Hydraulic Fracturing and Information Forcing

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I. INTRODUCTION

The recent, dramatic rise of drilling and hydraulic fracturing for domestic oil and natural gas has highlighted the fact that the United States remains, in certain regions, an industrial economy. In states like North Dakota, there were more active oil wells in 2012 than ever before in the state's history.[1] Two practices are driving this boom in many areas of the United States: horizontal drilling through shales and tight sandstones and the use of slickwater hydraulic fracturing—the pumping of large quantities of water and smaller quantities of chemicals down wells at high pressures.[2]

Natural resource extraction has long driven portions of the U.S. economy, but the recent growth in unconventional oil and gas has led to vocal demands for more and better information.[3] This unusually strong call for data may result from several factors. First, unconventional petroleum development is widespread, with large numbers of wells being drilled in many regions, from North Dakota and Pennsylvania to Arkansas, Louisiana, Colorado, and Texas,

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1 *See* N.D. DEP'T OF MINERAL RES., NORTH DAKOTA NEW WELL PERMITS ISSUED 3, http://www.ndoil.org/image/cache/NDPCAnnual092111_2.pdf (showing more new well permits issued post-2010 than ever had been issued (since 1950)).

2 *See* N.Y. STATE DEP'T OF ENVTL. CONSERVATION, REVISED DRAFT SUPPLEMENTAL GENERIC ENVIRONMENTAL IMPACT STATEMENT ON THE OIL, GAS, AND SOLUTION MINING REGULATORY PROGRAM 5-91, 5-93 to 5-94 (2011), http://www.dec.ny.gov/docs/materials_minerals_pdf/rdsgeisch50911.pdf (describing fracturing).

3 *See, e.g.*, *Written and Emailed Public Comments on Proposed Fracturing Rules*, MONT. DEP'T OF NATURAL RES. CONSERVATION, http://bogc.dnrc.mt.gov/PDF/CombinedComments.pdf (last visited June 2, 2013) (showing a number of citizen requests for the disclosure of chemicals used in hydraulic fracturing); *Petitions and Sign-On Letters Submitted as Comments on DRBC's Proposed Natural Gas Development Regulations*, DEL. RIVER BASIN COMM'N, http://www.nj.gov/drbc/library/documents/NGC/petitions_sign-on-letters_summary.pdf (last updated Nov. 28, 2011) (showing petitions and sign-on letters making similar requests).

among other states.[4] And the promise (or threat, depending on one's perspective) of abundant unconventional fuel reaches farther. California might have even larger shale oil reserves than North Dakota,[5] and oil and gas companies are still ascertaining the quantities of gas in the Utica Shale underlying Ohio, New York, and other nearby states.[6] Still other states are feeling the indirect effects of this boom, with Minnesota and Wisconsin experiencing extensive sand mining,[7] which provides the proppant that holds open fractures in formations once they are created.

Unconventional oil and gas development also involves large numbers of small facilities—thousands of several-acre sites,[8] some of which are, literally, in people's backyards.[9] The sheer number of wells contributes to habitat

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4 *See* ALOULOU FAWZI, U.S. ENERGY INFO. ADMIN., SHALE GAS AND TIGHT OIL DEVELOPMENT IN THE U.S., POLAND AND THE REST OF THE WORLD: STATUS AND OUTLOOK 3 (2013), http://www.usea.org/sites/default/files/event-/Shale_Gas_3_EIA_Aloulou_Fawzi.pdf (showing the areas of dramatic recent rises in production of shale gas and tight oil, both of which are unconventional resources).

5 U.S. ENERGY INFO. ADMIN., REVIEW OF EMERGING RESOURCES: U.S. SHALE GAS AND SHALE OIL PLAYS 4 (2011), http://www.eia.gov/analysis/studies/usshalegas/pdf/usshaleplays.pdf ("The largest shale oil formation is the Monterey/Santos play in southern California, which is estimated to hold 15.4 billion barrels or 64 percent of the total shale oil resources" in the United States.).

6 *See, e.g.*, LARRY WICKSTROM ET AL., OHIO DEP'T OF NATURAL RES., THE UTICA-POINT PLEASANT SHALE PLAY OF OHIO 20–24 (2012), http://www.dnr.state.oh.us/portals/10/energy/Utica-PointPleasant_presentation.pdf (showing many acres leased but the first horizontal drilling in the Utica occurring only in 2010, and noting that the shale play is still in early stages of development).

7 *See Frac Sand Mining*, MINN. POLLUTION CONTROL AGENCY, http://www.pca.state.mn.us/index.php/air/air-quality-and-pollutants/air-pollutants/frac-sand-mining.html (last modified Apr. 23, 2013) (describing "extensive deposits of sand that meets the specifications required for fracking" in Minnesota and Wisconsin); WIS. DEP'T OF NATURAL RES., SILICA SAND MINING IN WISCONSIN 3 (2012), http://dnr.wi.gov/topic/Mines/documents/SilicaSandMiningFinal.pdf (describing "60 mining operations involved in extraction of frac sand and approximately 30 processing facilities operating or under construction," as well as "20 new mining operations" proposed).

8 For surface disturbance estimates, see N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 2, at 5-6.

9 In some respects, unconventional development is more efficient than conventional extraction because operators can drill wells horizontally underground for thousands of feet. This reduces the number of wells at the surface that must be drilled to produce the same amount of petroleum. But unconventional formations still require thousands of wells to be economically exploited. For an example of wells sometimes being in people's backyards, see, for example, CITY OF FORT WORTH, GAS DRILLING REVIEW COMMITTEE MEETING NOTES 10–11 (2012), http://fortworthtexas.gov/uploadedFiles/Gas_Wells/GDRC/12_June_GDRC.pdf (describing one resident's comments about a well in Fort Worth proposed near his backyard); *Applications and Permits*, CITY OF FORT WORTH, http://fortworthtexas.gov/gaswells/default.aspx?id=50608 (last visited June 2, 2013) (showing 1,832 producing gas wells within city limits).

fragmentation and threatens the contamination of soil, water resources, and air[10] in the many areas in which drilling and fracturing are now occurring. It also may call more attention to this industry as energy companies develop wells in rural, suburban, and urban communities.[11]

As drilling and fracturing have grown, often visibly, certain groups have demanded more information relating to environmental and health concerns.[12] Drilled gas or oil wells can leak methane into underground and surface water supplies if the wells are improperly "cased" (lined with steel tubing and cement).[13] Surface pits that hold drilling and fracturing wastes can cause chemicals to leak into soil and surface or underground water sources.[14] Fracturing chemicals can also spill during transport or while being transferred to the well, among other risks.[15] If we are to fully understand these types of risks, we need to identify environmental degradation and to measure existing constituents in water, soil, and air—whether naturally occurring or caused by previous development— before widespread drilling and fracturing occurs. Indeed, energy companies often drill and fracture wells in areas that have previously experienced mining or other natural resource extraction, or other activity that can contribute to environmental and health-based problems.[16] Better baseline data on contamination will allow scientists to identify the type and extent of the impacts of the unconventional oil and gas boom and agencies to implement better substantive regulations to prevent and mitigate them. It will also provide needed evidence for the courts, where damages caused by oil and gas drilling have been difficult to prove so far.[17]

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[10] *See, e.g.*, NAT'L PARK SERV., POTENTIAL DEVELOPMENT OF THE NATURAL GAS RESOURCES IN THE MARCELLUS SHALE 16–17 (2008), http://www.nps.gov/frhi/parkmgmt/upload/GRD-M-Shale_12-11-2008_high_res.pdf (noting these and other potential impacts).

[11] *See supra* note 9.

[12] *See supra* note 3.

[13] *See* Hannah J. Wiseman, *Risk and Response in Fracturing Policy*, 84 U. COLO. L. REV. (forthcoming 2013) (manuscript at 153–54), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2017104 (describing methane contamination incidents).

[14] *See, e.g.*, N.M. OIL CONSERVATION DIV., CASES WHERE PIT SUBSTANCES CONTAMINATED NEW MEXICO'S GROUND WATER (2008), http://www.emnrd.state.nm.us/ocd/documents/GWImpactPublicRecordsSixColumns20081119.pdf.

[15] *See* Wiseman, *supra* note 13, at 132–33, 138–40 (describing spills).

[16] *See, e.g.*, John A. Harper, *The Marcellus Shale—An Old "New" Gas Reservoir in Pennsylvania*, 38 PENN. GEOLOGY 2, 2–3 (2008), http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_006811.pdf (describing gas drilling in Pennsylvania that preceded the current Marcellus boom).

[17] *See* SMITA WALAVALKAR, COLUMBIA CTR. FOR CLIMATE CHANGE LAW, DIGEST OF HYDRAULIC FRACTURING CASES (2013), http://www.law.columbia.edu/null/download?&exclusive=filemgr.download&file_id=622373 (showing no cases in which plaintiffs have received damages for contamination). *But see*, E. RES., INC., DELCIOTTO NO. 2, SUBSURFACE NATURAL GAS RELEASE REPORT: ROARING

The calls for more and better information in unconventional petroleum development might finally inspire real reform in the field of information forcing regulation in oil and gas. This, in turn, could aid other efforts to fill in the major data gap in environmental regulation.[18] Baseline surveys of existing pollution, including air, water, and soil resources conducted prior to energy development, and testing after the initiation of development, could allow us to identify a variety of impacts caused by industrial activity—not just drilling and fracturing.

This short essay explores three ways in which unconventional petroleum development has begun to force the systematic production and recording of data, which could lead to broader information forcing efforts. Part I provides examples of efforts to collect baseline contamination data in certain regions and around well sites, and Part II discusses certain requirements for disclosure during development, including disclosure of the chemicals and quantities and sources of water used in hydraulic fracturing. Readers should note that this is not a comprehensive regulatory survey. Rather, it provides limited examples of some states' requirements. Finally, Part III briefly introduces post-development sampling and studies of the impacts of drilling and fracturing. The essay concludes that much more must be done if we are to systematically and effectively measure the impacts of the unconventional petroleum boom, but that the boom may inspire broader information forcing reforms. Particularly where large baseline surveys are conducted, this could aid other efforts to identify the causes of contamination, beyond oil and gas drilling. And the proliferation of thousands of new oil and gas sites might lead us to finally implement widespread automated monitoring of small sources of pollution. The impact remains to be seen, but the public demand for data presents a rare window of opportunity.

II. PRE-DEVELOPMENT BASELINE SURVEYS

Information plays several key roles in any environmental regulatory regime. First, collecting data on the current state of the environment provides an important baseline. With knowledge of the existing state of things—the level of contaminants in the air, water, and soil of a region, for example—we can better understand the impacts caused by later industrial activity. Requiring industrial actors to disclose information about their activities, including the chemicals used and certain pollution releases, can both allow us to identify impacts above the baseline and, potentially, incentivize better industrial behavior.[19] Finally,

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BRANCH, MCNETT TOWNSHIP, LYCOMING COUNTY, PENNSYLVANIA 4–5, 10 (2009) (on file with author) (concluding that an improperly cased well that was drilled, not hydraulically fractured, partially contributed to methane that bubbled up into streams and water wells).

[18] *See, e.g.*, Wendy E. Wagner, *Commons Ignorance: The Failure of Environmental Law to Produce Needed Information on Health and the Environment*, 53 DUKE L.J. 1619 (2004).

[19] For discussion of information disclosure incentivizing better industry behavior, see, for example, Anil R. Doshi et al., *How Firms Respond to Mandatory Information Disclosure*

surveying the state of the environment after development provides additional information on impacts above the baseline and the cause of those impacts. It also allows governments to collect cleanup costs, and individuals harmed might have a higher likelihood of obtaining damages if this type of information is available. This Part focuses on baseline information collection in the unconventional oil and gas context, and Parts II and III describe information forcing during and after oil and gas development.

A. *Broad-Based Surveys*

To fully understand the type and extent of the impacts of any industrial activity—and, specifically, oil and gas drilling and fracturing—the most useful baseline (pre-development) data would be collected at multiple geographical points, covering many environmental media, prior to the emergence of industrial activity.[20] This data is, of course, often impossible to fully obtain. Many parts of the United States already have—or have hosted in the past—some level of industrial activity and residential and commercial development, all of which impact human health and the environment. But in some regions, there still is an opportunity to collect data prior to widespread unconventional oil and gas development activity, particularly where we know that higher levels of development may be looming. In the Utica Shale, for example, where thousands of acres of minerals have been leased but less drilling has occurred than in certain other formations,[21] there is still time. And even where drilling and fracturing already have commenced, conducting baseline surveys is important, as it will allow scientists to assess additional increments of pollution beyond a certain measurement baseline.

Despite the opportunity for broad-based information collection efforts prior to widespread drilling and fracturing, these efforts have not been common. This is slowly changing. The U.S. Geological Survey (USGS) is embarking upon a relatively ambitious "temporal and spatial analysis of surface-water and

(Harvard Bus. Sch., Working Paper No. 12-001, 2011) (forthcoming in STRATEGIC MGMT. J.), http://www.hbs.edu/faculty/Publication%20Files/12-001.pdf; Hannah J. Wiseman, *The Private Role in Public Fracturing Disclosure and Regulation*, 3 HARV. BUS. L. REV. ONLINE 49, 55 n.52 (2013), http://www.hblr.org/wp-content/uploads/2013/02/Wiseman_The-Private-Role-in-Public-Fracturing-Disclosure-and-Regulation.pdf (summarizing the literature and some of the key authors).

[20] Non-industrial activity, of course, also produces pollutants, as shown by widespread water pollution from residential nonpoint sources. *See, e.g.*, William E. Odum, *Environmental Degradation and the Tyranny of Small Decisions*, 32 BIOSCIENCE 728, 728 (1987). The notion of identifying pristine environments not impacted by human activities is an unrealistic one. Rather, the goal here is to encourage the measurement of the state of the environment and human health before widespread development occurs.

[21] *Well List of Utica Shale Activity from Division of Oil and Gas*, OHIO DEP'T OF NATURAL RES., http://oilandgas.ohiodnr.gov/portals/oilgas/shale-activity/comprehensive/Utica-Update.pdf (last updated May 18, 2013) (showing some wells drilling, and a few producing, but many wells only having been permitted).

groundwater quality in areas of unconventional oil and gas development."[22] This will use "existing national and regional datasets to describe water quality" and will later "evaluate water-quality changes over time where there are sufficient data" available.[23] To better understand historic and current baseline water quality, the USGS will use "754,000 water-quality samples" from 78,000 groundwater sampling sites and 32,000 surface-water sampling sites.[24] These samples typically show concentrations of ions in water, which can become elevated when salty produced waters from oil and gas development enter fresh water.[25] One USGS study beneath this larger project sampled 127 water wells in Arkansas and compared these sampling results to more general (not water well-specific) historic groundwater-quality data from the region.[26] The study found "no effects from gas-production activities."[27]

The existing baseline data used by the USGS to determine the impacts of oil and gas development in other regions will, of course, not be perfect: there are concerns that oil and gas development will cause changes other than higher ion concentrations, such as elevated chemical concentrations in water if fracturing waste leaks out of pits.[28] And fracturing solutions typically contain "a handful of chemicals" selected from a potential list of hundreds.[29] We lack data on the current concentration of many of these chemicals in groundwater. An improved baseline collection effort would require agencies to conduct new tests that included the many chemicals potentially used in fracturing, but it would be expensive and time consuming. Better baseline collection would also address parameters other than the concentration of various substances in water, as the impacts of oil and gas drilling and fracturing will not only be pollution-based; there also could be short-term and possible long-term effects on water availability, for example.[30] As a second-best option, many states—albeit not uniformly—are requiring industry to gather this type of baseline information.

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[22] U.S. GEOLOGICAL SURVEY POWELL CTR. FOR ANALYSIS & SYNTHESIS, WATER QUALITY STUDIED IN AREAS OF UNCONVENTIONAL OIL AND GAS DEVELOPMENT, INCLUDING AREAS WHERE HYDRAULIC FRACTURING TECHNIQUES ARE USED, IN THE UNITED STATES 1 (2012), http://pubs.usgs.gov/fs/2012/3049/FS12-3049_508.pdf.

[23] *Id.*

[24] *Id.* at 2.

[25] *Id.*

[26] TIMOTHY M. KRESSE ET AL., U.S. GEOLOGICAL SURVEY, SHALLOW GROUNDWATER QUALITY AND GEOCHEMISTRY IN THE FAYETTEVILLE SHALE GAS-PRODUCTION AREA, NORTH-CENTRAL ARKANSAS, 2011, at 28 (2012), http://pubs.usgs.gov/sir/2012/5273/sir2012-5273.pdf.

[27] *Id.*

[28] *See supra* note 14.

[29] N.Y. STATE DEP'T OF ENVTL. CONSERVATION, *supra* note 2, at 5-63 to 5-74.

[30] *See* Wiseman, *supra* note 13, at 146 (describing potential water quantity impacts).

B. *Limited Pre-development Data Requirements*

Several states have in the past required (or strongly incentivized) industry to conduct baseline tests, and more are beginning to add this mandate to their regulations. The most common types of baseline tests required or incentivized by states are the sampling of water for certain pollutants, although some states also require information on water quantity and the source of water to be used in fracturing. This section provides examples only and is not a comprehensive regulatory survey of baseline testing requirements.

Prior to 2012, Pennsylvania incentivized baseline testing for existing pollution in water by presuming that water contamination within 1,000 feet of oil and gas operations that was identified within six months of the end of the operations was caused by oil and gas activity.[31] This presumption could be rebutted by industry, thus incentivizing very careful baseline testing near the proposed oil or gas well site. The state recently expanded this rebuttable presumption to contamination within 2,500 feet and one year of well activity.[32] West Virginia has a similar presumption for water contamination that occurs within 1,500 feet of an oil or gas well.[33]

Other states directly require baseline testing, some of which covers existing water quantity and flow in addition to chemical constituents. Michigan, for example, requires a "hydrogeological investigation" around a proposed well facility to "establish local background groundwater quality," including sampling of certain water constituents (some of which are chemicals used in fracturing), a "geologic description of earth materials," a description of the most shallow groundwater, and an analysis of groundwater flow.[34] This type of detailed data is helpful, as it can suggest how far chemicals leaking from surface pits would have to migrate before reaching an aquifer, as well as how well the soil would slow migration—clay might better prevent pollutants from leaching into groundwater than would sand, for example.

Ohio requires operators to sample all water wells within 1,500 feet of proposed horizontal wells and provides guidelines for sampling.[35] These guidelines propose a sampling plan, which includes the limits of the well sampling area and contact information for landowners whose wells will be tested.[36] It also suggests "chemical and physical parameters" that should be

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31 58 PA. CONS. STAT. ANN. § 601.208 (West 1984), *amended by* Act of Feb. 14, 2012, Pub. L. No. 87, No. 13, *available at* http://www.legis.state.pa.us/WU01/LI/LI/US/HTM/2012/0/0013..HTM.

32 58 PA. CONS. STAT. ANN. § 3218(c)(2) (West 2012).

33 H.B. 401, 80th Leg., 4th Spec. Sess. (W. Va. 2011) (amending W. VA. CODE § 22-6A-18(b) (2012)).

34 MICH. ADMIN. CODE r. 324.1002(3)(a) (2012).

35 OHIO REV. CODE ANN. § 1509.06(A)(8)(c) (West 2012).

36 OHIO DEP'T OF NATURAL RES., BEST MANAGEMENT PRACTICES FOR PRE-DRILLING WATER SAMPLING 2–3 (2012), http://www.dnr.state.oh.us/Portals/11/oil/pdf/BMP_PRE-DRILLING_WATER_SAMPLING.pdf.

analyzed and how they should be reported—in milligrams of chemical or ions per liter of water, for example.[37] This will ensure more uniform baseline data, at least within the state. Colorado, in turn, recently required baseline testing around wells but limited testing to a maximum of four water wells near the proposed oil or gas well.[38]

Ohio also incentivizes the collection of some baseline information regarding water quantity in addition to quality. Its regulation provides that operators must describe anticipated sources from which they will withdraw water as well as the "proposed estimated rate and volume of the water withdrawal."[39] Although this does not produce data on existing water quantity and flow, it could encourage the state environmental agency to collect this data if it was concerned about potential impacts. Pennsylvania, too, requires information about anticipated water sources and a permit that describes how operators will prevent damage to aquatic life during water withdrawals.[40]

Considered together, the limited baseline data that states like Colorado, Michigan, Ohio, Pennsylvania, West Virginia, and others[41] require or incentivize operators to provide is not comprehensive; some states only require sampling for existing pollutants in water, ignoring information about water quantity and flow. Furthermore, the limited data produced is not uniform. States require operators to test for different types of water constituents and do not require the same laboratory testing techniques for the samples. This will prevent the formation of a nationwide, comparable dataset on existing water quantity and quality. And it ignores many other baseline factors, such as the existing nature of the habitat in which oil and gas drilling occurs, the degree of habitat fragmentation, and inventories of plant and animal life, among many other potential factors. State requirements for baseline data production and reporting are, however, an important start.

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[37] *Id.* at 3.

[38] COLO. OIL & GAS CONSERVATION COMM'N, FINAL RULE 609, STATEWIDE GROUNDWATER BASELINE SAMPLING AND MONITORING (2013), http://cogcc.state.co.us/RR_HF2012/Groundwater/FinalRules/FinalRule609-01092013.pdf.

[39] OHIO REV. CODE ANN. § 1509.06(A)(8)(a).

[40] 25 PA. CODE § 110 (2008); PA. DEP'T. OF ENVTL. PROT., WATER USE REGISTRATION AND REPORTING (2008), http://www.pawaterplan.dep.state.pa.us/StateWaterPlan/WaterUse/WaterUse.aspx (describing reporting requirements in more detail).

[41] Note that this is not a comprehensive survey of the fifty states. I have only provided limited examples of state requirements.

III. INFORMATION PROVIDED BY INDUSTRY DURING OR JUST AFTER DEVELOPMENT

If we are to more fully address the impacts of unconventional oil and gas development, we must understand how this development changes baseline environmental conditions. One way to develop this understanding is to force industry to disclose those incidents that are likely to have caused pollution—spills of drilling and fracturing wastes, for example. Less directly, we can require industry to disclose the types of materials that it uses and activities it engages in, so that if a spill or other event with potential environmental damage occurs, we have some idea of its impact.

Many states require operators to disclose spills, although typically only spills over a certain volume.[42] States are also rushing to require less direct disclosure in the form of the types and quantities of chemicals used in fracturing, as well as quantities of water withdrawn and sources from which the water was withdrawn.[43] Many industry actors are also voluntarily disclosing this data through a national database.[44] This will help agencies and scientists to identify impacts over the baseline in the event that spills occur, storage pits leak, or underground injection control wells—which are often used to dispose of oil and gas liquid wastes—leak into underground water.[45]

Some states are also beginning to monitor oil and gas activity, thus allowing agencies to detect (and thus notice and record) environmental incidents, including contamination events, when they occur. Many require oil and gas operators to provide at least twenty-four hours' notice to an oil and gas agency prior to fracturing, for example.[46] And states like Pennsylvania[47] and Texas[48] have conducted limited air quality monitoring around oil and gas sites.

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42 *See* Hannah J. Wiseman & Francis Gradijan, *Regulation of Shale Gas Development, Including Hydraulic Fracturing* 97–99 (June 15, 2012) (unpublished manuscript), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1953547 (comparing spill reporting requirements).

43 *See Hydraulic Fracturing Fluid Disclosure Requirements*, VINSON & ELKINS LLP, http://www.velaw.com/uploadedFiles/VEsite/Resources/HydraulicFracturingFluidDisclosureRequirements.pdf (summarizing disclosure requirements, including those that require disclosure of volumes of water used); Wiseman, *supra* note 19, at 53–55 (describing the disclosure requirements).

44 *See* FRACFOCUS CHEMICAL DISCLOSURE REGISTRY, http://fracfocus.org/.

45 *See, e.g.*, City of Midland's Motion for Estimation of Claims for Purpose of Allowance, Voting, and Determining Plan Feasibility, and Request for Determination that Remediation Claim Is Entitled to Administrative Expense Priority at 2, *In re* Heritage Consolidated, L.L.C., No. 10-36484-hdh-11 (Bankr. N.D. Tex. Nov. 15, 2010) (on file with author) (describing the contamination of a city's drinking water source by an oil and gas disposal well).

46 *See, e.g.*, THOMAS E. KURTH ET AL., HAYNES & BOONE, LLP, AMERICAN LAW AND JURISPRUDENCE ON FRACING—2012 (2012), https://www.haynesboone.com/files/Uploads/Documents/Attorney%20Publications/CURRE

Similar limitations to those encountered in baseline testing arise at the stage of collecting information about the impacts of oil and gas activity. States have different spill-reporting requirements,[49] and many do not require reporting of a range of other impacts, such as habitat fragmentation and emissions of air pollutants. Furthermore, in addition to measuring levels of pollution near certain oil and gas sites, as Pennsylvania and Texas are doing for air quality, an even better monitoring system would place small electronic monitors at each well site, and these monitors would send continuous data on pollutant emissions to a centralized database run by an agency or other organization.[50] It appears that no state has progressed this far.[51] But again, the rise of both required and voluntary disclosure of activities and impacts occurring during the development process is encouraging.

IV. POST-DEVELOPMENT INVESTIGATIONS

Having identified baseline data and polluting events during industrial development, it is equally important to conduct post-development sampling and broader investigations to identify the type and extent of impacts. This can ensure that actors contributing to pollution accurately compensate agencies for the costs of cleanup and pay individuals damaged, either through a regulatory compensation scheme or tort-based liability.

Limited efforts of this sort have begun in the area of unconventional oil and gas, although in many regions, development is still booming,[52] and the impacts cannot yet be comprehensively identified. Colorado requires sampling of groundwater between six and twelve months after the initial samples were collected, for example, and another sampling event after the well has been completed.[53] The Delaware River Basin Commission, a regional agency, also proposed rules in the river's watershed that would have required both baseline

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NT_RMMLF%20Fracing%202012%20Paper_Formatted.pdf (describing states' notice requirements).

47 PA. DEP'T OF ENVTL. PROT., NORTHCENTRAL PENNSYLVANIA MARCELLUS SHALE SHORT-TERM AMBIENT AIR SAMPLING REPORT (2011), http://www.dep.state.pa.us/dep/deputate/airwaste/aq/aqm/docs/Marcellus_NC_05-06-11.pdf.

48 *See Barnett Shale: Latest Activities*, TEX. COMM'N. ON ENVTL. QUALITY, http://www.tceq.texas.gov/airquality/barnettshale/bshale-next (last modified Dec. 21, 2012) (describing available "[n]ear real-time ambient air monitoring data" in the Barnett Shale area).

49 *See supra* note 42.

50 *See infra* note 58 and accompanying text (describing Professor Daniel Esty's proposal for this type of monitoring).

51 Ohio, however, requires continuous monitoring around underground injection control wells. OHIO ADMIN. CODE 1501: 9-3-07 (2012).

52 *See, e.g.*, *Newark, East (Barnett Shale) Field Discovery Date 10-15-1982*, R.R. COMM'N OF TEX., http://www.rrc.state.tx.us/data/fielddata/barnettshale.pdf (showing 16,530 Barnett Shale gas wells in Commission records).

53 COLO. OIL & GAS CONSERVATION COMM'N, *supra* note 38, Rule 609(d)(2).

groundwater testing around well sites and post-construction annual monitoring until all natural gas wells were "plugged and sealed."[54] The Environmental Protection Agency has conducted an extensive analysis of surface and groundwater contamination allegedly caused by drilling or hydraulic fracturing in the Pavillion, Wyoming area.[55] The study is ongoing, however, and it appears that no formal efforts at recovering cleanup costs or damages have yet been instituted. And as mentioned above, the USGS studied 127 water wells near drilling and fracturing activity in Arkansas, finding no negative impacts.[56] More post-development studies of this type will be essential moving forward, however, as the boom subsides in certain regions and potentially leaves contamination behind.

V. CONCLUSION

In a world with no cost limitations, we would know the exact state of the environment in a given region prior to drilling and fracturing—the amount of industrial and residential development (and associated pollution) that already has occurred; existing human populations in the area and their current health status; plant and animal species in the area; habitat fragmentation, average air quality for each regulated air pollutant; and current water quality as measured by the concentration of every potential substance that could enter water as a result of drilling and fracturing. We would then identify and record data on the types and area of habitat affected by new development, the types and numbers of species impacted, the types and volumes of chemicals and wastes spilled and total area affected by the spill, and the types and quantities of air pollutants emitted at each site. We would also assess the extent to which human health in the area had been impacted. Finally, post-development surveys might comprehensively assess the extent of total air pollution and soil and/or water contamination as well as any long-term impacts that would be difficult to remedy, such as a plume of highly persistent pollution within a relatively inaccessible aquifer.

The information forcing regulations and voluntary disclosure efforts emerging in the area of unconventional oil and gas development do not come close to this level of detail—in part likely due to the costs of monitoring and disclosure and more pressing regulatory priorities, and, in some cases,

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54 DEL. RIVER BASIN COMM'N, REVISED PROPOSED NATURAL GAS DEVELOPMENT REGULATIONS 71 (2011), http://www.nj.gov/drbc/library/documents/naturalgas-REVISEDdraftregs110811.pdf.

55 DOMINIC C. DIGIULIO ET AL., EPA, INVESTIGATION OF GROUND WATER CONTAMINATION NEAR PAVILLION, WYOMING (2011), http://www.epa.gov/region8/superfund/wy/pavillion/EPA_ReportOnPavillion_Dec-8-2011.pdf.

56 *See supra* text accompanying note 26.

resistance from industry actors.[57] But existing laws and studies do show that public agencies, and industry itself, are beginning to pay more attention to the need for information at all stages—before, during, and after development. And some of the information being collected, such as baseline water surveys, might be useful in the future to assess a broad range of environmental impacts—not just those from oil and gas development.

Further, the move toward monitoring well operations as they occur could lead us somewhat closer to the world of data collection envisioned by Daniel Esty, in which small technological devices would continuously monitor the impacts of a range of activities.[58] Currently, we tend to monitor only large pollution sources—through continuous emissions monitoring devices installed at large stationary facilities that emit air pollution, for example.[59] The public demand for more information about activities happening at each of the thousands of well sites around the country might lead us toward micro-monitoring, however, which could be applied in other industries. Why not install water-quality monitors below farms, for example, to measure manure, fertilizers, pesticides, and other pollutants running off of thousands of acres of fields? Why not place magnetized, digital emissions monitors on the tailpipes of cars? While there will of course be a range of objections to this type of pervasive information collection, it could move us toward a world of more and better information about the impacts of our many activities, from oil and gas development to growing thousands of acres of crops. Information forcing in oil and gas, although nascent, might be an initial step toward a world with better and more extensive data to guide industry behavior, and public responses.

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57 *See, e.g.*, John Murawski, *Fracking Giant Halliburton Nixes NC's Chemical Disclosure Rule*, NEWS & OBSERVER, May 2, 2013, http://www.newsobserver.com/2013/05/02/2866836/fracking-giant-halliburton-nixes.html.

58 *See generally* Daniel C. Esty, *Environmental Protection in the Information Age*, 79 N.Y.U. L. REV. 115 (2004).

59 *See Continuous Emission Monitoring—Information, Guidance, etc.*, EPA, http://www.epa.gov/ttn/emc/cem.html (last updated Aug. 7, 2007).