related to oil and gas operations.[237] The EPA's attempt to limit the application of the Energy Policy Act was invalidated by the Ninth Circuit in 2008.[238] As a consequence, uncontaminated sediments are not considered pollutants when generated by the oil and gas industry unless they result from construction.[239]

The Clean Air Act ("CAA") regulates emissions from area, stationary, and mobile sources.[240] Major sources of pollutants are limited by the National Emission Standards for Hazardous Air Pollutants. These prescribed standards are to be met by installing the Maximum Achievable Control Technology ("MACT") for each source. Under the CAA, smaller sources of pollution under common control are aggregated together and regulated as if they were a single source. However, oil and gas wells, along with some pipeline compressors and stations, are not required to be aggregated together, leaving these emissions not only unregulated, but largely untracked as well.

Enacted in 1969, the National Environmental Policy Act ("NEPA") established a national framework for protecting the environment by requiring all branches of the government to properly consider any actions which may significantly affect the environment.[241] The EPAct of 2005 created a "rebuttable presumption" that oil and gas activities could be analyzed and processed under the less stringent "categorical exclusion" process.[242] This change effectively shifted the burden to the public to prove that an activity requires further analysis. In short, whereas prior to 2005 federal agencies had the burden of showing that oil and gas activities would not harm the environment, now the public has the burden of showing there are "extraordinary circumstances" warranting a full NEPA review.[243]

The Emergency Planning and Community Right-to-Know Act of 1986[244] created the Toxics Release Inventory ("TRI"), which publically discloses facility-level data on the disposal or release of over 650 toxic chemicals by any facility in a listed SIC code with ten or more employees and that meets one of several chemical thresholds. The exploration and production of

237. Pub. L. No. 109-58, § 323, 119 Stat. 594 (codified as amended at 33 U.S.C. § 1362(24)).

238. Natural Res. Def. Council v. U.S. Envtl. Prot. Agency, 526 F.3d 591, 607–08 (9th Cir. 2008).

239. *See* Michael Goldman, *Drilling into Hydraulic Fracturing and Shale Gas Development: A Texas and Federal Environmental Perspective*, 19 TEX. WESLEYAN L. REV. 185, 192 (2012).

240. Clean Air Act Amendments of 1970, Pub. L. No. 91-604, 84 Stat. 1676.

241. Pub. L. No. 91-190, 83 Stat. 852 (codified as amended at 42 U.S.C. § 4321 et seq. (2011)); *see also* KOSNIK, *supra* note 219, at 15.

242. *See* Energy Policy Act of 2005, Pub. L. No. 109-58, § 390, 119 Stat. 594; KOSNIK, *supra* note 219, at 15.

243. *See* KOSNIK, *supra* note 219, at 16.

244. Pub. L. No. 99-499, 100 Stat. 1728 (1986) (codified as amended at 42 U.S.C. §§ 11001–11050 (2011)).

oil and gas easily meet all of these reporting criteria. However, any company listed in SIC code 13: Oil and Gas Extraction is exempt from these regulations. As a result, information that would otherwise be available is entirely opaque.

As these institutional voids have become more conspicuous, numerous regulatory agencies have begun taking steps to potentially fill them. Ten different federal departments and agencies are reportedly considering regulations related to unconventional oil and gas exploration and production, including the EPA, U.S. Department of the Interior, U.S. Department of Health and Human Services, U.S. Pipeline and Hazardous Materials Safety Administration, and the U.S. Securities and Exchange Commission.[245] Given that "much is still unknown about the environmental effects of shale gas production," other agencies are working to collect better data.[246] Within the past two years, the states of Wyoming, Arkansas, Louisiana, Texas, Colorado, North Dakota, and Pennsylvania all have adopted new regulations related to hydraulic fracturing. Other states, such as New York and New Jersey, have imposed moratoria on hydraulic fracturing. In April and May 2011, U.S. Congressional Committees held five different hearings on the practice.[247] After decades of exemptions from existing regulations, the American Petroleum Institute, the official oil and gas industry lobbying organization, is now worried about "regulatory overreach."[248] Despite these activities, little additional information has become available.

D. *Industry Self-Regulation Is Limited*

Faced with growing demands for increased disclosure and transparency, the oil and gas industry has recently attempted to demonstrate that it is capable of regulating itself. The industry's most prominent effort to date is FracFocus.org, a hydraulic fracturing chemical registry website that was launched on April 11, 2011, as a joint effort between the Ground Water Protection Council ("GWPC") and the Interstate Oil and Gas Compact Com-

245. Holtsclaw et al., *supra* note 56, at 2; Nick Snow, *API Suggests Single Agency Coordinate Federal Frac Rule Proposals*, Oil & Gas J., Mar. 1, 2012, at 21.

246. Daniel J. Soeder, *Environmental Impacts of Shale Gas Production*, Phys. Today, Nov. 2011, at 8.

247. On April 12, 2011, the Senate Environment and Public Works Committee held a hearing on hydraulic fracturing titled "Natural Gas Drilling: Public Health and Environmental Impacts." On May 6, 2011, the House Oversight and Government Reform Committee convened a field hearing HF. The Oversight Committee held an additional hearing on May 24 about domestic oil and gas production, and HF was one of the key topics covered. The Senate Energy and Natural Resources Committee held a hearing on May 10 on "new developments in upstream oil and gas technologies," that specifically addressed hydraulic fracturing. And on May 11, the House Science, Space, and Technology Committee held a hearing titled "Hydraulic Fracturing Technology and Practices."

248. Snow, *supra* note 245.

mission ("IOGCC").[249] In just over two months of operation, forty-two companies pledged to participate, and disclosures related to more than 1,000 wells were provided.[250]

But even before FracFocus.org launched, efforts at greater disclosure had begun. In June 2010, the Wyoming Oil and Gas Conservation Commission became the first state to require oil and gas operators to disclose the chemicals used in hydraulic fracturing. Under the new rules, which took effect on September 15, 2010, oil and gas well operators are required to provide the chemical additives, compounds, and concentrations or rates proposed to be mixed and injected for each stage of the well stimulation program. The necessary disclosures include: (a) stimulation fluid identified by additive type (e.g., acid, breaker, surfactant), (b) the chemical compound name and CAS number, and (c) the proposed rate or concentration for each additive.[251] However, consistent with Wyoming law,[252] confidentiality is provided for "trade secrets, privileged information and confidential commercial, financial, geological or geophysical data furnished by or obtained from any person."[253] Additionally, the disclosures are submitted to the supervisor of the Wyoming Oil and Gas Conservation Commission.

Arkansas later adopted similar regulations. Effective January 15, 2011, service companies are required to provide well operators with information on fracturing fluids, additives, and chemical constituents (except for chemicals that are deemed to be trade secrets) for each fracturing operation performed.[254] In turn, well operators are required to report all information provided by the service company along with any additional fracturing fluids, additives, and chemical constituents added by the operator to the Oil and Gas Commission.[255] Additionally, service companies are required to disclose all fracturing fluids, additives, and chemical constituents used in the state to the Arkansas Oil and Gas Commission, except for chemicals that are deemed to be trade secrets.[256]

Building on the new regulations in Wyoming and Arkansas, in September 2011 the Montana Oil and Gas Board ("MOGB") adopted new hydraulic fracturing disclosure rules under which oil and gas well operators are required to disclose completion procedures on new and existing wells, includ-

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249. *FracFocus Is Live*, FracFocus, http://fracfocus.org/node/27 (last visited Mar. 1, 2013).

250. *FracFocus Reaches Milestone*, FracFocus.org, http://fracfocus.org/node/311 (last visited Mar. 1, 2013).

251. Well Stimulation, 055-000-003 Wyo. Code R. § 45 (LexisNexis 2012), *available at* http://wogcc.state.wy.us/wogcchelp/commission.html.

252. Wyo. Stat. Ann. § 16-4-203(d)(v) (2012).

253. *Id.*

254. Rule B-19: Requirements for Well Completion Utilizing Fracture Stimulation, 2013 Ark. Reg. 6412.

255. *Id.*

256. *Id.*

ing (a) a description of the interval(s) or formation treated, (b) the type of treatment pumped (acid, chemical, fracture stimulation), and (c) the amount and type(s) of material pumped and the rates and maximum pressure during treatment.[257] For hydraulic fracturing treatments, operators must also disclose (a) a description of the stimulation fluid identified by additive type, (b) the chemical ingredient name and the CAS number for each ingredient used, and (c) the rate or concentration for each additive.[258] One key difference is that Montana allows operators to satisfy these new hydraulic fracturing disclosure requirements by submitting the information to the FracFocus database.[259] As with Wyoming, however, the rules allow for the exclusion of proprietary chemicals and trade secrets. Specifically, where the formula, pattern, compilation, program, device, method, technique, process, or composition of a chemical product is unique to the owner or operator or service contractor and would, if disclosed, reveal methods or processes entitled to protection as trade secrets, such a chemical need not be disclosed.[260] Instead, it is enough to identify the trade secret chemical or product by trade name, inventory name, chemical family name, or other unique name and the quantity used.[261]

Since then, five more states have followed suit, passing hydraulic fracturing disclosure regulations linked to the FracFocus database. In October 2011, the Louisiana Department of Natural Resources adopted a new rule requiring oil and gas operators to obtain work permits and disclose to FracFocus the types, compositions and volumes of chemicals used after completing a well.[262] Starting in February 2012, the Railroad Commission of Texas required oil and gas operators to disclose the chemical ingredients and water volumes used to hydraulically fracture wells on FracFocus.[263] However, a supplier, service company or operator is not required to disclose trade secret information unless the Attorney General or a court determines that the information is not entitled to trade secret protection.[264] In February 2012, Pennsylvania also enacted a new law that requires unconventional well operators to complete a chemical disclosure registry form for publication on

257. *See* Disclosure of Well Stimulation Fluids, Mont. Admin. R. 36.22.1015 (2013), *available at* http://bogc.dnrc.mt.gov/PDF/36-22-157adp-arm.pdf.

258. *Id.*

259. *Id.*

260. *See* Proprietary Chemical and Trade Secrets, Mont. Admin. R. 36.22.1016 (2013), *available at* http://bogc.dnrc.mt.gov/PDF/36-22-157adp-arm.pdf.

261. *Id.*

262. *DNR Office of Conservation Adopts New Regulation for Hydraulic Fracture Operations in Louisiana*, La. Dep't of Nat. Res. (Oct. 20, 2011), http://dnr.louisiana.gov/index.cfm?md=newsroom&tmp=detail&aid=894.

263. News Release, R.R. Comm'n of Tex., Railraod Commissioners Adopt One of Nation's Most Comprehensive Hydraulic Fracturing Chemical Disclosure Requirements (Dec. 13, 2011), *available at* http://www.rrc.state.tx.us/pressreleases/2011/121311.php.

264. *Id.*

FracFocus.org in addition to reports that are submitted to the department. Likewise, the Colorado Oil and Gas Conservation Commission enacted similar hydraulic fracturing disclosure regulations effective April 1, 2012.[265] Finally, as of April 2012, North Dakota requires that well operators submit information to FracFocus disclosing the fracture date, state, county, well number, operator name, well name and number, longitude, latitude, production type, true vertical depth, total water volume, and hydraulic fracturing fluid composition.[266] FracFocus also has gone international with the creation of FracFocus.ca (Canada). Effective January 1, 2012, British Columbia required disclosure of hydraulic fracturing fluids on FracFocus within thirty days of completion operations.

In part, due to these supportive state regulations, FracFocus listed the results of slightly more than 13,000 hydraulic fracturing treatments as of March 15, 2012. However, this number represents only a fraction of the more than 50,000 treatments performed annually.[267] In addition to severely underreporting actual hydraulic fracturing treatments, the reports posted to FracFocus have been criticized for being difficult to interpret and making risks intentionally obscure. For instance, ingredients are listed as a percentage of the total amount of the fluid. Because a typical hydraulic fracturing job uses one to eight million gallons of water, the chemical components look tiny by comparison, obscuring the risks from potent toxins.[268] But perhaps more important is what remains undisclosed. Rather than providing the complete recipe—each ingredient and its precise amount—oil and gas operators are allowed to withhold chemical components deemed trade secrets. For instance, a review of twenty-five recent disclosures totaling almost 1,300 ingredients, found that trade secrets were claimed for about fifteen percent of the chemical components reported to FracFocus.[269] The reports are also posted as individual PDF documents, making it impossible to easily search and download the entire database for further analysis. This omission did not escape the notice of the Colorado Oil and Gas Conservation Commission ("COGCC"). If FracFocus does not provide the ability to search by ingredient, CAS number or time period by January 1, 2013, then the COGCC is

265. Hydraulic Fracturing Chemical Disclosure, 2 Colo. Code Regs. § 404-1-205A (2012).

266. Hydraulic Fracture Stimulation, N.D. Admin. Code 43-02-03-27.1 (2012) (requiring that for each hydraulic fracturing fluid component, the well operator is required to list (a) trade name, (b) supplier, (c) fluid function, (d) ingredients, (e) CAS number, (f) maximum ingredient concentration in additive, and (g) maximum ingredient concentration).

267. Montgomery & Smith, *supra* note 51, at 27.

268. Forrest Wilder, *Texas' Fracking Disclosure Law Falls Short, Critics Say*, Tex. Observer (Mar. 13, 2012), http://www.texasobserver.org/texas-fracking-disclosure-law-falls-short-critics-say/.

269. *Id.*

required to build its own searchable database.[270] Finally, and perhaps most importantly, FracFocus has been criticized for diverting attention from the environmental and health hazards to disclosure. "Just focusing on disclosure allows the real issue of requiring prevention of contamination or harm to slip through the cracks and be ignored."[271] In short, whatever else it might accomplish, FracFocus is unlikely to adequately address the numerous information limitations detailed above.

E. *Access to Fluid Information Is Not Enough; Use Is Required*

In view of the need for more information on fracturing materials, parties unrelated to the extraction process will likely play a greater role. University scientists will need to generate data from independent experiments. Public interest groups may contract with universities or private labs to learn more about the impact of fracturing. And government agencies will be called upon to engage in more extensive reviews. Each of these activities will require more than knowledge about the chemical composition of compounds and basic fracturing techniques; effective experimentation and review will require use.

The need to use hydraulic fracturing products in order to assess their properties and performance is well established in the oil and gas industry.[272] For instance, laboratory tests are used to measure parameters considered critical to treatment outcomes.[273] Along the way, service company research laboratories have spent millions of dollars researching and developing fracturing fluids.[274] At the same time, what works in the laboratory has to be constantly adjusted to conditions in the field, and what works in one field needs to be adjusted to conditions in another, as Mitchell Energy found when it translated slickwater hydraulic fracturing techniques from the Cotton Valley to the Barnett Shale, and as Range Resources found as it translated these same techniques to the Marcellus Shale.[275] In the same way, it is only through using hydraulic fracturing products that their direct environmental and health effects can be assessed.

In addition to assessing the potential for hydraulic fracturing to cause direct environmental and health hazards, it is important to consider how the

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270. Hydraulic Fracturing Chemical Disclosure, 2 Colo. Code Regs. § 404-1-205A (2012).

271. Jeremy Fugleberg, *National "Fracking" Fluid Database Unveiled*, Billings Gazette, (Apr. 11, 2011), http://billingsgazette.com/news/state-and-regional/wyoming/national-fracking-fluid-database-unveiled/article_6088c631-669b-537e-bb39-c0a0b48799eb.html.

272. Howard & Fast, *supra* note 12.

273. Alfred R. Jennings, Jr., *When Fracturing Doesn't Work* 2 (Soc'y of Petroleum Eng'rs, SPE 71657, 2001), *available at* http://www.onepetro.org/mslib/servlet/onepetropreview?id=00071657.

274. Alfred R. Jennings, Jr., *Fracturing Fluids—Then and Now*, 48 J. Petroleum Tech. 604 (1996).

275. Yergin, *supra* note 23; Silver, *supra* note 34; Waters et al., *supra* note 23.

practice might interact with host materials.[276] There are numerous "chemical and physical reactions that can occur in the open wellbore, induced fractures, natural fractures, and the surrounding matrix . . . as a result of interactions between fracture fluids and the geologic target formations during the hydraulic fracturing process."[277] For instance, formation waters are variable within and between formations, including concentration levels of the most common VOCs and semi-VOCs.[278] Likewise, drilling and hydraulic fracturing "causes fluid-rock interactions that have the potential to mobilize heavy metals," such as barium, uranium, chromium, and zinc, that are naturally enriched in the shale formation.[279] However, the only way to determine the extent to which these heavy metals are mobilized during fluid-rock reactions is to perform extraction studies "using a measured mass of ground and sieved shale and a known volume of chemical extractant."[280]

Although many reactions in wells are subject to normal catalytic and restriction influences, others are subject to "a set of specific limiters that are found in few other places in [the] chemical industry."[281] For instance, the influences of temperature and pressure are reasonably predictable, but "other reaction controls such as reaction rate are strongly influenced by the area and mixing constraints described by the location of the reaction, the area-to-volume ratio and the behavior and stability of the byproducts," all of which can only be assessed by putting the products in question to use in real-world settings.[282] Similarly, "degradation reactions" related to well construction and pipe and cement stability cannot be easily assessed, even with formation access.[283] "Re-precipitation compounds" must also be considered.[284] Again, given the many complexities and uncertainties involved, such interaction hazards can only be assessed in the field during actual hydraulic fracturing

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276. U.S. Envtl. Prot. Agency, EPA/600/R-11/122, Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources 40 (Nov. 2011).

277. U.S. Envtl. Prot. Agency, EPA/600/R-11/066, Proceedings of the Technical Workshops for the Hydraulic Fracturing Study: Chemical & Analytical Methods 10 (May 2011).

278. Nancy Pes Coleman, *Produced Formation Water Sample Results from Shale Plays*, U.S. Envtl. Prot. Agency, http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/producedformationwatersampleresultsfromshaleplays.pdf (last visited Mar. 1, 2013).

279. Tracy L. Bank, *Trace Metal Geochemistry and Mobility in the MarcellusShale*, U.S. Envtl. Prot. Agency, http://www.epa.gov/hfstudy/tracemetalgeochemistryandmobilityinthemarcellusformation1.pdf (last visited Mar. 1, 2013).

280. *Id.*

281. George E. King, *Fracture Fluid Additive and Formation Degredations*, U.S. Envtl. Prot. Agency, http://www.epa.gov/hfstudy/fracturefluidadditivesandformationdegradations.pdf (last visited Mar. 1, 2013).

282. *Id.*

283. *Id.*

284. *Id.*

processes; mere knowledge of the hydraulic fracturing products and procedures would not be sufficient.

Another challenge to assessing any potential environmental and health hazards is obtaining representative samples.[285] For instance, the only way to determine whether some materials are present or not (e.g., endocrine disruptors and carcinogens) is through analytical tests conducted directly on flowback waters.[286] Additionally, "because fluids will undergo physical, chemical, and/or biological changes as they are moved from a geologic reservoir to the surface, sampling and preservation techniques affect the results."[287] To further complicate matters, the composition of fluid varies nonlinearly with flowback progress, necessitating time-series sampling.[288] Other analyses can only be carried out through "sub-sampling at the wellhead based on analyte."[289] Additionally, in the case of volatiles and reactive species, speed is important, and some samples may need to be processed within forty-eight hours.[290] Other samples may need to be preserved under well conditions.[291] But even such unfettered access may not be sufficient: "Many standard analytical methods apply to the analysis of [hydraulic fracturing] fluids and flowback water samples. However, they will perform poorly in some cases involving high levels of interferents."[292]

Again, all of these requirements suggest that hydraulic fracturing fluid disclosure is not sufficient to assess the concerns that have been raised about the practice. Rather, hydraulic fracturing products may need to be assessed in action. Given an "absence of rigorous data" on the migration of hydraulic fracturing fluids, the Department of Energy recently proposed conducting a field experiment in which tracers would be used to assess whether the fluids migrate from the target production formation into drinking water aquifers.[293]

As the level of IP related to hydraulic fracturing increases, more than simple disclosure is needed. Not only must the processes and products used be disclosed, third-party access to these processes and products—for noncommercial purposes—must also be made available. Without the ability to

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285. *Id.* at 85.
286. *Id.* at 13.
287. *Id.* at 85.
288. *Id.*
289. U.S. Envtl. Prot. Agency, EPA/600/R-11/066, Proceedings of the Technical Workshops for the Hydraulic Fracturing Study: Chemical & Analytical Methods 86 (May 2011).
290. *Id.*
291. *Id.* at 87.
292. *Id.* at 97.
293. Daniel J. Soeder, Jr., *Design and Rationale for a Field Experiment using Tracers in Hydraulic Fracture Fluid*, U.S. Envtl. Prot. Agency (Mar. 10–11, 2011), http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/designandrationaleforafieldexperimentusingtracersinhffluid.pdf.

analyze the consequences of specific products and processes, the disclosure of their use is largely inconsequential.

Witnesses at a hearing of the U.S. Senate Environment and Public Works Committee testified that "strong state enforcement programs are essential to ensure that drinking water supplies are protected as more natural gas is produced from tight shale formations," prompting some lawmakers to suggest "that a bigger federal role might be necessary if states fall short."[294]

F. *Patents Are More Prominent in Modern Gas Extraction*

The need for active experimentation to obtain information is a critical issue if the material in question is under patent. As stated above, the use of patented compounds impacts two of the patent owner's fundamental rights of exclusivity: making and using the invention.[295] A third party interested in investigating the impact of fracturing fluids on the environment or evaluating issues beyond discrete chemical composition (such as interactions between different chemicals) will need to make use of the patented materials. Without a license, it is unlikely that any exception in patent law would excuse such activity from infringement. A patentee can assert its rights to control testing and experimentation, and thereby shape the information environment.

If patents can pose such an important barrier, why have they not been identified as an issue to date? It appears that the application of patents as a significant information barrier is a relatively new phenomenon in gas extraction. In the past, conflicts between patent rights and information generation were relatively unlikely to occur because the number of patents related to fracturing compounds and methods was small, and entities that would be inclined to make infringing use of the materials existed primarily in industry. The primary concern on the part of patent owners would be restricting competition rather than controlling the public exposure of information. However, patent factors have changed, placing the focus more squarely on property rights as a potential barrier.

Strategically, there appears to have been a shift in the perceived importance of patents. Such rights related to hydraulic fracturing have increased over the last twenty years. Companies have obviously become more aware of the utility of protecting intellectual property, and among businesses in general, there is a greater effort to capture rights as part of overall research and development investments.

G. *Patents Emerge as the Paradoxical Information Constraint*

With the increased ownership of patents and consequential ability of companies to assert them as a downstream information-control mechanism,

294. Snow, *supra* note 54.
295. 35 U.S.C. § 271 (2011).

patents can become the very antithesis of their statutory intent. Although they may initially provide important disclosure of aspects of hydraulic fracturing materials, they become functionally more important as a constraint. This is true even if information control was not a primary motivator in obtaining the patents in the first place. A company that reflexively patents or even seeks patents as a market exclusion device may find itself with tremendous power to protect sensitive information. One would expect that such a company would be more likely to employ restrictive licensing terms in order to preserve the option of exploiting the value of downstream information.

Perhaps even more interesting is the fact that patents can be expected to play a greater role in information constraint in the future. As noted above, the pressure to disclose more about fracturing chemicals is increasing.[296] Searchable databases will likely become available and the nature of the extraction materials used will become more public.[297] And, the more that basic information disclosure is required, the more likely it is that patents will be used to lock up secondary information production.

This seeming paradox of increased information disclosure rules resulting in more contracts is a consequence of opposing levers. As one method of protecting information—trade secrecy—becomes less viable, fracturing innovators will be more likely to pursue downstream protection over uses through patents. Such disclosure will essentially eliminate much of the protection that is now provided by trade secret law. The loss is not likely to be stemmed by the argument that forced disclosure is a taking of property, as it has been recognized that voluntary disclosure of information to government agencies does not implicate constitutional protections.[298] As we craft additional rules to compel disclosure, companies will be expected to employ patents more frequently as a means to lock up information. And the increasing population of patents suggests that this ability to restrict information dissemination already exists.

IV. Options for Addressing Information Limitation

The concern that patents can be used as a means of information limitation in highly sensitive fields like gas extraction suggests a need for reform. As with any other federally created property system, the law can be changed on a national scale to curtail rights and increase openness. Two obvious routes for reform would be to create a legislative exception for experimental use related to safety or to broaden the boundaries of the judicially created doctrine through the courts. However, success through these routes is not

296. *See supra* note 9 and accompanying text.

297. *See, e.g.*, *What Chemicals Are Used*, Frac Focus, http://fracfocus.org/chemical-use/what-chemicals-are-used (last visited Apr. 26, 2012).

298. Ruckelshaus v. Monsanto Co., 467 U.S. 986, 1006 (1984) (no investment-backed expectation of secrecy when submission was voluntary and on notice of government's authorization to use and disclose).

guaranteed. Legislative reform faces constitutional obstacles that render it ineffective in the short term. Doctrinal reform is discretionary, and the judiciary has not shown any inclination to revisit experimental use since *Madey*.

If there is a ray of hope, it is the fact that patent exclusion is not automatic. The nature of the litigation process, as well as the likely defendants involved, provide some flexibility for retaining information flow. Before overreacting to patent obstacles, it is important to appreciate current options and identify the actors with flexibility. In the end, creating awareness of the problem of patent restriction will likely be the most effective means of ensuring that the threat of strong patents does not encumber necessary research.

A. *Legislative Revision of Rights Is Direct but Faces Obstacles*

Congress has the power to create an exception for experimental uses that would cover safety investigations, quality assurance or even competitor research and development. Such an exception would not need to be justified as "non-commercial" to be enforceable, but could serve any purpose related to promoting the progress of the useful arts.[299] This is essentially what occurred in 1984 with the passage of the Hatch-Waxman Act, creating rules for pharmaceutical regulation that included a research exception for submissions to the FDA.[300] This limitation on rights is known as the *Bolar* exemption in reference to its overruling of a Federal Circuit case, *Roche Products, Inc. v. Bolar Pharmaceutical Co.* that found no infringement relief for clinical testing in preparation for generic drug applications.[301] The rule is facially commercial in furtherance of its public mission. Essentially, Congress created an exception to permit generic pharmaceutical companies to have an approved drug ready to market as soon as the patent expires.[302] This reduces patent owner profitability and creates a more favorable environment for competitors, but it does so for an important social goal. The *Bolar* exception does not affect patentability; rather, it simply carves out part of the patent owner's enforcement rights.

Similarly, in 1996 an exception was enacted that limited the enforcement of patents on surgical procedures.[303] The exception was specifically

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299. The courts have generally given Congress great freedom to craft law under the Constitution's intellectual property clause, U.S. Const. art. I, § 8, cl. 8, even if the innovation benefits are not clear. *See* Golan v. Holder, 132 S. Ct. 873, 889 (2012) (detailing the deference Congress must receive related to the copyright aspects of the intellectual property clause). Thus, the argument that a particular exemption is unconstitutional because it is too broad or reduces inventions incentives is not viable.

300. 35 U.S.C. § 271(e) (2011).

301. Roche Products, Inc. v. Bolar Pharm. Co., Inc., 733 F.2d 858, 863 (Fed. Cir. 1984).

302. *See* Gerald J. Mossinghoff, *Overview of the Hatch-Waxman Act and Its Impact on the Drug Development Process*, 54 Food & Drug L.J. 187, 190 (1999) (describing the intent of the law to overrule *Bolar* and its impact on the regulatory system).

303. 35 U.S.C. § 287(c) (2011).

directed to physicians and their places of practice[304] to address the concern that the threat of litigation would compromise medical care.[305] As with pharmaceutical patents, the basic enforceability of the right was left in place.

More radical would be an attempt to prospectively eliminate the patenting of technology related to hydraulic fracturing, or even fracturing fluids specifically. This tactic raises obvious problems with respect to impacting important incentives to innovate in the field as well as international obligations to issue patents in a manner that does not discriminate against certain technologies.[306] The recent legislation to declare tax strategies part of the prior art is an example of one possible way to thread the needle on technology preclusion,[307] but its effectiveness is yet to be determined. In any case, the downsides of patent elimination make carving out a small exception the far more preferable reform path.

The major limitation with any legislative reform is that an enactment that reduces or eliminates existing property rights may run afoul of the Fifth Amendment unless compensation is provided.[308] A classic example of how this can derail an exception was Congress's attempt to prevent DataTreasury from enforcing its patent rights related to check processing.[309] The Congressional Budget Office determined that such an exception would constitute a

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304. *Id.* (creating an exception specifically for a "medical practitioner" or "related health care entity").

305. *See* Leisa Talbert Peschel, *Revisiting the Compromise of 35 U.S.C. § 287(c)*, 16 Tex. Intell. Prop. L.J. 299, 306–09 (2008) (relating the history of the Act and the outrage that spawned it).

306. Agreement on Trade-Related Aspects of Intellecutal Property Rights, art. 27, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299, 33 I.L.M. 1197 (1994) (applies to countries that are members of the World Trade Organization and prevents discrimination in granting inventions by field of technology, with certain exceptions), *available at* http://www.wto.org/english/tratop_e/trips_e/t_agm0_e.htm.

307. Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 14(a), 125 Stat. 284, 327 (2011).

308. U.S. Const. amend. V. To be fair, there is some ambiguity regarding to what extent patents are protected by the Fifth Amendment. In 2006, the Federal Circuit issued a per curiam opinion in *Zoltek Corp. v. United States*, 442 F.3d 1345 (Fed. Cir. 2006), holding that infringement claims against the government were not actionable as Fifth Amendment claims under the Tucker Act, but only under 35 U.S.C. § 1498. *Id.* at 1352–53. For many, this case stood as a clear pronouncement of the limited nature of patents as constitutional property. *See, e.g.*, Adam Mossoff, *How the "New GM" Can Steal from Toyota*, 13 Green Bag 2d 399, 403–04 (2010). However, the *Zoltek* opinion was vacated by a later decision in the case that rendered moot the decision on Fifth Amendment protections. Zoltek Corp. v. United States, 672 F.3d 1309, 1317–18 (Fed. Cir. 2012) (en banc). Thus, the argument is still viable in the courts. *Id.* at 1327 ("Since the Government's potential liability under § 1498(a) is established, we need not and do not reach the issue of the Government's possible liability under the Constitution for a taking.").

309. S. Rep. No. 110-259, at 51 (2007).

taking, requiring the government to pay approximately $1 billion to DataTreasury as compensation.[310] The provision never became law.

Congress generally avoids the constitutional issue by ensuring that any reduction of rights applies prospectively. For example, the surgical procedure enforcement exception applied to patents issued after the date of the enactment.[311] Similarly, the AIA's prohibition against claims "directed to or encompassing a human organism" did not apply to existing patents.[312] However, a prospective application means that all existing patents are available to act as information-containment devices. This severely curtails the effectiveness of congressional action to address a problem related to patent power.

A second limitation with any legislative reform is the difficulty in identifying the proper scope of an exception. Broadly eliminating liability for safety testing, for example, could inadvertently immunize competitors seeking a commercial advantage in developing competing products. The aforementioned *Bolar* exception is nicely cabined with the requirement that the experimental use be "reasonably related to the development and submission of information under a Federal law [that regulates drugs or biologics]."[313] However, a similar limit on infringement liability in the context of hydraulic fracturing is not possible since much third party generated safety information would have no relation to a federal submission. Without a doubt, the effort to identify the proper industry to be targeted, the actors who should be immunized, and the language that captures the appropriate uses would be subject to significant debate. Ultimately, the effort to create a circumscribed exception acceptable to business, regulators, and public interest groups would very likely stall.

B. *Judicial Reform Is Unlikely to Provide Immediate or Broad Relief*

The courts could respond to the deficiencies in the experimental use exception by articulating an increased safety dimension or distinguishing the use by Duke University in *Madey* as more commercial than typical university research.[314] The ability to expand the doctrine's boundaries is solidly within the court's domain. Moreover, to the extent that the current rule is

310. Jeffrey H. Birnbaum, *Lawmakers Move to Grant Banks Immunity Against Patent Lawsuit,* Wash. Post, Feb. 14, 2008, at A22; *see also* Christopher S. Storm, *Federal Patent Takings*, 2 J. Bus. Entrepreneurship & L. 1, 28–29 (2008) (describing the Data Treasury dispute and interpreting the Congressional Budget Office report in light of the 2006 decision in *Zoltek*).

311. 35 U.S.C. § 287(c)(4) (2011).

312. Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 33(a), 125 Stat. 284, 340 (2011).

313. 35 U.S.C. § 271(e) (2011).

314. See Madey v. Duke Univ., 307 F. 3d 1351, 1352–53 (Fed. Cir. 2002), where the court describes Duke's use of Madey's patented laser as the basis for a center supported by grants. Although the opinion clearly categorizes student education and even university reputa-

ambiguous against the historic treatment of the doctrine, further articulation would provide an opportunity for the courts to add predictability to the law.

In favor of a judicial route to reform is the fact that courts have an advantage over the legislature in that the constitutional property restraints do not apply. The Supreme Court has found that judicial revisions of the law must apply retroactively.[315] The majority of the Court has so far declined to hold that such decisions that impact property would affect a taking.[316] As such, there is no clear path for pursuing a Fifth Amendment case against the government for a judicial act that reduces rights by broadening experimental use to protect information production.

Still, courts face the same obstacles as legislatures in articulating a new rule that is properly positioned to increase information flow while preserving innovation.[317] That difficulty is compounded by the fact that a sufficiently broad case must arise for review, and indications suggest that both patent owners and potential defendants will be reluctant to litigate.[318] Moreover, the Federal Circuit has shown no inclination to revisit experimental use in the wake of much academic commentary.[319] Thus, it seems that revision through the courts is potentially no more viable than legislation as a means of immediately impacting the information environment.

C. *Existing Equitable Limitations on Injunctions Provide an Opening*

Perhaps the greatest hope for ensuring information flow is making use of the existing flexibility in the current patent litigation system. As it stands now, full exclusion of information production may be hard to achieve in practice. The current environment for injunctive relief is more limited and presents a solid opportunity for relief based on a social policy argument.

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tion as commercial, *id.* at 1362, the court could pare the doctrine back by focusing on use that increases income or an actor's funding.

315. Harper v. Va. Dep't of Taxation, 509 U.S. 84, 97 (1993).

316. In *Stop the Beach Renourishment, Inc. v. Florida Dep't of Environmental Protection*, 130 S.Ct. 2592, 2601 (2010), only three members of the Court joined Justice Scalia in asserting that judicial decisions can constitute a taking.

317. *See* Elizabeth A. Rowe, *The Experimental Use Exception to Patent Infringement: Do Universities Deserve Special Treatment?*, 57 Hastings L.J. 921, 949–51 (2006) (describing how difficult it is to find agreement on the scope of an increased experimental use exception in the wake of *Madey*).

318. *See id.* at 942–44 (detailing reasons that universities are generally less likely to be sued for patent infringement); Rebecca S. Eisenberg, *Noncompliance, Nonenforcement, Nonproblem? Rethinking the Anticommons in Biomedical Research*, 45 Hous. L. Rev. 1059, 1098 (2008) (after reviewing several surveys of university researchers, concluding that scientists "rarely face patent enforcement").

319. The Federal Circuit declined to extend common law experimental use to cover research outside of the 271(e) exemption in *Integra Lifesciences I, Ltd. v. Merck KGAA*, 331 F.3d 860, 863 n.2 (Fed. Cir. 2003), *vacated on other grounds*, 545 U.S. 193 (2005). The court has not considered the issue subsequently.

Potential defendants should be aware of these limitations before capitulating to cease and desist demands.

Until recently, a patent owner who established infringement could expect to obtain an injunction relatively automatically. That changed as a result of the Supreme Court's decision in *eBay v. MercExchange*.[320] In that case involving a patent holding company's assertion that eBay, an Internet auction service, should be enjoined from infringement, the Court emphasized the fact that injunctions are equitable remedies that can be applied only when necessary to prevent irreparable harm and when legal remedies are deemed inadequate.[321] That standard may be difficult to surmount when the alleged harm relates primarily to information disclosure. In the abstract, most parties making use of fracturing patents will not compete with the patent owners or damage the market for the products. A court would be very likely to conclude that a royalty is the preferred remedy.

Of course, a royalty fee can still be a significant disincentive to use. This is particularly the case when one factors in litigation costs. In these times of tight budgets, a university or public interest group may be disinclined to take the risk of infringing a patent, and may be unable to prospectively enter into a license. Absent additional limiting factors, a remedy at law can be a significant deterrent that will constrain the information environment.

D. *Sovereign Immunity Opens Even Broader University Powers*

The fact that damages will be the most likely result of litigation leads to one more important limitation on patent rights that could act as a saving grace: sovereign immunity. This is a broad doctrine recognizing that governments are generally immune from lawsuits unless they waive immunity and agree to the jurisdiction of a court.[322] In the context of patents, state immunity from suit in federal court is the most important application of this doctrine.[323] By statute, litigation arising under the Patent Act must take place in federal court.[324] States are immune from such actions as a result of the Eleventh Amendment to the U.S. Constitution. The Eleventh Amendment, which was adopted to overrule a 1793 Supreme Court decision declaring that states

320. eBay Inc. v. MercExchange, L.L.C., 126 S. Ct. 1837 (2006).

321. *Id.* at 391–92.

322. *See* Katherine Florey, *Sovereign Immunity's Penumbras: Common Law, "Accident," and Policy in the Development of the Sovereign Immunity Doctrine*, 43 Wake Forest L. Rev. 765, 771–82 (2008) (providing an overview of the development of state, federal tribal and foreign sovereign immunity doctrine in the United States).

323. Although the federal government has the right to invoke immunity from patent lawsuits as well, this immunity is specifically waived by 28 U.S.C. § 1498 (2011).

324. 28 U.S.C. § 1338 (2011); Gunn v. Minton, 133 S.Ct. 1059, 1064 (2013).

are subject to suit in federal court by citizens of other states,[325] explicitly precludes private patent lawsuits unless a waiver is granted.[326]

State immunity is not ironclad, and can be abrogated by statute if based in a congressional power granted subsequent to the Eleventh Amendment's passage.[327] In fact, Congress specifically attempted to abrogate patent litigation immunity in 1992 with the Patent and Plant Variety Remedy Clarification Act,[328] grounding its power in part on the Fourteenth Amendment's due process clause related to property.[329] However, the Supreme Court in *Florida Prepaid Postsecondary Education Expense Board v. College Savings Bank* declared the abrogation invalid.[330] According to the Court, Congress identified no pattern of constitutional violations under the Fourteenth Amendment that justified abrogation.[331]

As a result of the *Florida Prepaid* decision, state governments and their instrumentalities (including universities) are immune from patent infringement lawsuits. This fact creates some asymmetry because states are not passive observers in the intellectual property world. State universities hold significant portfolios of patent rights and they pursue infringers in federal court.[332] Thus, states currently have the power to use the federal courts to enforce their rights but they are protected from others' rights.[333] Bills that

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325. *See* John Randolph Price, *Forgetting the Lyrics and Changing the Tune: The Eleventh Amendment and Textual Infidelity*, 104 Dick. L. Rev. 1, 20–25 (1999) (providing the historic context of the adoption of the Eleventh Amendment in response to the decision in *Chisholm v. Georgia*, 2 U.S. (2 Dall.) 419 (1793)).

326. *See, e.g.*, A123 Sys., Inc. v. Hydro-Quebec, 626 F.3d 1213, 1219–20 (Fed. Cir. 2010) (finding that the University of Texas held sovereign immunity from participation in patent litigation, and such immunity was not waived by participation in another suit involving the same patents).

327. The Supreme Court ruled in *Seminole Tribe v. Florida*, 514 U.S. 44 (1996), that Congress cannot abrogate immunity based on Article I powers. Thus, the patent clause, U.S. Const., art. 1, § 8, cl. 8, cannot serve as a basis for abrogation. Conversely, the Court found abrogation could be properly based on § 5 of the Fourteenth Amendment. *Id.* at 59.

328. Pub. L. 102-560, 106 Stat. 4230 (1992) (codified at 35 U.S.C. § 271(h) (2011)).

329. *See* S. Rep. No. 102-280, at 7–8 (1992); H.R. Rep. No. 101-960, at 39–40 (1990).

330. Fla. Prepaid Postsecondary Educ. Expense Bd. v. Coll. Sav. Bank, 527 U.S. 627, 645–47 (1999).

331. *Id.*

332. *See* Jacob H. Rooksby, *University Initiation of Patent Infringement Litigation,* 10 J. Marshall Rev. Intell. Prop. L. 623, 661–62 (2011) (analyzing 57 university-lawsuits filed during 2009–2010 and extrapolating that universities initiated roughly 285 lawsuits in the previous decade); Jacaonda Wagner, *Patent Trolls and the High Cost of Litigation to Business and Start-Ups—A Myth?,* Md. B.J., Sept./Oct. 2012, at 12, 14–15 (2012) (citing evidence that state universities own many patents and filed 139 patent infringement lawsuits between 2000 and 2008).

333. *See* Michael Landau, *State Sovereign Immunity and Intellectual Property Revisited*, 22 Fordham Intell. Prop. Media & Ent. L.J. 513, 553 n.214 (2012) (listing cases in which state entities have been granted immunity from patent infringement).

make another attempt at abrogation have surfaced in Congress from time to time.[334] But to date, none have succeeded.

Given state immunity, universities should have much more freedom to conduct basic research using a patented invention, even if the research involves making patented compounds. Materials received via a license could be more restricted, but one might argue that the damages flowing from a breach of such a license would be minimal due to the inability to collect damages in court.[335]

One interesting twist in this area of the law is that universities could potentially face a greater likelihood of injunction. While the traditional injunction test would not be applicable due to state immunity, the doctrine of *Ex Parte Young*[336] could be used to stop prospective infringement.[337] *Ex Parte Young* permits a government official to be enjoined for a violation of federal law, including patent infringement.[338] It is unclear whether *Ex Parte Young* would apply when the traditional injunction test under *eBay* is not satisfied, but there is at least an argument for different treatment. In any case, courts have been reluctant to impose an injunction on university officials when they have not closely acted to support the infringement.[339]

An open question regarding state governments and patents is whether the Constitution provides an additional litigation pathway under the takings clause. As noted above, there is still debate about the extent to which patents are Fifth Amendment (extended to state governments under the Fourteenth Amendment) property. If they are so characterized, state universities could theoretically be sued in state court for a taking of property or inverse condemnation rather than patent infringement.[340] While liability for such a case is not guaranteed and depends very much on how a state waives its sovereign immunity for takings claims, it is a consideration that should be incorporated into the assessment of flexibility.

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334. *Id.* at 560–61.

335. *See, e.g.*, Bowers v. Baystate Techs., Inc., 320 F.3d 1317, 1325–26 (Fed. Cir. 2003) (noting that one might elect to efficiently breach a license that prevented a use not otherwise protected under law and pay minimal damages).

336. *Ex parte* Young, 209 U.S. 123 (1908).

337. Frew *ex rel.* Frew v. Hawkins, 540 U.S. 431, 437 (2004).

338. Pennington Seed, Inc. v. Produce Exch. No. 299, 457 F.3d 1334, 1341 (Fed. Cir. 2006).

339. *Id.* at 1342–43; Wesley D. Greenwell, Note, *State Immunity from Patent Infringement Lawsuits: Inverse Condemnation as an Alternative Remedy*, 63 S.C. L. Rev. 975, 984 (2012).

340. Daniel R. Cahoy, *Patent Fences and Constitutional Fence Posts: Property Barriers to Pharmaceutical Importation*, 15 Fordham Intell. Prop. Media & Ent. L.J. 623, 676–76 (2005) (describing state liability for takings of patent rights and listing cases); Greenwell, *supra* note 339, at 998–99 (advocating the use of state takings claims as an alternative to subjecting states to federal patent infringement actions).

Conclusion

The patent system has traditionally been viewed as a means for disseminating information as much as providing an incentive to innovate. Rapid information disclosure has traditionally been viewed as part of the bargain with the patentee. However, when reproduction or use of the patented invention is necessary to understand how it impacts the rest of the world, patent rights can actually serve as a barrier. This information limitation problem is particularly apparent in hydraulic fracturing technology. The great need for third-party experimentation combined with the lack of an effective experimental use exception has resulted in the unexpected emergence of patents as a means to keep secrets. This problem is not limited to hydraulic fracturing and is worth considering as a general issue of patent policy.

Before engaging in the wholesale reform of patent rights, policy makers should examine the relief options that already exist. Certain actors, specifically public universities, possess greater flexibility in avoiding liability. Fully appreciating the intellectual property issues and prospectively planning a response may avoid many of the most negative impacts of information containment.