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Article

*115 UNTESTED WATERS: THE RISE OF HYDRAULIC FRACTURING IN OIL AND GAS
PRODUCTION AND THE NEED TO REVISIT REGULATION

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I. Introduction

As conventional sources of oil and gas become less productive and energy prices rise, production companies are developing creative extraction methods to tap sources like oil shales and tar sands that were previously not worth drilling. Companies are also using new technologies to wring more oil or gas from existing conventional wells. This article argues that as the hunt for these resources ramps up, more extraction is occurring closer to human populations - in north Texas' Barnett Shale and the Marcellus Shale in New York and Pennsylvania. And much of this extraction is occurring through a well-established and increasingly popular method of wringing resources from stubborn underground formations called hydraulic fracturing, which is alternately described as hydrofracturing or "fracing," wherein fluids are pumped at high pressure underground to force out oil or natural gas.

Coastal Oil and Gas Corp. v. Garza Energy Trust, [\[FN1\]](#) a recent Texas case addressing disputes over fracing in Hidalgo County, Texas, exemplifies the human conflicts that are likely to accompany such creative extraction efforts. One conflict is trespass: whether extending fractures onto adjacent property and sending fluids and agents into the fractures to keep them open constitutes a common law trespass. Few state courts have addressed this issue directly, and Texas' conclusion in Coastal Oil that damages from the drainage of natural gas from adjacent property through fracing do not constitute an actionable*116 trespass claim is likely to have national implications, as other jurisdictions may follow the lead of a court highly familiar with oil and gas law. Companies in Pennsylvania and southern New York are already citing Coastal Oil as a defense when property owners argue that loud seismic trucks are trespassing on private property. [\[FN2\]](#) But trespass is only one piece of a larger puzzle. In 2005, Congress exempted fracing from the Safe Drinking Water Act, bringing to an end a long legal and political debate over whether the federal government should regulate fracing under its water laws. [\[FN3\]](#) Without federal statutes or common law liabilities like trespass governing fracing, the regulation of fracing is left wholly to state governments. And some decline to regulate. In Texas, for example, "neither the Legislature nor the [Railroad] Commission has ever seen fit" to regulate hydrofracturing, in the words of the supreme court. [\[FN4\]](#) Although some states like Pennsylvania and New York have relatively comprehensive regulations that cover fracing, other states lack regulations that specifically address the practice. The absence of regulation is not of great concern if fracing is a relatively benign practice that can be sufficiently controlled through the general permitting process; but if fracing has significant environmental and public health impacts, the lack of regulation is problematic. This article investigates fracing through an environmental lens and concludes that given the potential consequences of this increasingly common practice, more regulatory control over fracing may be needed, and, at minimum, regulators should re-visit existing controls in light of an up-to-date scientific investigation of fracing and determine whether these controls are adequate.

The article begins by providing a brief introduction, in Part II, to the practice of fracing and then describes its geographic expansion as *117 a result of the search for unconventional sources of oil and gas. Part III discusses the potential environmental effects of fracing. Part IV describes the current laws and regulations that apply to fracing, including the low level of federal and court oversight and varying degrees of regulation by state agencies. Finally, Part

V analyzes the implications of this legal and regulatory framework, suggesting that the EPA's conclusion that fracking did not merit further research and Congress' exemption of fracking from the Safe Drinking Water Act involved two types of regulatory failure. Part V also suggests needed reforms, arguing that given the potential, but under-researched, environmental impacts of fracking, a comprehensive national survey that is scientifically rigorous should identify the environmental effects of fracking in all regions of the United States. Studies take time, however, and there may be substantial risks associated with fracking with toxic fluids in underground sources that are in or potentially connected to underground sources of drinking water. As such, while the study is taking place, Congress should begin to reconsider its decision to exempt fracking from the Safe Drinking Water Act. States should also determine whether their current oil and gas regulation - the general regulation of oil and gas production or specific control of fracking - adequately identifies and accounts for the effects of fracking on human health and the environment.

II. Fracing: The Practice and its Prevalence

A. An Introduction to the Technical Aspects of Fracing

Several types of subterranean formations in the United States have valuable oil or gas that is difficult to extract. Some coalbeds, for example, contain "high concentrations" of methane, [\[FN5\]](#) although the *118 value of coalbed methane depends on its concentration and "the rate at which [the gas is] able to flow from the coal matrix to a production well." [\[FN6\]](#) The same is true for shales which, like coalbeds, may contain large quantities of "trapped" natural gas or oil. One way to increase the flow rate and the productivity of the gas or oil in shale or a coalbed is to create fractures in the formation, providing space through which the gas or oil can flow. To frac a formation, engineers inject a fluid into the well bore at high pressures to induce fractures or expand existing natural fractures and to carry "proppants" into those fractures. Proppants "are sand or other granular substances injected into the formation to hold or 'prop' open fractures created by hydraulic fracturing." [\[FN7\]](#) The ultimate goal of many fracing operations is to ensure that the fractures connect the wellbore to the area of the shale or coalbed in which production has been stimulated, [\[FN8\]](#) allowing the gas or oil to flow into the well.

There are several methods of fracing, although all require some sort of fluid. The fluids used in the process vary from pure water to water mixed with solvents or gel (a drilling mud or a polymer, for example [\[FN9\]](#)) to hydrochloric acid [\[FN10\]](#) and even diesel fuel, [\[FN11\]](#) although *119 many operators have signed a non-enforceable [\[FN12\]](#) memorandum of agreement not to use diesel fuel. [\[FN13\]](#) Fracing fluids must have properties that allow them to stimulate fractures and to send proppants into the fractures. [\[FN14\]](#) The fluids also help to pull back the excess proppants once the fractures have been stimulated. [\[FN15\]](#) From the production perspective, the ideal fracturing fluids are not too expensive, do not require too much added water, flow well and have low friction, induce "wide fractures," suspend the proppants in solution and move them in "high concentrations," [\[FN16\]](#) and "break back to a low viscosity fluid for clean up after treatment." [\[FN17\]](#) For some fracing, specialized fluids are used - often to improve the efficiency or effectiveness of the process, whether by decreasing the amount of fluid that must be injected or by more thoroughly removing the excess proppants that do not remain in the fracture. [\[FN18\]](#) "Foamed" or "energized" fluids, for example, which have added carbon dioxide or nitrogen, reduce the quantity of water required and thus the wastewater produced by fracing. [\[FN19\]](#)

*120 The type of fracing applied to a formation depends, in part, on the type of formation [\[FN20\]](#) and the resource (oil or gas) being extracted, as well as the "tightness" of the formation, meaning the extent to which it naturally releases oil or gas when pressure is changed. [\[FN21\]](#) Under the most basic technique, an operator injects fluids into the well bore to increase the pressure in the well; at a certain pressure, the formation surrounding the well begins to crack. [\[FN22\]](#) It is, however, difficult to predict the length, type, or extent of fractures that will occur using this technique. [\[FN23\]](#) In Montana's Bakken Shale formation, where all oil wells are fraced, [\[FN24\]](#) an increasingly common method of fracing *121 allows operators to better control fracture direction and length. Drillers run a liner through a hole that has been horizontally drilled, and they fit objects called "swell packers" at intervals within the liner. Certain injected fluids cause the packers to swell, and the swelling blocks off portions of the horizontal drill hole. This allows the operator to isolate the areas where fracing occurs. [\[FN25\]](#)

Because fracking is applied to so many different types of formations using an array of methods and fluids, the environmental effects will of course differ depending on factors such as the toxicity of the fluid used; the closeness of the fracture zone to underground drinking water; the existence of a barrier between the fractured formation and other formations; whether or not the fracking service withdraws groundwater from the area or transports it in; and whether the service company recycles wastewater, filters it and disposes of it on the surface, or sends it to a treatment plant. [\[FN26\]](#) Part II explores several of these factors in evaluating the range of potential effects.

B. The Expansion of Fracing and Potential Conflicts with Human Populations

Although engineers are still fine-tuning fracing techniques - from the type of fluid used [\[FN27\]](#) to the amount of pressure required [\[FN28\]](#) and the *122 methods of predicting the location and size of fractures [\[FN29\]](#) - fracing has historically been and will continue to be a profitable method of extracting non-renewable resources. Fracing was "first used commercially in 1949," and "is now essential to economic production of oil and gas and commonly used throughout the United States, and the world." [\[FN30\]](#) As the Pennsylvania Supreme Court observed as early as 1983:

Commercial exploitation of coalbed gas has remained very limited and sporadic until recently. As a result of our nation's high energy demands and shortage of energy supplies both the gas industry and the mining industry have come to regard coalbed gas as having sound market potential. [\[FN31\]](#)

And as the Texas Supreme Court more recently explained, the unprecedented success of fracing in the Barnett Shale in north central Texas has "prodded exploration elsewhere," and "'spurr[ed] efforts to produce gas in many other areas and geological formations that were previously considered unrecoverable or uneconomic.'" [\[FN32\]](#)

Indeed, there is evidence that domestic producers in many regions of the United States have responded in full force to the demand for natural gas as technologies for unconventional extraction have improved. [\[FN33\]](#) By the late 1980's, coalbed-produced methane gas was *123 "the primary source of natural gas for the state of Alabama" and was already "rapidly becoming a major source of natural gas in the San Juan Basin of New Mexico and Colorado." [\[FN34\]](#) In the Black Warrior coal basin, no methane wells had been drilled in 1980; by 1987, it boasted 400 wells. [\[FN35\]](#) Nationwide, more than six percent of domestically-produced natural gas came from coal seams in 2000. [\[FN36\]](#) The EPA identified at least 26 states with coal basins by 2004, [\[FN37\]](#) with eleven of those states having major coal basins with the potential to produce natural gas. [\[FN38\]](#) At the time of the EPA's report, fracing had commenced to various degrees in all of the eleven major basins, [\[FN39\]](#) and hydraulic fracturing was "common" in at least three of these basins. [\[FN40\]](#)

Fracing is not only occurring in coalbeds. As the Texas Supreme Court's opinion in Coastal Oil discusses, fracing of shale is increasingly commonplace in areas like North Central Texas, where it is the only method to extract natural gas from Barnett Shale. [\[FN41\]](#) In 2000, *124 the Railroad Commission of Texas issued 273 permits for drilling in the Barnett Shale. In 2004 it issued 1,112 permits, and by 2007 the number of permits issued had skyrocketed to 3,653. [\[FN42\]](#) In Montana, every oil well in the Bakken Shale formation is fraced, with more than 600 wells drilled to-date, [\[FN43\]](#) while local newspapers report that operators in New York's Marcellus Shale may drill and frac more than 1,500 wells annually. [\[FN44\]](#) The Marcellus formation as a whole, which underlies large portions of New York, Pennsylvania, West Virginia, and Ohio, may contain as much as 1.9 trillion cubic feet of natural gas. [\[FN45\]](#) And on a countrywide basis, one industrial consultant believes that drillers could produce more than 842 trillion cubic feet of currently untapped natural gas from shales. [\[FN46\]](#) Fracing service companies have similarly observed that "[t]he exploitation of shale reservoirs is the fastest-growing segment" of the land-based natural gas market. [\[FN47\]](#)

Practices like fracing that eke out more profitable resources from existing mining or drilling sites, or from underground formations that cannot be tapped with traditional drilling methods, will likely continue to grow. [\[FN48\]](#) While international natural gas supplies have *125 been forecast to increase in 2009, and domestic supplies skyrocketed in 2008 - largely due to techniques like fracing [\[FN49\]](#) - demand for natural gas in the United States will remain high. [\[FN50\]](#) Rising energy prices continue to drive production, [\[FN51\]](#) and the productivity of natural gas

*126 extracted from conventional sources and drilling techniques in the United States has already peaked. [FN52] The National Petroleum Council "estimates that sixty to eighty percent of all wells drilled in the next decade to meet natural gas demand will require fracturing." [FN53]

All of the recent fracing activity and particularly the fracing frenzy in Texas' Barnett Shale region, an area covering four "core counties" (the "most active production zones," [FN54] two of which include the Fort Worth area) and fourteen other counties in North Central Texas, [FN55] shows that as fracing grows in prevalence it will not occur in isolation of human populations. [FN56] In Texas, companies are fracing in the suburbs and even near urbanized areas, causing concerns of gas well explosions or "twenty-four-hour drilling disrupting the tranquility of sleepy subdivisions." [FN57] Individuals and environmental groups in Colorado, New Mexico, Virginia, and Wyoming have reported concerns that fracing affected drinking water sources. [FN58] Cities like Bellingham, Seattle, Tacoma, and Olympia, in Washington and Portland *127 in Oregon "lie in or adjacent to the sub-basins" of the Pacific Coal Region, [FN59] and conflicts with human populations could arise if fracing activities grow in these areas. In New York, residents near Ithaca are pushing for environmentally-oriented fracing processes as production companies seek oil and gas leases for fracing in that region's Marcellus Shale. [FN60] Towns in Pennsylvania and southern New York are also upset by the exploration activities that precede fracing and drilling: fleets of three to four seismic trucks called "thumpers" are roaring into quiet communities and striking the ground to map out the subterranean formations and identify the fracing potential. Some citizens are threatening legal action if thumping continues. [FN61] Residents in Alabama have already sued. In *Legal Environmental Assistance Foundation, Inc. v. EPA* ("LEAF") two members of the Foundation claimed that they experienced diminished water quality in their drinking well after fracing began in a nearby coalbed. [FN62] Fracing near human populations, whether urban or rural, will inevitably generate conflicts. The important question with respect to regulation is whether these conflicts involve significant environmental and human health-related impacts that are not currently addressed by regulatory controls.

III. The Environmental Effects of Fracing

There have been several national reports on fracing and its potential impacts on nearby human populations, some sponsored by the government and others by non-profit associations. Few, however, have addressed the full range of potential environmental impacts of fracing. In a survey developed by state agency representatives with responses from "all of the major coal producing states in which any coalbed methane gas was produced in 1997," [FN63] the Ground Water *128 Protection Council identified only one complaint of drinking water contamination from hydraulic fracturing - in Alabama - and the state reported that it investigated the complaint and determined that it was unsubstantiated. [FN64] However, the Council's survey did not address fracing in shale. The Department of Energy prepared a "Hydraulic Fracturing White Paper" that discusses various technical fracturing issues, from determination of whether a formation is a good candidate for fracturing to fluid and proppant selection and fracture treatment design. [FN65] The report mentions that "[c]urrently, a discussion is taking place on the effects of hydraulic fracturing in coal seams" on U.S. drinking water [FN66] but does not address these effects. The EPA cited the white paper, among many other studies, in a more comprehensive investigation of fracing completed in June of 2004. [FN67] The EPA ended at "Phase I" of the investigation, however, concluding that the potential effects did not merit more detailed study. [FN68] Furthermore, the study only addresses one component of fracing (underground injection of fluids) and one potential environmental effect (contamination of underground sources of drinking water), and also fails to investigate the effects of fracing in shale. [FN69]

Although the EPA's 2004 study is limited in scope and never moved beyond Phase I, it provides useful preliminary data on some of the environmental and human health effects of fracing. Specifically, the study addresses the potential contamination of underground drinking water in eleven coalbed basins, defining the underground sources pursuant to federal Underground Injection Control regulations as:

An aquifer or a portion of an aquifer that "[s]upplies any public water system; or [c]ontains [a] sufficient quantity of groundwater to supply a public water system; and currently supplies drinking water for human consumption; or contains fewer than 10,000 milligrams *129 per liter total dissolved solids; and [i]s not an exempted aquifer." [FN70]

Exempted aquifers are those that do not "currently serve as a source of drinking water" and "cannot now and will not in the future serve as a source of drinking water" because of contamination, commercial uses, or physical location or depth. [FN71] The study investigates both direct and indirect injection of the fluids used in hydraulic fracturing into underground drinking water. Hydraulic fluid is directly injected into water in cases where a coalbed is located within an underground water source, and this practice is common. As the EPA describes it, "In many coalbed methane-producing regions, the target coalbeds occur within [underground sources of drinking water], and the fracturing process injects stimulation fluids directly into" the underground drinking water source. [FN72] Indirect injection into underground water sources occurs where the coalbed is adjacent to a water source; fractures in the coalbed can extend into the adjacent source and contaminants may pass through the fractures into the source. [FN73]

After receiving comments and interviewing citizens and state officials, as well as reviewing reports historically made by citizens and citizen representatives to environmental and state organizations, the EPA summarized "water quality incidents" associated with fracturing in four of the major basins. In the San Juan Basin of Colorado and New Mexico, a county employee measured methane levels in citizens' homes in response to complaints. [FN74] He reported that he had found "explosive levels of methane" and "toxic levels of hydrogen sulfide in homes," likely "due to the removal of water, rather than to hydraulic fracturing," and that "hundreds of wells ha[d] been affected," likely from "older, poorly cemented wells." [FN75] In New Mexico, a citizen complained that following the onset of coalbed methane production, methane levels in his well rose - an observation confirmed by the San Juan Regional Authority - and he observed "streams of gas bubbles in the nearby Los Pinos River." [FN76] Other *130 wells in the area "were also contaminated with methane, and two of the four residences near the coalbed methane drilling had explosive levels of methane in their crawl spaces. [FN77] The EPA concluded that "[t]he methane sampled in the shallow wells and the bubbling river and the high concentration of methane detected in residences suggest that coalbed methane was following some conduit from the [coal] formation to the surface or to shallow" underground sources of drinking water. [FN78] Citizens in Colorado reported that coalbed methane development had increased methane concentrations in their water wells, that the water in their well "turned cloudy with grayish sediment a day or two after nearby fracturing events," that water flow in their wells decreased after fracturing, and that after wells were contaminated with methane, they experienced increased levels of hydrogen sulfide and then anaerobic bacteria. [FN79] There were also reports of impacts unrelated to drinking water. The EPA toured a methane coalbed development area in Colorado and observed "areas where patches of grass and trees were turning brown and dying;" other areas within the observed zone had old-growth trees, suggesting that "the area previously had prolonged normal soil conditions." [FN80] Citizens and local officials complained of higher levels of methane in the soil and lower levels of air in the soil's shallow root zone. [FN81]

In Colorado's Fruitland Formation, the EPA reviewed citizen complaints and state reports and also investigated whether there was a hydrologic connection between the fracturing area and the underground source of drinking water. The EPA concluded that "methane, fracturing fluid, and water with a naturally high [total dissolved solids] content could possibly move" through "natural fractures" or "poorly constructed, sealed, or cemented manmade wells used for various purposes" but that "no reports provide direct information regarding hydraulic fracturing." [FN82]

In the Powder River Basin of Wyoming and Montana, the EPA reviewed reports from individuals indicating that after coalbed methane production, the quantities of water in individuals' wells decreased *131 and that there were "flooding problems on the surface." [FN83] A consultant reported that some individuals near the basin "had problems with increased methane content in their water" that caused "frothing and bubbles" after coalbed methane production commenced. [FN84] Similarly, citizens in the Black Warrior Basin of Alabama complained in their lawsuit that "drinking water contained a milky white substance and had strong odors shortly after a fracturing event," and that the water continued to have a bad odor and contained "black coal fines" in the six months following fracturing. [FN85] Another citizen told the EPA that soon after fracturing, her "kitchen water had globs of black, jelly-like grease and smelled of petroleum" - it also "turned brown and contained slimy, floating particles." [FN86] One homeowner complained of problems with her well caused by fracturing and other "coal resource exploitation," which she also believed caused "significant environmental damage." [FN87] She attached a letter showing that the Alabama Oil and Gas Board had approved "proppants tagged with radioactive material" for a fracturing operation, based

on determinations about the location of drinking water wells and the depth of fracturing, and another letter from EPA Region 4 showing that it had tested her well for contaminants and had found "no purgeable and extractable organic compounds" and no petroleum products. [FN88] The EPA also reviewed a report from an individual to the Natural Resources Defense Council complaining that fluid from a fracing operation had drained to a site near her home, killing "all animal and plant life in its path" and that her well was soon thereafter contaminated with a "petroleum-smelling fluid." [FN89] Another individual reported that after fracing her "water well had become filled with methane gas, causing it to hiss," "the tap water became cloudy, oily, and had a strong, unpleasant odor," and the water "left behind an oily film and contained fine particles." [FN90] A private *132 consultant, according to the individual's report, "confirmed the presence of methane." [FN91]

Finally, in the Central Appalachian Basin of Virginia and West Virginia, the EPA found that "[t]he state received complaints of soap bubbles flowing from residential household fixtures." The soaps apparently did not come from fracing but rather from the process of "extract[ing] drilling cuttings from the borehole." [FN92] Other individuals reported "water loss, soapy water, diesel odors, iron and sulfur in wells, rashes from showering, gassy taste, and murky water," a miner "who was burned by a fluid, possibly hydrochloric acid used in hydraulic fracturing, that infiltrated a mineshaft," fish kills in a stream "caused by the runoff from drilling fluids," and thousands of wells going dry "overnight." [FN93]

After considering the complaints in each region, the EPA looked at state and federal agency responses to these complaints, as well as compensation to landowners for damages caused by methane coalbed drilling. In some cases, agency testing results did not verify the existence of the contaminants complained of, or that hydraulic fracturing had caused the contamination. [FN94] Some testing results verified individuals' complaints, [FN95] while others were inconclusive, as testing was not conducted until several months after the complaint was lodged, or a department or agency failed to test for the substance complained of. [FN96] Drilling companies' responses to citizens' complaints *133 also varied. Some companies provided potable drinking water but the individuals felt that this was inadequate compensation for the loss of their wells. [FN97] In the San Juan Basin, Amoco bought out several ranches "after county officials tested indoor air and found extremely high levels of methane." [FN98] The EPA concluded in its summary of reported incidents that,

the body of reported problems considered collectively suggests that water quality (and quantity) problems might be associated with some of the production activities common to coalbed methane extraction. These activities include surface discharge of fracturing and production fluids, aquifer/formation dewatering, water withdrawal from production wells, methane migration through conduits created by drilling and fracturing practices, or any combination of these. Other potential sources of drinking water problems include various aspects of resource development, naturally occurring conditions, population growth and historical practices. [FN99]

In the next chapter of the report, however, the EPA found that "[b]ased on the information collected and reviewed, EPA has concluded that the injection of hydraulic fracturing fluids into coalbed methane wells poses little or no threat to underground sources of drinking water and does not justify additional study at this time." [FN100] This was despite its earlier observations, in the same chapter, that "hydraulic fracturing fluids may contain constituents of potential concern," including "bactericides, acids, diesel fuel, solvents, and/or alcohols." [FN101] The EPA apparently reconciled this finding with its conclusion that fracing posed little or no threat to drinking water by finding that "the largest portion of fracturing fluid constituents is nontoxic (>95% by volume)" and that "dilution and dispersion, adsorption, and potentially biodegradation, minimize the possibility *134 that chemicals included in the fracturing fluids would adversely affect underground sources of drinking water." [FN102]

The EPA followed the requisite administrative procedures in conducting the study - publishing a Federal Register notice to request comments and holding public meetings for stakeholder input, for example. [FN103] It also reviewed existing literature; interviewed citizens, state agencies, other federal agencies, and companies that perform hydraulic fracturing; visited hydraulic fracturing sites in Colorado, Kansas, and Virginia; solicited public input on incidents of hydraulic fracturing that contaminated underground water sources; reviewed previously-reported groundwater contamination incidents; and compiled past reports from individuals on drinking water wells contami-

nated by various coalbed methane activities. [\[FN104\]](#) After submitting the report for peer review, the EPA publicized a draft for public comment, receiving input from 105 commenters and incorporating "many" comments in the final draft. [\[FN105\]](#)

Despite the apparent procedural validity of the report, which itself has been questioned, [\[FN106\]](#) the EPA report has important weaknesses. First, the report largely ignores environmental issues unrelated to underground sources of drinking water, as it was aimed at determining whether fracking should be regulated under the Safe Drinking Water Act. But fracking has many other potential environmental effects *135 that citizens have complained of and that the EPA observed but remain under-researched. In the Powder River Basin, for example, a consultant for the Powder River Basin Resource Council reported that "the biggest concern among people in the area is loss of water" and "[m]any of the [citizen] complaints relate to water quantity issues; the EPA considered such issues to be "beyond the scope of [its] study." [\[FN107\]](#) Water quantity issues are, however, an important environmental concern, as are potential burns caused by hydrochloric acid used in fracking, fish kills, and "brown and dying" grass and trees. [\[FN108\]](#) Although the EPA is not at fault for focusing on drinking water quality issues, since its objective was to determine whether fracking should be regulated under the Safe Drinking Water Act, the narrowness of the EPA's conclusion is sometimes forgotten when proponents of fracking use the report as evidence that fracking has purportedly "no" environmental effects.

Second, and related to the EPA's narrow focus on underground drinking water quality issues, is the narrowness of the EPA's causal analysis. The EPA investigated only whether the injection of hydraulic fluids undermined underground drinking water quality. [\[FN109\]](#) But its report alludes to other steps in the fracking process unrelated to injection that can also contaminate underground drinking water, and it fails to fully analyze these steps. The report states, for example,

It is important to note that activities or conditions other than hydraulic fracturing fluid injection may account for some of the reported incidences of the contamination of drinking water wells. These potential causes include surface discharge of fracturing and production fluids, poorly sealed or poorly installed production wells, and improperly abandoned production wells. [\[FN110\]](#)

Just as the report focuses solely on the effects of underground injection of fracking fluids on drinking water and should therefore not be *136 used to conclude that fracking is not dangerous, [\[FN111\]](#) the report does not include an in-depth study of fracking's non-injection-related effects on drinking water and should not be read otherwise.

Directly related to issues of non-injection activities that may cause groundwater contamination is the question of separating out the effects of fracking from the effects of other drilling activities. The EPA's report concludes that "the body of reported problems considered collectively suggests that water problems might be associated with some of the production activities common to coalbed methane extraction," one of which is fracking. [\[FN112\]](#) In other words, the EPA concedes in its report that it had difficulty determining whether the environmental effects observed and discussed were caused by fracking, other activities associated with coalbed methane production, or some combination of fracking and other production activities. This difficulty is highlighted elsewhere in its discussion of reported incidents. In the San Juan basin, the EPA found:

The history of documented gas seeps and methane occurrence in water wells indicates that natural fractures probably serve as conduits in parts of the basin where coal formations are near or at the surface and in the interior of the basin, where the coal formations are deeper. These conduits may enable hydraulic fracturing fluids to travel from targeted coalbeds to shallow aquifers. However, there is no unequivocal evidence that this fluid movement is occurring and, even given the presence of these possible conduits, other hydrogeologic conditions (such as certain pressure gradients, etc.) would be required for fluid movement from targeted coalbeds to shallow aquifers. [\[FN113\]](#)

*137 The multiple factors that contribute to well contamination suggest that further research on the extent to which fracking contributes to contamination is important - not that fracking, as one factor among many, has unsubstantial effects.

In addition to studies by the Ground Water Protection Council and the EPA, several brief investigative reports on fracking and its effects on the national scale have been prepared by environmental groups. In 2002, the Natural Resources Defense Council concluded that "[t]he greatest concern about the hydraulic fracturing of coalbed methane wells is that the fracturing fluids being pumped into ground water are likely to contain toxic and carcinogenic chemicals." [\[FN114\]](#) The report suggested that "20% to 30%" of the hazardous fluids "may remain in the ground" [\[FN115\]](#) and summarized a number of landowner complaints related to fracking, including complaints from citizens in Alabama (three complaints), Virginia (more than 100 documented complaints), Colorado, Wyoming, and Montana. [\[FN116\]](#)

Earthworks, through its Oil and Gas Accountability Project, has studied the effects of fracking with respect to drinking water contamination. Its report, *Our Drinking Water at Risk*, published in 2005, critiques the EPA's conclusions and lists numerous fracking-related concerns. The report concludes - generally relying upon the EPA's data, studies cited by the EPA, and an EPA whistleblower's letter [\[FN117\]](#) - that hazardous fracking fluids are a threat to human health even when diluted, that many fluids are injected directly into underground sources of drinking water or migrate to nearby underground water, and that some fracking fluids are left "stranded" in fraced formations, meaning they could contaminate groundwater far into the future as the water table rises. [\[FN118\]](#) The Accountability Project's report further finds that waste fluids from fracking are often injected into drinking water sources, despite at least one fracking company having recommended *138 that they be disposed of as hazardous wastes, and that citizens in many states have complained of well contamination caused by fracking, again referring to the EPA's report. [\[FN119\]](#)

Some citizens have also individually testified to negative health effects possibly caused by fracking. At a congressional hearing in 2007, Dr. Daniel Teitelbaum of Denver testified that "[t]here have been documented complaints by residents of the area. There are also anecdotal stories of medical problems in those exposed." [\[FN120\]](#) Steve Mobaldi, formerly a resident of a ten-acre ranch in Rifle, Colorado, testified that after a company "began drilling on a property about 3,000 feet to the west," he and his wife "began to experience burning eyes and nosebleeds." "Later," his wife "began to experience fatigue, headaches, hand numbness, bloody stools, rashes, and welts on her skin. When she showered she would turn red, tiny blisters covered her entire body." "Soon after she was diagnosed with chemical exposure but the doctor was unaware of what the chemicals were that were causing her symptoms." Steve "began to experience rectal bleeding." He also testified that he planted trees on his property, but they died. In 1997, an oil and gas company informed Mr. Mobaldi and his wife that "a natural gas well was being placed across the street and drilling was going to go under [their] property." After drilling began, his wife "lost her voice and got headaches, burning eyes." Drilling ended in 1998, but "the neighbors' water well had exploded when fracking fluid spewed causing them to evacuate their home." Mr. Mobaldi further testified that employees of the oil and gas company "told us to stop drinking our water." The "water would fizz like soda with small bubbles." "Sand began to accumulate in our water. If you set a glass of water out overnight an oily thin film would float on top." He also reported that in 2001, his water well "had to be reinstalled ten feet higher because the sand was filling the water well shut." [\[FN121\]](#)

There have also been sporadic news reports on fracking accidents that have gone unreported to public officials suggesting that conclusions*139 that there have been few citizen complaints (as determined by the Ground Water Protection Council's survey, [\[FN122\]](#) for example) may fail to account for the fact that citizens sometimes complain to environmental agencies or local lawyers as opposed to state regulators. In August 2008, for example, Newsweek reported that an employee of an energy-services company in Colorado allegedly "caught in a 'fracturing fluid' spill" arrived in the emergency room "complaining of nausea and headaches." The emergency room nurse who treated the employee "began vomiting and retaining fluid" several days later, and her skin turned yellow. She was diagnosed with chemical poisoning, which she believes was from the fracking fluid she encountered. The material safety data sheet for the fracking fluid, although it contained several unrevealed "confidential compounds" for proprietary reasons, indicated that the fluid contained methanol and that "[p]rolonged exposure can cause kidney and liver damage, irritate lung tissue, decrease blood pressure, and result in dizziness and vomiting." Newsweek reported that "not a single incident report was filed with any government agency by [the companies involved] documenting the spill" that led to the employee's emergency room visit. [\[FN123\]](#)

All of the reports and articles prepared to-date, whether sponsored by a government agency or a non-profit group, suggest that, at least in some regions, fracing has potential environmental effects, such as the contamination of groundwater through direct injection or migration to nearby formations, diminution of groundwater quantities, surface and groundwater contamination from disposal of fracing fluids, and contamination of the surface soil and vegetation. Furthermore, there is a strong consensus against one practice: fracing with diesel fuel. Although the Ground Water Protection Council opposes federal regulation of underground injection of fracing fluids under the Safe Drinking Water Act, [\[FN124\]](#) the Council objects to the use of diesel fuel as fluid used for hydraulic fracturing. It signed a resolution in September 2002 urging "the oil and gas industry to discontinue *140 the use of diesel fuel" as a fracturing fluid in underground sources of drinking water. [\[FN125\]](#) Three industry groups purportedly stopped injecting diesel fuel directly into coalbeds with underground sources of drinking water after they signed a memorandum of agreement with the EPA, [\[FN126\]](#) and the Energy Policy Act of 2005 exempted all forms of fracing from the Safe Drinking Water Act with the exception of diesel fuel. [\[FN127\]](#)

Aside from general agreement over the dangerousness of diesel fuel used in fracing, as well as acknowledgment that fracing has some environmental effects, there is an ongoing debate as to the seriousness and prevalence of these effects - in part because the effects are under-researched to-date, which in turn perhaps partially is due to some companies' opposition to further study. [\[FN128\]](#) The rapid expansion of fracing has not allowed researchers to keep up, and the effects of fracing vary widely by region, making a comprehensive and thorough study difficult. One member of the Ground Water Protection Council Board, for example, urges that the Oil and Gas Accountability's Report does not sufficiently break down effects based on the type of formation being fraced; while fracing in a shallow coalbed may present concerns, he says, fracing in a formation like Montana's Bakken Shale, far from most underground sources of drinking water and with a strong barrier between the formation and the water where sources exist, is relatively benign, [\[FN129\]](#) at least with *141 respect to groundwater contamination. The deepest freshwater formation in the Bakken Shale area, according to Tom Richmond, Administrator of Montana's Oil and Gas Board, has a maximum depth of about 1,500 feet. This creates about 7,000 feet of separation between the shale that is fraced and the lowest portion of the drinking water. Further, there are several hundred feet of salt between the shale and drinking water formations, and salt is an effective barrier to contamination. Salt cannot be effectively fraced because even if fractured for a short time, it collapses and quickly "heals" - the fractures do not remain. [\[FN130\]](#) And Steve Sasaki, Chief Field Inspector with Montana's Board of Oil and Gas Conservation, believes that fracing service companies in Montana have been using relatively non-intrusive fluids - mostly a gel water sand frac, with the gel consisting of a drilling mud or a polymer. [\[FN131\]](#) Ted Loukides, a Mineral Resources Specialist with the New York State Department of Environmental Conservation, makes a similar point and has emphasized to citizens that there is no coalbed methane drilling in New York. Fracing in New York occurs in shale "thousands of feet blow drinking water," he explains. And while there have been citizen complaints in the western United States, he believes that many of the impacts complained of are more related to surface mismanagement of fracing fluid than the actual fracturing of the formation. [\[FN132\]](#) Invariably, effects will differ by region, by the type of operation and disposal methods used, and the type of formation fraced.

The Accountability Project's report, however, is not the only one that suffers from a failure to fully investigate the range of environmental impacts by region. No report has sufficiently investigated and compared the effects of fracing in the many formations currently being tapped for oil or gas. The EPA's report studied fracing in eleven different coalbeds, but it did not investigate shales, where much of fracing boom is now occurring. [\[FN133\]](#) While there is specific data on effects in some regions, as evidenced by the EPA's discussion of citizen complaints and some testing results in four different coalbed fracing regions, none of it has been thoroughly and comprehensively analyzed side-by-side. The current data can typically only *142 tell us that there are effects, some more serious than others; that they differ depending on a number of factors, including the region and the type of fluid used; and that there have been a number of citizen complaints that fracing has contaminated their wells or otherwise affected their property.

IV. Current Regulation of Fracing: A State-centric Process

Although the environmental effects of fracing vary by region and practice, there are some known trends. As dis-

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cussed in Part II, fracking has generated citizen complaints in a number of states - not all related to drinking water - and "[i]n many coalbed methane-producing states, the target coalbeds [for fracking] occur within" underground sources of drinking water. [FN134] Contamination of drinking water sources with concentrations of gases similar to the concentration in coalbeds in these areas has been identified, although there is insufficient information to determine whether fracking has caused or extended the connections between coal formation and underground water sources. [FN135] Beyond this, the literature on the environmental effects is scarce. And just as the effects vary and are in some cases unknown, the regulation of fracking throughout the United States is spotty.

A. The Lack of Federal Regulation

The debate over federal environmental regulations' application to fracking simmered for a time [FN136] before coming to a head in the Eleventh Circuit, where an environmental group argued that the EPA should regulate fracking under the Safe Drinking Water Act's Underground Injection Control regulations. [FN137] Under the Safe Drinking *143 Water Act, the EPA establishes minimum regulatory requirements for Underground Injection Control to be implemented by states and, once the states' programs are approved by the EPA, states retain primary responsibility for administering an Underground Injection Control program unless they fail to meet the minimum requirements. [FN138] At the time of the case, state Underground Injection Control programs were to prohibit unauthorized "underground injection," defined as "the subsurface emplacement of fluids by well injection." [FN139] The EPA approved Alabama's program in 1982 for Class II wells - "[w]ells which inject fluids: (1) [w]hich are brought to the surface in connection with ... conventional oil or natural gas production ...; (2) [f]or enhanced recovery of oil or natural gas; and (3) [f]or storage of hydrocarbons," [FN140] giving the State Oil and Gas Board of Alabama the responsibility of administering that program. In 1983 the EPA approved Alabama's Underground Injection Control program for the remainder of the wells (Classes I, III, V, and VI), to be administered by the Alabama Department of Environmental Management. [FN141] State agencies administering these programs did not believe that wells used for hydraulic fracturing in Alabama coalbeds - several thousand of which had been developed at the time of the case - fell within the definition of any of the wells regulated by the Safe Drinking Water Act. [FN142] The Legal Environmental Assistance Foundation accordingly petitioned the EPA to "initiate proceedings to withdraw approval of the Alabama [Underground Injection Control] program," alleging that the program was "deficient" due to its failure to regulate hydraulic fracturing for methane gas production [FN143] and that two of its members had experienced diminished drinking water quality after fracking. [FN144] The EPA denied the Foundation's petition, concluding that the "principal function" of methane gas wells used for hydraulic fracturing is not "underground injection" as defined by the Underground Injection Control regulations. [FN145] It also disagreed with the Foundation's claim *144 that drinking water was contaminated as a result of hydraulic fracturing. [FN146] The Foundation then filed a petition for review of the EPA's order denying the Foundation's petition with the Eleventh Circuit. [FN147] The court found that the language of the Safe Drinking Water Act requiring that state Underground Injection Control programs approved by the EPA "shall prohibit...any underground injection in such State which is not authorized by a permit issued by the State (except that the regulations may permit a State to authorize underground injection by rule)" [FN148] gave a "straightforward statutory command" [FN149] and "dictated that all underground injection be regulated under the UIC programs." [FN150] Accordingly, the court granted the Foundation's petition for review of the EPA's denial of the Foundation's petition to initiate proceedings to withdraw Alabama's UIC program as a result of the program's failure to regulate fracking and remanded the case to the EPA. [FN151] Alabama eventually incorporated fracking into its UIC regulations under a portion of the Safe Drinking Water Act that applied to secondary recovery of resources, which the EPA and the court accepted. [FN152]

Following LEAF, the EPA commenced a study to determine whether the Safe Drinking Water Act should apply to fracking. Several industry groups encouraged the EPA to conclude that it should not apply and lobbied Congress to exempt fracking from the Act, [FN153] *145 while environmental groups argued for federal regulation. [FN154] Ultimately, the Energy Policy Act of 2005 exempted all fracking with the exception of diesel fuel from the definition of underground injection in Section 1421 of the Safe Drinking Water Act, providing:

The term "underground injection"--

(A) means the subsurface emplacement of fluids by well injection; and

(B) excludes--

- (i) the underground injection of natural gas for purposes of storage; and
- (ii) the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities. [\[FN155\]](#)

Although the Act conclusively withdrew fracing from the realm of federal regulation, the debate over fracing has not died. Several environmental groups have continued to push for federal regulation, [\[FN156\]](#) while industry and states argue that the Energy Policy Act reached the right result. The Chairman of Texas' Railroad Commission, for example, testified before the House Committee on Energy and Commerce in February 2005 that "regulations at the Federal level would not result in cleaner water but only in adding significant cost" and applauded "the provisions of the Energy Policy Act of 2005 in *146 this respect." [\[FN157\]](#) The Independent Petroleum Association of America wrote in a bulletin summing up the political year, "The Safe Drinking Water Act was clarified to prevent new federal regulation threatened by a 1997 decision - a significant success given the increasingly important use of hydraulic fracturing." [\[FN158\]](#) Despite the debate, the Energy Policy Act remains. As such, aside from the possibility of sporadic application of federal statutes, [\[FN159\]](#) control lies in the states.

B. Fracing in the Courts: A Focus on Trespass and Ownership, not Environmental Effects, with Potential Opportunities for Nuisance

The dearth of federal regulation of fracing would be less of a concern if courts systematically addressed, through the common law or interpretation of state statutes, problems caused by fracing. Courts have, however, generally played a narrow role. As a relatively new technology, [\[FN160\]](#) fracing has come before courts in only a limited number of cases, typically presenting ownership, pooling, and trespass questions as well as related damages issues. No state cases appear to have directly addressed claims of environmental damage caused by fracing.

In Utah, the state supreme court addressed a fracing-related pooling issue (forced "sharing" of resources underlying different tracts of *147 land, in order to prevent one owner from obtaining an unfair portion of resources from an underground reservoir) in the "Drunkards Wash Field," part of a coalbed methane-producing formation. [\[FN161\]](#) The River Gas Corporation created an exploratory unit [\[FN162\]](#) and attempted several times to lease private lands in the area, but the landowners refused. Notably, River Gas did not alert the landowners to the fact that it was drilling other wells in the area and that a large percentage of the drainage field was beneath their property. [\[FN163\]](#) River Gas drilled a well closer to the landowners' tract than was permitted by the Utah Administrative Code, failing to obtain consent from the landowners, and Utah's Bureau of Land Management office mistakenly approved the well. [\[FN164\]](#) One of the landowners noticed the well when he was working on his land, and the landowners leased their land to Hegarty, hoping to offset the drilling and fracing and protect their interests. [\[FN165\]](#) Hegarty and River Gas attempted but failed to agree on a voluntary pooling arrangement, and Hegarty sought Board action on pooling, requesting that pooling be made retroactive. [\[FN166\]](#) The Utah Board of Oil, Gas, and Mining denied retroactive pooling. [\[FN167\]](#)

The Utah Supreme Court affirmed the denial of retroactive pooling, finding that although the landowners had not received official notice of the drilling, "[l]andowners knew their correlative rights, or at least had notice to inquire after them" but failed to do so. [\[FN168\]](#) Furthermore, although "[m]ethane gas recovery in the [Drunkard Wash Unit] has involved depressurization, hydraulic fracturing, and draining," of the gas from beneath the landowners' property, meaning that River Gas could have entered an agreement for cooperative development, it was not required to do so: the Utah statute did not require pooling agreements and was merely permissive. [\[FN169\]](#) In sum, "parties in possession of the necessary information to act in protection of their own rights bear the responsibility for doing so," and there was no mandatory pooling. [\[FN170\]](#) The landowners failed to protect *148 their interests, the court concluded, and could not obtain retroactive pooling. [\[FN171\]](#)

In Pennsylvania, the Superior Court in *U.S. Steel Corp. v. Hoge* [\[FN172\]](#) addressed the question of who owns coalbed gas and indirectly reached related trespass issues. U.S. Steel owned coal in Greene County, and two separate parties owned the surface of two tracts overlying the coal. [\[FN173\]](#) These parties' predecessors had relinquished the right to the coal through severance deeds, reserving the "right to drill and operate through said coal for oil and gas

without being held liable for any damages." [\[FN174\]](#) The surface owners leased "all of the oil and gas and all of the constituents of either in and under" the surface to Cunningham, the gas and oil lessee, who promised to give one-eighth of all methane gas, casing gas, and gas "produced and sold" under the surface to the surface owners/lessors. [\[FN175\]](#) U.S. Steel intended to mine coal in a coal seam underlying the two tracts but then learned that Cunningham had begun drilling for coalbed gas in the coal seam and planned to use hydrofracturing to increase production. It brought an action for trespass and urged that it owned the coalbed gas in the coal seam. [\[FN176\]](#) The Superior Court concluded, based on the deed language, that in purchasing the coal, U.S. Steel had not purchased the coalbed gas, although it could "exploit the coalbed gas released in its mining operations," [\[FN177\]](#) thus finding in favor of the surface owners. The Pennsylvania Supreme Court reversed, finding that "as a general rule, subterranean gas is owned by whoever has title to the property in which the gas is resting" but that "[w]hen a landowner conveys a portion of his property, in this instance coal, to another, it cannot thereafter be said that the property conveyed remains as part of the former's land, since title to the severed property rests solely in the grantee." [\[FN178\]](#) It concluded that such gas as is present in coal must necessarily belong to the owner of the coal, so long as it remains within his ***149** property and subject to his exclusive dominion and control. The landowner, of course, has title to the property surrounding the coal, and owns such of the coalbed gas as migrates into the surrounding property. [\[FN179\]](#)

As such, it determined, "[T]he coal owner may mine his coal, extract the gas from it, or both. If he chooses to extract the gas, drilling as well as hydrofracturing are available means, so long as their utilization does not impinge upon the rights of owners of the surrounding property." [\[FN180\]](#) U.S. Steel clarifies the rights that belong to coal owners as opposed to surface owners - giving the coal owners the right to frac or use other creative extraction techniques, provided this does not impinge excessively on the surface owner's rights - but leaves open the question of whether coal owners who choose to frac to extract coalbed gas may induce fractures in neighboring subsurface property without being liable for trespass.

A recent landmark Texas case, *Coastal Oil & Gas Corp. v. Garza Energy Trust*, [\[FN181\]](#) decided this issue, at least partially, in the affirmative. In an opinion finding that trespass damages for gas royalties lost due to drainage from fracing are not recoverable, [\[FN182\]](#) one concurring justice wrote that fracing is simply not a trespass, no matter what types of damages are sought. [\[FN183\]](#) This case is likely to influence not only the state of the hydraulic fracturing business in Texas but also future decisions, as other jurisdictions will look to a court in the heart of oil and gas country for guidance. In *Coastal Oil*, the Salinas family and other respondents (which the court refers to collectively as "Salinas") owned "Share 13," a 748-acre tract of land in Hidalgo County. [\[FN184\]](#) Because Salinas leased the minerals on Share 13 to a production company, Salinas had a "royalty interest and the possibility of reverter" in the minerals. [\[FN185\]](#) *Coastal Oil & Gas Corp.* ("Coastal") leased the minerals on Share 13 as well as the adjacent tracts, Share 15 and Share 12. It later acquired the mineral estate on Share 12. A natural gas reservoir called the Vicksburg T formation ***150** underlies all three tracts. [\[FN186\]](#) The reservoir "is a 'tight' sandstone formation," meaning that fracing is necessary for commercial production of natural gas from the reservoir. [\[FN187\]](#) Coastal used fracing to drill three wells on Share 13 and a highly productive fourth well close to the Share 12-Share 13 border. Coastal drilled another well very close to the same border, this time on Share 12, and yet another well close to the border on Share 13. Pursuant to Railroad Commission requirements, it shut in one well on Share 12 that was close to the border, as the Commission was concerned that two adjacent wells on Share 12 would drain natural gas from Share 13. [\[FN188\]](#) Despite this shut-in to alleviate drainage concerns, Salinas sued Coastal, arguing that it had breached its implied covenants by failing to develop Share 13 and by failing to prevent drainage from Share 13, urging that gas from Share 13 was draining to Share 12. Coastal commenced a "flurry of drilling" on Share 13. [\[FN189\]](#) For one well on the northeast corner of Share 12, "the fracing hydraulic length was designed to reach over 1,000 feet from the well," while "the farthest distance to the Share 13 lease line was 660 feet." [\[FN190\]](#) Fractures from the well on Share 12, in other words, would most certainly extend onto Share 13. Neither party was certain as to how far the fractures extended onto Share 13, although they agreed that the fractures were longer than 660 feet. [\[FN191\]](#) Salinas asserted, among other claims, that Coastal trespassed by fracing the well on Share 13 and draining gas from the reservoir. [\[FN192\]](#) Salinas' expert testified that 25-35% of the gas that the well on Share 12 produced through fracing consisted of gas drained from Share 13. [\[FN193\]](#)

Addressing the respondents' trespass claim, the Texas Supreme Court looked not directly at trespass but rather to the rule of capture, which "gives a mineral rights owner title to the oil and gas produced from a lawful well bot-tomed on the property, even if the oil and gas flowed to the well from beneath another owner's tract," a rule that is "fundamental both to property rights and to state regulation." [FN194] *151 Under this rule, the court observed, the adjacent landowner who may be harmed by a nearby operating well has remedies to prevent that well from draining away all of the gas underlying her property. She may drill an offset well herself, or, if she has leased the mineral rights on her property, she may sue the mineral lessee to drill a well to uphold the covenant to protect against drain-age. [FN195] In some cases, an offset well may still not protect against drainage, in which case the adjacent land-owner may offer to pool, wherein some of the adjacent landowner's land is added to land where there are other wells draining the gas beneath her property. The landowner receives a share of the royalties, or whatever other rights the lease may afford her, in the oil or gas produced from all of the pooled wells. [FN196] If her offer is rejected, the Railroad Commission may force pooling. [FN197]

The court observed that "the rule of capture determines title to gas that drains from property owned by one person onto property owned by another" and is justified because of the many remedies available to the adjacent owner. [FN198] It found no reason for why the rule should not apply to coalbed gas and concluded that "[t]he rule of cap-ture makes it possible for the [Railroad] Commission, through rules governing the spacing, density, and allowables of wells, to protect correlative rights of owners with interests in the same mineral deposits while securing 'the state's goals of preventing waste and conserving natural resources.'" [FN199] In sum, given the strength of this rule and its clear applicability to the gas at issue in the case, the court determined that under the rule of capture, the gas underly-ing respondents' property did not in fact "belong" to respondents. Under this view, damages for gas drained from beneath one property by fracing - a process that also extends fractures, fracing fluids, and proppants beneath *152 those properties - is not an actionable trespass but rather an activity properly governed by the rule of capture and its associated remedies. [FN200] In looking to the strength of the rule, the court also emphasized the power of the Rail-road Commission to provide remedies where the rule creates problems and gave deference to those remedies, find-ing, "No one suggests that these various remedies provide inadequate protection against drainage." [FN201]

Three justices concurred in the opinion but did not join in the trespass portion of the opinion. These three justices would not have relied on the rule of capture but would have first looked directly at the trespass issue - asking whether "hydraulic fracturing across lease lines constitute[s] subsurface trespass." [FN202] In Texas, they empha-sized, "the underlying premise is that a landowner owns the minerals, including oil and gas, underneath his prop-erty." [FN203] The rule of capture - permitting another entity to capture oil and gas - applies only where that entity legally captures the oil and gas. An operation like fracing cannot be a legal method of capture if it is a trespass. [FN204] The three concurring justices did not conclude whether fracing is a trespass but suggested that it may be, pointing out that deviated wells - those that cross onto adjacent property - are a trespass in Texas, and that both fracing and deviated wells "involve a lease operator's intentional actions which result in inserting foreign materials without permission into a second lease, draining minerals by means of the foreign materials, and 'capturing' the min-erals on the first lease." [FN205]

Coastal Oil only addressed the question of whether "incursion of hydraulic fracturing fluid and proppants into an- other's land two miles below the surface constitutes a trespass" and whether the owner, through trespass, could re- cover damages for the royalties the owner would have recovered from the gas beneath his land drained by fracing. [FN206] The only injury asserted by the respondents in Coastal Oil was the loss of gas through drainage, not that the extension *153 of fractures and fracing fluid underneath the property damaged his land or deposited materials on the surface. [FN207]

Other state cases have addressed practices that, like fracing, require the introduction of off-site substances beneath a property in order to extract oil or gas. These, too, tend to give the benefit of the doubt to the producer, looking to the central purpose of oil and gas leases, which is "obtaining production" or, in many cases, "obtaining additional oil [or gas] production." [FN208] In Crawford v. Hrabe, for example, the Kansas Supreme Court addressed the question of "whether a lessee/oil operator has the right without the lessor/landowner's consent to bring off-lease salt water upon

the leased premises for [the] purpose of injecting it into the producing formation in a secondary recovery project." [FN209] The Court concluded that the operator did have this right and that injecting the water was not an "enjoinable trespass" [FN210] because "Crawford's salt water injection [was] related to the primary purpose of obtaining additional oil production;" [FN211] the water was being injected to improve the productivity for the lessor's lease - not other leases; [FN212] "[t]he secondary recovery operations increased production," were "beneficial to all parties;" and the off-lease salt water used for injection was "economically available." [FN213] The Kansas court also relied on other state cases with holdings that supported its conclusion, citing, for example, Railroad Commission of Texas v. Manziel [FN214] for the proposition that the injection of salt water on one property that migrates to another property is not an enjoinable trespass, provided its purpose is for secondary recovery. [FN215] Indeed, the Manziel case has strains of the same deference to state agency decisions in the oil and gas field as are later reiterated in Coastal Oil. The Court in Manziel concluded,

[I]f, in the valid exercise of its authority to prevent waste, protect correlative rights, or in the exercise of the powers *154 within its jurisdiction, the Commission authorizes secondary recovery projects, trespass does not occur when the injected, secondary recovery forces move across lease lines, and the operations are not subject to an injunction on that basis. The technical rules of trespass have no place in the consideration of the validity of the orders of the Commission. [FN216]

The Pennsylvania and Texas fracing cases, as well as other cases addressing similar techniques used to increase oil and gas production, have a common theme: the owners of mineral rights or mineral lessees need to be able to extract the resources that are part of these rights, including gas or oil that may be difficult to reach. To be able to do so and to avoid waste, they may need to use relatively intrusive or unconventional extraction strategies such as those that induce long fractures into the subsurface property. They are entitled to do so, although surface owners and adjacent owners may have recourse in the courts for physical damage, particularly physical damage to the surface. As the Texas Supreme Court noted in Coastal Oil, "[h]ad Coastal caused something like proppants to be deposited on the surface of Share 13, it would be liable for trespass." [FN217] And the court's language suggests that had Salinas claimed "that the hydraulic fracturing operations damaged his wells or the Vicksburg T formation beneath his property," he might have claimed damages that were recoverable in a court of law. [FN218] Thus, the case law does not remove state courts entirely from the regulation of the effects of fracing. The extent to which courts may be used to challenge physical damage to property caused by fracing - whether the surface owner's or adjoining property - remains to be seen. Furthermore, the Texas court made clear its general distaste for court intervention into fracing, stating that

briefs from every corner of the industry - regulators, landowners, royalty owners, operators, and hydraulic fracturing service providers - all oppose liability for hydraulic *155 fracturing, almost always warning of adverse consequences in the direst language. Though hydraulic fracturing has been commonplace in the oil and gas industry for over sixty years, neither the Legislature nor the [Railroad] Commission has ever seen fit to regulate it, though every other aspect of production has been thoroughly regulated. Into so settled a regime the common law need not thrust itself. [FN219]

State courts' general deference to state agency decisions, as highlighted by Coastal Oil, makes sense from the production perspective because it avoids overlapping and potentially conflicting sources of control. If a state commission authorized a method of oil or gas recovery, only for a producer to discover that she was liable for trespass in court, it is likely that producers would quickly become frustrated and either lobby for change or simply give up and drill elsewhere. And courts also reasonably engage in a "balancing of interests" approach when looking to a given method of oil or gas recovery, weighing the interests of the surface owner in preserving the surface against those of the producer in wringing as much oil and gas from the subsurface as is feasible and productive. As the court in Manziel determined, "Certainly, it is relevant to consider and weigh the interests of society and the oil and gas industry as a whole against the interests of the individual operator who is damaged." [FN220]

The balancing of interests approach, however, often weighs on the side of the producer and is not very helpful to plaintiffs claiming injury. The Texas Supreme Court in Manziel, for example, determined that "if the authorized activities in an adjoining secondary recovery unit are found to be based on some substantial, justifying occasion,

then this court should sustain their validity." [\[FN221\]](#) As traditional oil and gas reserves become less productive and more unconventional sources are tapped, the interests of producers, consumers, and states will only add more weight to the resource production side. As one concurring justice in *Coastal Oil* concluded, "Amid soaring demand and sagging supply, Texas common law must accommodate cutting-edge technologies able to extract untold reserves from unconventional fields." [\[FN222\]](#)

***156** Even if fracking were to be considered to be a trespass--which might not be the "right" result given state courts' precedential deference to practices that increase production and avoid waste--it is not an ideal method to regulate the environmental effects of fracking. The physical presence of contaminants that leak into nearby formations or onto the surface might not be discovered for decades, and the ability of landowners to identify contaminants, particularly those thousands of feet below the ground, is limited. As such, landowners would have difficulty identifying causes of action in trespass, aside from situations where obvious pools of fracking fluids crossed their boundary line.

Nuisance might be a feasible alternative to trespass, particularly in places like the Fort Worth region where residents on suburban lots may be able to prove easily that their lawn used to be green but is now dead from fracking fluids or other fracking-related surface activities. [\[FN223\]](#) Lower courts in Texas, for example, have consistently validated city and other local oil and gas ordinances that protect human populations from the nuisances caused by drilling, such as water supply contamination, [\[FN224\]](#) the prevention of "orderly growth" of a city, [\[FN225\]](#) or "'escaping gas, explosions, fire, cratering, etc.'" [\[FN226\]](#) But landowner's general difficulties encountered in identifying fracking contaminants or other effects, which present problems in trespass cases, also carry over to causation problems in nuisance suits. A landowner who experiences decreased water pressure or a dried up well may be unable to prove that a fracking operation caused these problems. Nuisance suits will likely be insufficient to adequately address the effects of fracking.

If state courts and the federal government continue to leave most of the regulation of oil and gas extraction to state agencies, and given the limitations of common law nuisance and trespass to address fracking, the question remains whether state regulation will ensure that human health and environmental concerns are adequately considered as fracking becomes more prevalent.

***157 C. State Regulation: Varying Levels of Complexity**

Given the lack of federal regulation and the likelihood that state courts, following *Coastal Oil*'s lead, will be hesitant to interfere with states' regulation of fracking, state regulation is the central mechanism controlling fracking and its effects. And states do, to some extent, have programs in place. The Ground Water Protection Council found that four of the eight "major producing states" had "regulatory or oversight programs in place specifically for coalbed methane wells," and the remaining states regulated the wells through their "general oil and gas production rules." [\[FN227\]](#) It concluded, as of 1998, that "[e]xisting state authorities and oversight of this process have been obviously sufficient to protect [underground drinking water sources] from contamination" from coalbed methane wells, and that "[i]f additional federal regulations were to be imposed they would not be based on scientific observation of associated contamination and there would be little if any increase in protection of public health and the environment." [\[FN228\]](#) Of course, in the past ten or so years, much has changed. There are more wells, higher production levels, and new fracking technologies. Most states continue to regulate fracking as part of the general permitting process for drilling.

Although the Texas Supreme Court observed in *Coastal Oil* that Texas has consistently declined to regulate fracking, [\[FN229\]](#) some regulation of fracking in Texas occurs through approval of the drilling permit application as well as more general controls over groundwater withdrawals and surface disposal. Although these regulations do not specifically mention fracking, they apply to various components of the fracking process. Each operator wishing to drill and frac a well in Texas must submit an application for a permit to drill, deepen, plug back, or reenter any oil well. [\[FN230\]](#) Texas does not require an environmental review or assessment of a proposed drilling operation, unlike, for example, New York and Pennsylvania, but it does require operators to "obtain and file a 'Water Board Letter' from the Texas Commission ***158** on Environmental Quality." [\[FN231\]](#) In a "Surface Casing" Letter, the operator must

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submit a "location map" with surveys and a copy of the well's log (if the driller is re-entering a previously-drilled well). [FN232] After reviewing the request, the Commission on Environmental Quality may require the operator to obtain a groundwater protection recommendation letter from the Commission, which "states the depth to which groundwater must be protected in the well or other boring." [FN233] For disposal of drilling wastes, including fracturing fluids, operators may only use authorized disposal methods or obtain a disposal permit. [FN234] Operators are also prohibited from "caus[ing] or allow[ing] pollution of surface or subsurface water in the state." [FN235] An operator may dispose of wastes in a pit only "if the commission determines that the [disposal] will not result in the pollution of surface or subsurface waters." [FN236] For offsite disposal, an operator must use a carrier with a permit to transport wastes. [FN237]

In Montana, fracturing is also regulated through general oil and gas permitting requirements. Drillers request approval for fracturing as part of an application for a Permit to Drill from Montana's Board of Oil and Gas Conservation. [FN238] Fracturing typically occurs in association with horizontal drilling. [FN239] An operator applying for horizontal drilling creates a temporary spacing unit - describing where the wells will be located - and then after production is established, typically within 90 days, returns to the Board for approval of permanent spacing. [FN240] At this point, if landowners are concerned that operators will encroach on their mineral rights, they may contest the operator's *159 spacing at a hearing. [FN241] Once a drilling permit is approved and the operation is completed, the driller submits a Completion Report. If the operator fraced as part of the drilling operation, the operator must report information such as the length of fractures and the pressures and types of fluids used. [FN242]

There is a separate permitting process for operators that frac after submitting a Completion Report. These operators must submit a form entitled "Sundry Notices and Report of Wells" to the Board, [FN243] and provide "Notice of Intention to Stimulate or Chemically Treat." [FN244] In these forms, the operator must describe the formation in which the fracturing will occur and the fracturing process to be followed. Provided there are no issues with respect to correlative rights and the fracturing will occur in a single formation, the Board typically approves the request. Following completion of fracturing, the fracturing service company submits a subsequent report on stimulation effects, including data such as the fracturing pressures used and the total amount of fracturing completed. [FN245]

Although New York also regulates fracturing through its general oil and gas permitting provisions, [FN246] these provisions require more specific measures for environmental protection than do Montana's regulations, and the state has been working to update its Generic Environmental Impact Statement to consider the potentially widespread horizontal drilling of Marcellus Shale units; the results of the update were slated to be published in a draft scoping document, [FN247] which would be available for public comment. [FN248] An operator applying to drill and frac in New York must submit an application for a Permit to Drill, Deepen, Plug Back or Convert a Well, along with "[a] description of the proposed drilling program, three copies of a plat, the *160 permit fee, and an Environmental Assessment Form." [FN249] The permit application must indicate, inter alia, whether the drilling will be vertical, directional, or horizontal, the "proposed target formation," the type of well, the drilling fluid to be used, and the type of tools used. The Environmental Assessment form, which each applicant must submit along with a drilling permit, requires the applicant to answer detailed questions regarding "water storage and disposal" and describe how drilling and stimulation fluids will be contained and disposed of. The applicant must also describe the project and its dimensions, and the percentage of the project site that is forest or agricultural land or other vegetated land. [FN250] The applicant must indicate the "environmental resources on/near the project site," such as whether the site is "over a primary or principal aquifer; whether it is within a certain distance of a public water supply well, surface municipal water supply, or "lake, stream, or other public surface water body"; within an agricultural district; in a flood plain or regulated wetland; in an area with threatened or endangered animal life; or in a coastal zone management area or "Critical Environmental Area." [FN251] Furthermore, the applicant must explain whether topsoil will be disturbed and whether the applicant will implement erosion control measures as well as whether the applicant will build new access roads or use existing corridors. [FN252]

New York's Department of Environmental Protection reviews fracturing proposals that accompany applications for permits to drill in New York to ensure that applicants describe the chemical constituents of fracturing fluids and give a

"cradle to grave" description of the acquisition of water for drilling, including methods of acquisition, location of the water source, and transportation of water onto the site. [\[FN253\]](#)

Similar to other states' general requirements for obtaining drilling permits, an operator intending to drill or re-enter a well in Colorado ***161** must submit an Application for Permit-to-Drill to the Director of the Oil and Gas Conservation Commission. This application must indicate, among other things, the proposed well location and water wells and other water sources within 200 to 400 feet of the wellhead. [\[FN254\]](#) The Director may "withhold approval of any Application for Permit-to-Drill" if the Director "has reasonable cause to believe" that the proposed well "presents an imminent threat to public health, safety, and welfare, including the environment." [\[FN255\]](#) If an operator plans to commence "subsequent well operations" that will further impact the surface, including fracing, the operator must submit a Notice of Subsequent Well Operations at least seven days before operations are anticipated to commence. [\[FN256\]](#)

Operators wanting to perform "enhanced recovery operations" such as fracing in Colorado must first submit an application for authorization to the Commission. [\[FN257\]](#) Most of the detailed requirements for reporting - including the type and amount of fluid as well as a chemical analysis of the fluid [\[FN258\]](#) - apply to underground injection wells used to enhance recovery, not fracing. But operations that intend to use fracing must include "[a] description of any proposed stimulation program" [\[FN259\]](#) in their application for authorization. Colorado, like Texas and New York, also has regulations for the management and disposal of oily wastes, one of which includes "frac sand," [\[FN260\]](#) requiring operators to either dispose of the waste at a commercial solid waste disposal facility or through land treatment. If the operator uses the land treatment option, the free oil must first be removed from the oily waste before treatment, the oily waste "shall be spread evenly," and "[c]ontamination of ground water or surface water shall be prevented." [\[FN261\]](#) The Director may require a more comprehensive plan "[w]hen a threatened or significant adverse environmental impact from onsite land treatment exists." [\[FN262\]](#)

Due to the recent increase in shale fracing, Colorado has also considered revising its oil and gas regulations to include more environmental ***162** protections and allow more landowner participation in decisions on permits to drill; deliberations were slated to be complete by the end of September 2008. [\[FN263\]](#) A staff proposal from September 2008 suggested that the requirements for drilling and recompletion applications be modified to require an operator, prior to drilling or commencing subsequent well operations such as fracing, to give notice to "any party that has indicated a desire to receive it," rather than only to the surface owner of the property being fraced. [\[FN264\]](#) In the Notice of Subsequent Well Operations, the proposed modifications would require an operator to provide:

to the surface owner or agent at least seven (7) days advance notice of subsequent well operations with heavy equipment that will materially impact surface areas beyond the existing access road or well site, such as recompletion or refracturing of the well, and specifically including plugging and abandonment of the well and final reclamation. [\[FN265\]](#)

The modified rules in Colorado, if accepted, will provide relatively comprehensive regulation of all aspects of fracing, as they address the underground and surface impacts; they also provide specific opportunities for citizens to voice concerns about a proposed fracing project. New Mexico has implemented similar changes to its oil and gas rules as fracing in the San Juan basin has become increasingly common; a new "pit rule" governing disposal of wastes from oil and gas operations places limitations on chemical constituents sometimes found in fracing fluids (although not referring to them as such), requiring operators to take special precautions when closing a pit that is near groundwater. Operators must sample the area for chemicals like benzene or BTEX - benzene, toluene, ethylbenzene, and xylenes ***163** - and ensure that they do not exceed designated concentration limits. [\[FN266\]](#)

Like New Mexico and Colorado, Pennsylvania has relatively strong fracing controls. Although it regulates fracing as part of its general oil and gas regulations, it mentions fracing extensively in regulations and best management practices aimed to control the environmental effects of oil and gas drilling. It also has separate regulations addressing the drilling and fracing of wells in the Marcellus Shale.

As in other states, any operator wishing to drill for oil or gas in Pennsylvania must obtain a well permit. [\[FN267\]](#) The application for a well permit must indicate, inter alia, the proposed location of the well, "the name of all surface landowners or water purveyors whose water supplies are within 1,000 feet of the proposed well location," and the workable coal seams underlying the tract. [\[FN268\]](#) There are special spacing requirements for gas wells drilled in coal areas. These wells must be "not less than 1,000 feet from other such wells," and 330 feet from the tract boundary, although exemptions are permitted. [\[FN269\]](#) The Pennsylvania Department of Environmental Protection may deny a permit application if issuing the permit would violate "any applicable environmental statute, rule or regulation." [\[FN270\]](#) If the surface owner is not the same entity as the operator, the surface owner may file objections if the owner believes that the proposed well location violates the rules or that the application has incorrect information. [\[FN271\]](#) A landowner or purveyor of water who experiences problems with water quality or quantity after drilling may request the Department to conduct an investigation, and the Department must determine within 45 days whether the drilling caused the pollution. If there is a causal connection, or if the Department presumes that the well operator is responsible, the Department orders the operator to restore or replace the water supply. [\[FN272\]](#) The Department presumes that well operators are responsible for water pollution occurring within six months after drilling or completion of a well that is within *164 1,000 feet of a water well, unless the well operator provides an affirmative defense. [\[FN273\]](#)

Pennsylvania also has specific requirements for the disposal of waste and wastewater from drilling and fracing, requiring a control and disposal plan for fluids, including "stimulation fluids" (those used in fracing). [\[FN274\]](#) Its regulations on "activities utilizing pollutants" are similarly stringent, requiring that operators submit "a report or plan for activities" and stating that "[t]he Department will encourage the use of pollution prevention measures that minimize or eliminate the generation of the pollutant," including "reuse, recycling, treatment and disposal." [\[FN275\]](#)

To satisfy Pennsylvania's requirement for a plan for the disposal of fluids from drilling (and fracing), an operator completes and implements a "Preparedness, Prevention and Contingency (PPC) Plan for Oil and Gas Development." [\[FN276\]](#) In the plan, the operator must list the chemicals in the fracing fluids, including data on their toxicity, and describe the wastes generated and methods for clean-up, disposal, or reuse of waste. [\[FN277\]](#) The operator must also designate a representative to report pollution incidents. [\[FN278\]](#) The management practices encourage operators to use "[e]fficient [f]rac [f]luids" such as foam frac and "[a] polymeric material." [\[FN279\]](#) Further, the management practices attempt to reduce surface impacts of drilling and fracing, encouraging, for example, "unloading pad[s]" to prevent vehicles from carrying mud from the drilling site onto public roads [\[FN280\]](#) and asking operators to identify all water sources that could be affected by activities on the surface or subsurface before preparing the site or drilling. [\[FN281\]](#) Finally, Pennsylvania's management practices provide guidance on treating and discharging waste fluids, explaining that some fracing fluids can be treated and discharged on the surface of the site but that this method typically requires the operator to acquire a National Pollutant Discharge Elimination permit (a Clean Water Act requirement) and a permit under Pennsylvania's Clean Streams Law. [\[FN282\]](#)

*165 Operators planning to drill for oil and gas in the Marcellus Shale formation in Pennsylvania must also submit special water management plans and specific descriptions of the well site. Like other oil and gas drillers, they must "develop and implement" a Preparedness, Prevention and Contingency (PPC) Plan including "a description of the operation, pollution prevention measures, chemicals or additives used and waste generated, waste disposal methods, incident response plans and corrective action plans, and an implementation schedule." [\[FN283\]](#) This evaluation must show the water uses on the site prior to fracing and/or drilling and that the operator will protect the water quality necessary for those uses and will not "cause pollution." Further, the applicant must "[p]rovide chemical analysis of the fracing fluids to be added to the raw water," a "sampling and analyzing plan for all fluids (associated with fracing) that are used, reused/recovered, processed/treated, stored and disposed," and describe how the fluids and wastewater will be managed onsite or at the treatment facilities to which they will be sent. [\[FN284\]](#)

Alabama, a state where fracing primarily occurs in coalbeds, has a long experience with fracing regulation. It is the only state to have regulated fracing through its Underground Injection Control program, although it now joins other states in regulating through the general permitting process. [\[FN285\]](#) Following the LEAF case, fracing was regu-

lated as "an injection well which is used for enhanced recovery of oil or natural gas" under the definition of Class II injection wells in Alabama's underground injection well regulations. [FN286] An applicant for a Class II well injection was required to follow a two-step process. The first step was the application for drilling, conversion, or reentry of a plugged and abandoned well for injection purposes; the application required, among other things, a description of the procedures for the proposed injection, the "estimated location of the base of the deepest" underground source of drinking water, a description of where the fracturing fluids would come from and what they would consist of, the estimated pressure for injection the fluids, the amounts of fluids to be used daily, and proof that the operator *166 has notified the public of the proposed fracturing. The second step, involving the "Application for Permit to Inject Fluids," required, among other things, a well bore sketch showing the depth of the injection formation and again, the "base of the deepest" underground source of drinking water, an affidavit and statement "specifying the source of injected fluids," and proof that the well would be protected with casing such that the "injected fluids cannot migrate" to the underground drinking water source. [FN287] Like Pennsylvania, this regulatory system covered a range of the effects of fracturing, from the use of toxic fluids to concerns about the source of the fluid and the potential migration of contaminants to nearby formations. In 2007, however, Alabama's Oil and Gas Board voted to "exclude hydraulic fracturing from the regulatory requirements of the Class II Underground Injection Control Program." [FN288]

Like most other states with fracturing operations, Alabama now regulates fracturing activities through the oil and gas permitting process, although it has additional requirements to control the effects of fracturing. Operators proposing to fracture a coalbed must submit a \$175 check with their proposal to fracture, and special approval from the Oil and Gas Board Supervisor is required before fracturing commences. The Operators must provide the Supervisor with a document describing the name of the coalbed and the depth of proposed fracturing, maintain "an inventory of fresh water supply wells within a one quarter mile radius" of the fraced well, and must "affirm to the Supervisor, in writing," that the "inventory of fresh water supply wells have [sic] been evaluated and that the results of this evaluation indicate that the proposed hydraulic fracturing operations can be conducted without adverse impact on any fresh water supply wells or any fresh water resources." [FN289] The operator must also describe the likely maximum length and direction of the fractures, and detail which types of fluids and other materials will be used in the fracturing operation. [FN290] The use of diesel fuel as a fracturing fluid is prohibited. Finally, operators must *167 maintain "all records associated with each [fracing] proposal" for at least three years following the completion of fracturing. [FN291]

This sampling of state regulations shows the wide range of fracturing controls that exist today. Some states have only basic regulations that address fracturing indirectly, while others have comprehensive requirements covering nearly every step of the fracturing process. Most states are, at minimum, collecting data on the fracturing fluids used and the formation that has been fractured. A few address groundwater withdrawal and disposal concerns specific to fracturing. And still fewer allow public participation in the decision to grant a permit to drill and frac, beyond complaints of traditional neighboring landowner concerns such as drainage of the oil and gas beneath their property. Few states have banned the use of hazardous fracturing fluids, and few have specifically addressed the concerns that arise where fractures extend further than anticipated and enable fracturing fluids to flow into neighboring formations. The following Part discusses the implications of this regulatory structure, urging that both states and the federal government should revisit their regulations after obtaining better scientific data on the range of the potential and observed effects of fracturing.

V. Regulatory Problems and the Need for Reform

The varying complexity and breadth of state oil and gas regulations suggests that some states are not adequately protecting underground sources of drinking water - sources that are of federal concern - from the impacts of fracturing. It is true that many fracturing fluids are benign; [FN292] but others like benzene or formaldehyde can be toxic at certain concentrations [FN293] and are currently not directly regulated at the federal or state level in the context of fracturing. The EPA concluded in its 2004 report that "evidence suggests that coalbeds in 10 of the 11 major coal basins in the United States are located at least partially within" underground sources of drinking water. [FN294] And *168 fracturing activity in recent years has rapidly expanded in several shale formations throughout the United States. Yet in a report questioned by members of Congress and an EPA whistleblower, [FN295] the EPA determined that

further research, was unnecessary, [\[FN296\]](#) and fracing was ultimately exempted from federal regulation. [\[FN297\]](#)

A. Federal regulatory failures

Despite the EPA's and several environmental and national non-profit groups' having conducted preliminary studies of the effects of fracing, the full range of effects remains largely untested. As such, we cannot yet know the extent of the regulatory failure, unlike a pollutant like MTBE, for which the gravity of regulatory problems is now widely recognized. [\[FN298\]](#) It is possible, however, to identify several problems that foreshadow potentially grave concerns for the future with respect to the effects of fracing. This is best accomplished by looking to the broader environmental literature on regulatory failures.

A useful reference point is MTBE, which is perhaps the quintessential case study for regulatory decisions gone awry. Tom McGarity provides a thorough analysis of these failures in his article, MTBE: A Precautionary Tale, describing the several "critical points" at which EPA or Congress could have avoided the regulatory pitfalls that occurred for this groundwater contaminant. [\[FN299\]](#) Given the potential effects of MTBE and its presence in drinking water sources throughout the United States, its continued contamination of these sources [\[FN300\]](#) raises regulatory flags. McGarity discusses two critical steps in the MTBE regulatory process that may be relevant to fracing. The first was the omission of MTBE from federal emissions regulation. In 1977, Congress amended the Clean Air Act to prohibit the marketing of fuel used in vehicles with catalytic converters if the fuel was dissimilar to the fuels used in emissions certification of vehicles. But the EPA was allowed to waive this requirement if *169 the fuel was unlikely to damage catalytic converters, [\[FN301\]](#) and was required to do so unless it commenced its own rulemaking to determine that the additive might "reasonably be anticipated to endanger the public health or welfare" or that it damaged an emissions reduction system. [\[FN302\]](#) In granting the MTBE waiver, the EPA failed to consider MTBE's potential environmental and health effects, as it was not directed to by Congress. [\[FN303\]](#) The second problem was inadequate toxicity testing of MTBE under the Toxic Substances Control Act ("TSCA"). Although the EPA had the authority under TSCA to require the manufacturer of a chemical substance like MTBE to conduct specific environmental and toxicity testing, industry, after conducting extensive tests of its own, "launched a major effort" to avoid time-consuming testing requirements imposed by the EPA. [\[FN304\]](#) The EPA entered into a consent order with the major oil companies that used MTBE, wherein the companies agreed to conduct some tests on toxicity and human health, but there were no provisions for environmental testing. [\[FN305\]](#)

Somewhat similar to the course of the MTBE decision-making process, both Congress and the EPA have made several significant and potentially harmful decisions in the regulation of fracing. Just as industry obtained a waiver from federal regulation for MTBE, Congress exempted fracing, with the exception of fracing with diesel fuel, from the Safe Drinking Water Act. [\[FN306\]](#) And just as the toxicity data on MTBE remains woefully inadequate, information on the environmental and health effects of the substances used in fracing is limited to the EPA study and several smaller reports or white papers *170 by government agencies and environmental and industry-based interest groups. [\[FN307\]](#) None of these provide adequate scientific data on the effects of fracing.

1. Insufficient or "Bent" Science

The theory of "unsound science" as a regulatory failure posits that agencies writing regulations rely on science of questionable quality. [\[FN308\]](#) Often an attack launched by industry, [\[FN309\]](#) individuals and groups arguing for "sound science" claim that an agency has "failed to consult with outside experts" or "made biased interpretations of scientific evidence," [\[FN310\]](#) or that further testing of a product or practice's danger would be flawed and would not generate useful results. [\[FN311\]](#) It is not only a one-sided criticism, however: "Nearly everyone believes that society is better off when governmental interventions are driven by sound science, rather than unfounded emotions." [\[FN312\]](#)

But sound science is itself a politically-charged critique and does not fully explain the problems with fracing regulation. McGarity, for example, does not attribute the problems with MTBE regulation to unsound science, apart from a lack of "decision-making informed by a complete set of relevant toxicological and environmental fate data." [\[FN313\]](#) Any lack of sound science, he argues, was due to industry's resistance to providing EPA with additional

testing results on toxicity, *171 not EPA's failures. [FN314] Similarly, in the context of fracking, industry has resisted further scientific testing. [FN315] Aside from those problems, the failures of EPA's fracking conclusions result from a lack of science, not "unsound" science. Although the EPA consulted with outside experts--many from industry--its study was not designed to be scientifically rigorous. Rather, it aimed to "review hydraulic fracturing processes, practices and settings"; "identify incidents that had not been reported to the EPA"; and "review reported incidents of groundwater contamination and any follow-up actions or investigations by other parties." [FN316] Nowhere in its description of the report did the EPA suggest that it would conduct scientific analysis of toxicological data or toxicity pathways in human.

In a critique distinct from the question of sound science, Wendy Wagner and Tom McGarity have more recently observed the problem of entities' "bending" of science: "where research is manipulated to advance economic or ideological ends." [FN317] The bending of science occurs through many paths. In the governmental context, agencies can convene federal science advisory panels that "might satisfy legal requirements [under the Federal Advisory Committee Act] but are nevertheless badly imbalanced and therefore likely to reach a predetermined outcome," [FN318] for example. Weston Wilson, an EPA whistleblower, argued that this sort of scientific "packaging" [FN319] occurred in the preparation of EPA's fracking report, urging that "EPA decisions were supported by a Peer Review Panel; however, five of the seven members of this panel appear to have conflicts-of-interest and may benefit from EPA's decision not to conduct further investigation or impose regulatory conditions." [FN320] Specifically, he identified three industry experts - a "petroleum engineer with BP Amoco," "a technical advisor for Halliburton Energy Services, Inc.," and "an engineer with the Gas Technology Institute." [FN321] Two other members were an assistant professor and a Colorado Oil *172 and Gas Conservation Committee member who were formerly BP Amoco and Mobil Exploration employees: Weston argued that these members had "an appearance of potential conflict of interest." [FN322] Furthermore, Weston urged that the EPA failed to include on the Peer Review Panel EPA professionals knowledgeable in specific industry fracking practices in each basin, "human and animal toxicological effects," or "groundwater flow regarding the fate and transport of [fracking] fluids in specific underground conditions." [FN323]

Although the EPA's scientific peer-review panel may have "been fairly balanced in terms of the points of view represented and the functions to be performed," [FN324] as it contained members from at least three different areas (industry, academia, and lab research), "balance" would ideally require more than representation of individuals from various professions. More information on the EPA's procedures for appointing the board would be helpful, such as a general discussion of whether and how the EPA determined that individual members did not have financial or other conflicts of interest and whether the EPA followed up on any financial disclosures from panel participants that raised potential conflict-of-interest concerns. [FN325] The GAO, for example, has in the past faulted the EPA for failing to evaluate disclosures on a peer review panel for 1,3-Butadiene, wherein several panelists "identified completed or ongoing research studies on the chemical that they had conducted," some of which had been supported by chemical company-sponsored organizations, and another panelist "reported a prior long-term affiliation with a chemical industry organization that had commented to EPA on its revised guidelines." [FN326] The GAO concluded that "while the above disclosures may not represent activities or affiliations that would necessarily preclude any of these individuals from participating *173 on the peer review panel, they do represent information that should be evaluated by the staff's office before finalizing its selection of panelists." [FN327] Since the GAO's report, the Scientific Advisory Board has reformed appointment procedures, requiring, for example, new conflict-of-interest forms eliciting more disclosure, as well as investigation of a panelist's appearance of partiality. [FN328] But these reforms may not be enough, as the process still assumes that "institutionally driven viewpoints" are "facially irrelevant" to the question of balance and thus fails to "gather relevant information on the real or apparent biases of panelists." [FN329]

In sum, with respect to panel composition for the EPA's report on fracking, there is no information suggesting that the panel was in fact biased, although the industry affiliations create strong appearances of non-impartiality: the EPA relied on data from Halliburton, Inc. and the Gas Technology Institute in its report [FN330] and also included employees of these companies on its peer review panel. Of graver concern, however, is another method of "bending"

that may have occurred in preparing the report: the "hiding" of science, which occurs when an individual or organization omits data or analysis from a report or presentation. [\[FN331\]](#) McGarity and Wagner, for example, point to a National Marine Fisheries Service report, wherein a scientific panel suggested a particular distinction in endangered species designation (separating wild salmon from hatchery salmon), which the panel deleted from its final report in 2000. [\[FN332\]](#) Similarly, they discuss an incident wherein the FDA prevented a staff scientist from presenting a meta-analysis with important results to an FDA advisory committee. [\[FN333\]](#) A group of Representatives expressed concern that similar data-hiding may have occurred in the midst of the EPA's *174 fracking research. A letter from Henry Waxman in October 2002 stated:

Two weeks ago, congressional staff working on the energy conference met with EPA officials to discuss the risks posed by hydraulic fracturing to drinking water sources. The congressional staff were seeking information about whether the energy bill should contain a provision that would potentially exempt hydraulic fracturing from EPA regulation. At that meeting, congressional staff pointed out that data from an August 2002 report by EPA on hydraulic fracturing showed that hydraulic fracturing could result in benzene and other toxic chemicals in underground source of drinking water at levels that exceeded federal drinking water standards. A week later, however, EPA provided congressional staff with a new analysis, using changed numbers. This new analysis showed that hydraulic fracturing would not produce benzene levels in drinking water sources that were above the federal standards. The explanation of these sudden changes was that they were 'based on feedback' from unidentified industry sources. [\[FN334\]](#)

The EPA responded, stating that there "was no alteration of data" and that "in preparing the September 20/23 Supplemental Material, there was no discussion by Agency staff with industry sources or others." [\[FN335\]](#) Representative Waxman wrote another letter, however, urging that "[b]oth of these assertions are contradicted by the document dated September 18, 2002 that EPA staff gave to my staff." [\[FN336\]](#) He reproduced tables from that document, showing benzene levels at the edge of a fracture zone at concentrations higher than the federal standard, and a revised table from a later report showing lower concentrations, with an explanation that "EPA confirmed the volumes and calculations used to estimated point-of-injection and edge of fracture zone concentrations *175 with industry sources. Based on that feedback, we changed the point-of-injection concentration to more accurately reflect the actual density of the gel-water mixture." [\[FN337\]](#) Waxman's letter also responded to the EPA's argument that his complaint "'seriously undermines attempts to base environmental decisions on sound science.'" [\[FN338\]](#) He explained that "[i]n fact, the whole purpose of my letter was to understand whether the basis of the 'changed' data in the September 18 document was good science or the political influence of companies that benefit from the revised data. Your insistent denials that EPA did anything improper do not answer the important questions raised by my letter." [\[FN339\]](#)

In addition to potentially "bending" science, many portions of the report are simply not "scientific" and are instead based in generalized conclusions. In discounting the effects of toxic substances used in fracking in its final report, for example, the report concedes that "some of the fluids and fluid additives" used in fracking "may contain constituents of potential concern." [\[FN340\]](#) It then lists in table form "examples of chemicals found in hydraulic fracturing fluids according to [material safety data sheets] provided by [fracking] service companies, and potential human health effects associated with the product." [\[FN341\]](#) These are of course only examples, and the report fails to provide a comprehensive analysis of potentially harmful components of fracking fluids. The report includes fifteen products of potential concern, [\[FN342\]](#) whereas one health analyst has testified that there are at least 171 products and 245 chemicals within those products used for natural gas development. [\[FN343\]](#) Although her testimony focused on fracking, this analyst did not specify, however, whether these products and chemicals were components of fracking fluids or gas production more generally. [\[FN344\]](#)

*176 Second, and more importantly, the EPA's report is too general to provide adequate data on risk. It emphasizes, for example, that "[i]t is important to note that information presented in [material safety data sheets] is for pure product. Each of the products listed in [the table of constituents of potential concern] is significantly diluted prior to injection." [\[FN345\]](#) In the descriptive text preceding the table, the report relies upon industry data, BLM reports, and three site visits to identify the typical dilutions of each constituent. [\[FN346\]](#) But this does not explain how each frac-

ing product, as diluted or mixed with underground water or environmental media, will act. Nor does it explain the quantities of the constituents of various fracturing products that are likely to remain following recovery of fracturing fluid from the ground: for fluids that do not mix well with water, substantial amounts may remain underground, as mentioned elsewhere in the EPA's report. [\[FN347\]](#) Although the report discusses quantitative estimates for recovery in general, [\[FN348\]](#) it does not specify fluid types, and it recognizes that there are factors likely to reduce the effectiveness of recovery. [\[FN349\]](#) All of these details may have been too specific for an EPA "Phase I study," wherein the objective was to "assess the potential for contamination of [underground sources of drinking water] due to the injection of hydraulic fracturing fluids into coalbed methane wells and to determine, based on these findings, whether further study is warranted." [\[FN350\]](#) As Administrator Whitman emphasized in a letter, "[t]he Study was not designed, nor does it claim to be, a detailed, site-specific risk assessment of all potential locations for coalbed methane *177 hydraulic fracturing." [\[FN351\]](#) But after recognizing the "potential concern" of several human health effects related to fracturing fluid constituents, including potential "[c]hronic effects/ [c]arcinogenicity," death after ingestion, "eye, skin, respiratory irritation," "liver and kidney effects," "heritable genetic damage in humans," "tissue damage," "discomfort, pain, coughing, dermatitis," "permanent eye damage," "eye, blood, liver, kidney, heart, central nervous system and spleen damage," [\[FN352\]](#) and other effects, the report, instead of suggesting that more specific scientific data would elucidate these concerns, determined that no additional study was needed. [\[FN353\]](#) The report concluded that none of the chemicals of potential concern, aside from diesel fuel, were on the Contaminant Candidate List to be evaluated by EPA's drinking water program. Two of the potential constituents of concern listed in the EPA's fracturing report, including ethylene glycol and methanol, are now on the candidate list. [\[FN354\]](#)

The EPA further stated, in concluding that chemicals other than diesel were not of major concern,

EPA does not believe that the other constituents potentially contained in fracturing fluids are introduced through coalbed methane fracturing in concentrations high enough to pose a significant threat to [underground sources of drinking water]. First, it is EPA's understanding, based on conversations with field engineers and on witnessing three separate fracturing events, that fracturing fluids used for coalbed methane fracturing do not contain most of the constituents listed [in the table of constituents of potential concern." Second, if the constituents were used, EPA believes some of the same hydrodynamic phenomena listed in steps 2 and 4 (flowback and dispersion), step 3 (adsorption and entrapment), and potentially step 5 (biodegradation) would minimize *178 the possibility that chemicals included in the fracturing fluids would adversely affect [underground sources of drinking water]. [\[FN355\]](#)

This is not a scientific result. First, the EPA's conclusions, as indicated by its language, are often based on limited "beliefs" and assumptions and on small samples - three field visits, references to BLM studies, and "conversations" with industry, [\[FN356\]](#) for example. The "steps" to which the EPA refers as mitigating contamination in the context of diesel constituents include general conclusions such as "dilution may significantly reduce concentrations available to drinking water wells, especially when they are great distances from the hydraulic fracture" and "entrapment of gel may reduce the availability of [the contaminant] to the surrounding groundwater." [\[FN357\]](#) While these generalized "steps" are based on discussions of literature reviewed and industry data, [\[FN358\]](#) many of the discussions lack citations. The report states, "Dilution can have a significant effect on the [chemical constituent] concentrations that could migrate to drinking water wells, especially if those wells are hundreds to thousands of feet from a hydraulically induced fracture," but provides no citation, aside from later referencing a source that defines "hydrodynamic dispersion." [\[FN359\]](#) It also provides no citation for its conclusion that "[a]s groundwater flows through a formation, chemicals such as [diesel constituents] may be retarded by adsorption." [\[FN360\]](#) Its discussion of adsorption in its chapter on the "Characteristics of Coalbed Methane Production" is similarly general and in that context, describes adsorption as a barrier to recovery of fracturing fluids, suggesting that although adsorption could potentially retard the flow of fracturing fluids into groundwater (a proposition unsupported by citations), *179 it could also prevent the recovery of fracturing fluids from the ground. [\[FN361\]](#) This alternate discussion of adsorption also recognizes that "adsorption to other surrounding geologic material (e.g., shale, sandstone) is likely to be minimal." [\[FN362\]](#) Furthermore, the report concedes at times that specific information was not available for the mitigating effects to which it cited. With respect to the degradation of diesel in groundwater, for example, the report explains that "[n]o information was found about the occurrence of biodegradation or biodegradation rates of [diesel constituents] in coalbeds or surrounding rock." [\[FN363\]](#) In discussing adsorption of contaminants in coalbeds and dilution of chemicals after

injection and prior to their migration to wells, the report recognizes that "quantification of adsorption is difficult in the absence of laboratory or site-specific studies" [\[FN364\]](#) and that

EPA does not provide estimates of concentrations beyond the point-of-injection in the final report. Developing such concentration values with the precision to compare them to [maximum contaminant levels] would require the collection of significant amounts of site-specific data. This data in turn would be used to perform a formal risk assessment, considering numerous fate and transport scenarios. These activities are beyond the scope of this Phase I study. [\[FN365\]](#)

In sum, the EPA report is not a rigorous scientific analysis of the specific impacts of fracing on human health or the environment - whether "bent" or not. As such, it provides inadequate data and analysis to determine potential impacts on human health and specifically, whether the risks are sufficiently low to merit exemption from the Safe Drinking Water Act.

*180 2. Agency Capture

The EPA's conclusion that further study of fracing's effects may also have been the result of agency capture--another type of regulatory failure. The theory of agency capture observes that agencies are likely to be influenced by interested industry players, which often lobby and provide data to the agencies that write regulations and influence statutes. [\[FN366\]](#) Individuals, environmental non-profits, state regulators, and industry stakeholders all made their views heard prior to the EPA's final report and Congress' exemption of fracing from the Safe Drinking Water Act. But industry and state regulators, who have a stated intent of advocating for "environmentally-sound ways to increase the supply of American energy" [\[FN367\]](#) and "states' rights to govern petroleum resources within their borders" [\[FN368\]](#) may have had the upper hand. In 2000, 35 industry associations opposed EPA's study, urging,

The sheer magnitude of fracturing jobs is indicative that no environmental problem exists that is not already controlled under existing state programs. In fact, this judgement [sic] was clearly verified by a study done by the Ground Water Protection Council at EPA's request. But now, because "EPA has received verbal and written reports from several environmental interest groups that practices associated with methane gas production from coal beds has resulted in contamination of their underground drinking water sources," EPA is choosing to ignore this ponderous body of evidence to initiate its study. There is no clear justification why "several" reports can trigger a study of the magnitude EPA is proposing. Based on the study design, it will take EPA roughly 18 months to determine whether these "reports" are so compelling that they offset a history of over a million hydraulic fracturing *181 jobs and the Ground Water Protection Council analysis EPA has used the Court decision [LEAF] to generate this overly broad and obtuse study. [\[FN369\]](#)

In 2001, Halliburton allegedly asked EPA to complete its slated investigation of hydrofracturing in time for a "Cabinet-level gathering" on energy issues, but the EPA "balked" at preparing a report in such a short time frame. [\[FN370\]](#) Following the completion of the report, industry vigorously used its results to lobby Congress. In October 2003, for example, the American Exploration and Production Council urged,

In view of the 2002 EPA study findings, in the 108th Congress the House of Representatives adopted a straightforward provision to prevent hydraulic fracturing from being regulated under the EPA [underground injection control] program. Now, the 108th Congress can and should move quickly to pass the House's simplified legislation included in recent comprehensive energy bill Conference Committee drafts. [\[FN371\]](#)

The Interstate Oil and Gas Compact Commission, a group of state regulators, called the legislation its own, stating, "President Bush signed into law the new energy bill this summer, which includes the IOGCC's proposal to resolve the hydraulic fracturing issue and brings several years of hard work by the Commission to fruition." [\[FN372\]](#) While the extent to which industry pressure in fact affected EPA's conclusions and Congress' exemption of fracing from the Safe Drinking Water Act can only be surmised, industry had a strong stake in both the outcome of the report and the legislation, and made its views on the matter clear.

*182 B. Recommendations for reform

The EPA's and Congress' initial regulatory failures in the area of fracing suggest that reform is needed to ensure the

production and analysis of better data and the enactment of harm-preventing regulation in the face of incomplete risk information.

1. Generate More Data and Complete a Comprehensive Study of Fracing and its Effects

Given that oil and gas production companies are injecting hazardous fluids into shale formations and coalbeds at an increasingly rapid rate without federal oversight and, sometimes, without adequate state controls, a more comprehensive and scientifically rigorous study of the effects of fracing is imperative. A federal study will require close collaboration with states, but combining the states' information into a larger report is vital. It will provide a broad picture of the extent of fracing activity throughout the United States, including information about the regions where it is most prevalent, the differing environmental concerns in these regions, and the existence of affected resources that cross state boundaries, such as large underground aquifers. A comprehensive study should investigate fracing not only in coalbeds but also in shales. It should focus particularly on fracing occurring in regions where the fraced formations are close to human populations and underground drinking water sources, although it should not ignore the potential for fracing contaminants to remain in areas that may later experience population growth. Finally, the study should look beyond direct and indirect injection and contamination of underground drinking water; the study should investigate diminution of drinking water supplies caused by the large quantities of groundwater pumping sometimes required for fracing, and also consider the effects of surface or underground disposal of wastewater from fracing. [\[FN373\]](#)

A national, comprehensive, science-based report on fracing is not a novel concept, and there may be sufficient political will to make it happen. Senator Jeff Bingaman, former Chairman of the Senate Energy *183 Committee, and Senator Inhofe, Chairman of the Senate Committee on the Environment and Public Works, proposed "a full National Academy of Sciences study of hydraulic fracturing" in a provision that passed by 78 to 21, although it ultimately failed because it was attached to the 107th Congress' energy bill, which never passed. [\[FN374\]](#) As Senator Inhofe, one of the bill sponsors, argued, "well-grounded and academically rigorous science, and not special interest groups and trial lawyers, should be the foundation for regulation." [\[FN375\]](#) While the EPA made a first attempt at the scientific side, it was incomplete and was less insulated from political forces on both sides of the issue than an NAS study would be.

In addition to having political support from both sides of the aisle, a comprehensive scientific study of fracing would benefit many people in addition to the government, environmental groups, and concerned citizens. If fracing in many regions is indeed benign, operators can use the results of the report to persuade citizens that fracing will not be as invasive as citizens may fear. It will also benefit states, providing information as they revise regulations, as in Colorado, or as they update their environmental impact assessments, as in New York. It will produce the "scientific observation of [fracing-] associated contamination" that the Ground Water Protection Council argued for in opposing federal regulation ungrounded in science. [\[FN376\]](#) Furthermore, a report that investigates fracing with all types of fluids, in all regions, and in all types of formations, may verify and provide further support for many state regulators' belief that fracing in their shales or coalbeds poses few threats that are unaddressed by current regulation.

2. Re-Consider the Regulation of Fracing under the Safe Drinking Water Act

Although only a thorough scientific study will determine the breadth of regulation needed, there are known risks of fracing that should be addressed immediately. The gravest concern - and one that is most easily regulated within existing statutory framework - is groundwater contamination. The EPA report on fracing recognized that some hazardous fluids are used in fracing, that fluids are often *184 injected into formations at high volumes (a maximum average of 150,000 gallons per well, and a minimum average of 57,500 gallons per well), [\[FN377\]](#) and that not all fluids are removed post-fracing. The rate at which the fluids are removed from the formation after fracing varies from 30 to 61 percent in studies summarized by the EPA, although some predict that total recovery could be as high as 68 or 82 percent. [\[FN378\]](#) Furthermore, the recovery process lasts 10 to 20 years, [\[FN379\]](#) meaning that nearly all of the fluid initially injected may remain in the ground for years before being even partially recovered. The EPA report also recognizes that fluids can leak away from the hydraulically induced fracture "into smaller secondary frac-

tures" and "become trapped in the secondary fractures and/or pores of porous rock." [FN380] "[S]ome fluid constituents may not completely mix with groundwater," thus preventing their recovery when the producer pumps groundwater as part of the production process. [FN381] Of greatest concern is the EPA's acknowledgement that some chemical constituents in fracturing fluids that are not captured in recovery "will likely be transported by groundwater flowing according to regional hydraulic gradients," [FN382] and its conclusion, without adequate scientific support, that concentrations of contaminants in the aquifer would be sufficiently reduced as a result of processes such as adsorption and dilution to avoid substantial human harm. [FN383]

Because some fracturing fluids are injected directly into groundwater sources and may contaminate those sources, Congress should consider repealing the exemption of fracturing from the Safe Drinking Water Act. Efforts along these lines have already commenced, although they may not be ultimately successful. On September 29, 2008, Representative Diana DeGette of Colorado introduced a bill "[t]o repeal the exemption for hydraulic fracturing in the Safe Drinking *185 Water Act." [FN384] The bill was referred to a House Committee, [FN385] however, and does not appear to have made progress. Further congressional attention to this matter is important.

Even if all states had relatively comprehensive protections against pollution of underground drinking water by fracturing, there are valid arguments for federal regulation under the Safe Drinking Water Act. Underground sources of drinking water are of national concern, yet the existing state protections tend to address pollution of local sources of water, focusing on landowner wells or local lakes, streams, or aquifers. [FN386] A contaminant released underground will not necessarily remain where it is released. Particularly with fracturing, which may induce or lengthen fractures of unanticipated size or connect fractures in one formation to another naturally fractured formation, the migration of pollutants underground and across state lines is difficult to predict. [FN387] Despite improved technology to better identify natural fractures and underground formations, the impact of a pollutant released thousands of feet below ground remains unpredictable, not only for landowners lacking the technology to identify underground pollutants and bring a nuisance or trespass suit, but also for scientists who must drill thousands of samples or produce a complex model that determines the pollutant's location and migration. [FN388] Furthermore, even in an area that is currently sparsely populated, a fracturing fluid that enters a formation or an underground drinking water *186 source may remain there for decades, [FN389] posing problems for future inhabitants. The Safe Drinking Water Act was designed to protect against these very types of concerns: originally aimed at problems arising from state regulations of varying effectiveness, [FN390] the Act attempted to unify drinking water regulation to ensure that all communities were protected against contamination of their drinking water sources. [FN391] And the Underground Injection Control program in particular was a direct response to the dearth of federal limitations on ground water pollution, as Congress worried that underground water sources were not adequately protected. [FN392]

Certain federal regulations already apply to fracturing, highlighting the need for federal regulation of activities with effects beyond the jurisdiction of individual states. In Pennsylvania, for example, operators disposing of certain hazardous fluids on the surface must first obtain a National Pollutant Discharge Elimination System Permit [FN393] under the federal Clean Water Act. New York also alerts drillers to the possibility that there may be threatened or endangered species on the fracturing site, raising the possibility of Endangered Species Act restrictions. [FN394]

Various industry members, and even the Department of Energy, have vehemently argued against federal regulation of fracturing, urging *187 that state regulation is adequate [FN395] and that federal intervention will add another confusing and costly regulatory layer to the process. [FN396] Drilling companies' objections to more regulation, whether at the federal or state level, are understandable. The oil and gas industry is already heavily regulated, [FN397] and national companies wrestle with numerous state regulations, many of which are inconsistent. But federal regulation of fracturing under the Safe Drinking Water Act should pose few problems for industry if fracturing indeed poses low risks to underground drinking water: the Underground Injection Control regulations only require states to "prevent underground injection which endangers drinking water sources. [FN398] Although the permit applicant must "satisfy the State" that its injection will not endanger these sources, [FN399] this process will not be overly burdensome for permit applicants who plan to frac using relatively benign fluids or in formations isolated from drinking water sources.

3. Evaluate State Fracing Policy and Regulations

In addition to Congress' seriously considering the re-inclusion of fracing within the Safe Drinking Water Act, more is needed at the state level to address environmental effects that extend far beyond injection - regardless of whether federal regulation occurs. States should use the information from a comprehensive scientific study to revisit and potentially update their regulations and best management practices. [FN400] In states like Montana, where most fracing is occurring *188 far from concentrated human populations and in formations that are generally isolated from drinking water sources, and in states like New York, where the fracing occurs "thousands of feet below drinking water sources," state regulators tend to believe that general regulation through the permitting process is adequate. [FN401] A national study would, however, allow these states to consider a range of potential environmental impacts beyond groundwater-related concerns and to identify whether or not further regulation is necessary.

Some states, like Colorado and Pennsylvania, [FN402] have already begun or completed this process. This "re-visitation" of regulation should focus on methods for reducing the amount of water required for a fracing operation, surface impacts of the fracing operation on local plant and animal species, the use of non-toxic fracing agents, better methods for removing more of the excess sand and proppants from the formation, and on ways to reduce wastewater from the fracing operation and to filter the wastewater before disposing of it. States that determine that fracing is insufficiently regulated have good examples to build from, such as Pennsylvania's oil and gas management practices and Marcellus Shale permit requirements, which cover everything from the surface impact of roads leading to fracing operations to concerns over plant and animal biodiversity on the drilling site, the amount of drawdown from local groundwater sources, use of public water supplies, and disposal methods for wastewater. States should consider all of these "cradle to grave" effects when regulating and should also provide specific opportunities for citizen input; citizens near fracing operations may be the best watchdogs for state regulators who do not have the time and resources to monitor each and every fracing operation.

Furthermore, states that have not yet done so should ban the use of fracing fluids for which there is national consensus of a danger of *189 contamination. Diesel fuel should be the first regulatory focus. [FN403] Although the EPA in 2003 "entered into a Memorandum of Agreement with three major service companies to voluntarily eliminate diesel fuel from hydraulic fracturing fluids that are injected directly" [FN404] into underground sources of drinking water during coalbed methane development, and industry representatives at the time "estimated that these three companies perform approximately 95 percent of the hydraulic fracturing projects in the United States," [FN405] the agreement is not enforceable, as it provides that "[a]ny Company or EPA may terminate its participation in this [memorandum of agreement] by providing written notice to the other signatories Such termination as to that Company will be effective 30 days after the receipt of written notice and will result in no penalties or continuing obligations by the terminating companies." [FN406] Nor is there any guarantee that the three companies that signed the Agreement - BJ Services Company, Halliburton Energy Services, Inc., and Schlumberger Technology Corporation - will continue to maintain this large percentage of production. The EPA report also fails to explain where the five percent of injection with diesel fuel identified in 2004 might still be occurring. If operators are still fracing with diesel fuel near water sources serving substantial populations or in particularly sensitive areas, the memorandum of agreement is not enough. Nor does the EPA's report discuss whether the service companies who have voluntarily agreed to stop using diesel fuel in fracing have in fact stopped; there is no discussion of monitoring.

There is some federal protection against diesel fuel contamination of groundwater caused by fracing, as the Safe Drinking Water Act, even after revision in 2005, includes diesel fuel used in fracing in the definition of underground injection, thus requiring states to control its use in their underground injection programs. [FN407] Under the EPA regulations enacted under the Act, states must have regulations at least as stringent as the federal regulations in order to have primary *190 enforcement authority over underground injection activities, [FN408] and the federal regulations provide that "[n]o owner or operator shall construct, operate, maintain, convert, plug, abandon, or conduct any other injection activity in a manner that allows the movement of fluid containing any contaminant into underground sources of drinking water" if the contaminant would violate relevant drinking water regulations. [FN409] But an underground injection program does not cover the other potential problems with diesel fuel, such as surface con-

tamination from the disposal of fracturing fluids. Given the consensus over the risks of diesel fuel in fracturing, a ban on this practice by states would provide a better guarantee against all types of environmental contamination than does a memorandum of agreement signed by the oil and gas industry and the EPA in 2003 or states' underground injection control regulation.

States should also consider banning or tightly controlling other fracturing fluids that have already been identified as risky. [FN410] EPA concluded in 2004, for example, that

[a]ccording to information gathered from [material safety data sheets], on-site reconnaissance of fracturing jobs, and interviews with service company employees, some hydraulic fracturing fluids may contain constituents of potential concern. Constituents of potential concern include bactericides, acids, diesel fuel, solvents, and/or alcohols. Although the largest portion of fracturing fluid constituents is nontoxic (>95% by volume), direct fluid injection into [underground sources of drinking water] of some potentially toxic chemicals does take place. [FN411]

*191 In identifying and considering control options for harmful fracturing fluids, states should investigate whether any new toxic agents have been introduced as fracturing fluid constituents since EPA's study, as fracturing activity has increased substantially since the study was completed. [FN412]

4. Highlight and Encourage Successful Private Efforts of Companies

The importance of the private sector in reducing the environmental effects of fracturing also cannot be overemphasized. As the technology and techniques of fracturing have advanced, so has the technology for reducing the contamination and waste generated by fracturing. Collaboration between GE and a corporation in Midland, Texas, [FN413] for example, has resulted in a water distillation process that reclaims nearly 70% of the wastewater from oil and gas fracturing operations. [FN414] This could greatly improve fracturing operations in states like Texas, where GE estimates that there are more than 50,000 permitted disposal wells for wastewater. [FN415] GE plans to first make this process available to the "Barnett, Fayetteville and Appalachian Shale natural gas drilling" operations, "locations notorious for difficult-to-treat wastewater." [FN416] Private companies, as demonstrated by the EPA's report, have also responded to landowner concerns by purchasing property polluted by methane after coalbed fracturing or providing replacement water when fracturing or related operations polluted nearby wells, although some landowners complained that supplies were not adequate. In Pennsylvania, companies are required to restore or replace landowner water supplies polluted by fracturing or related activities if the Department of Environmental Protection finds that there is a causal connection between the operation and pollution, *192 [FN417] but some regions have no formal landowner compensation programs. [FN418] States should consider implementing compensation or mitigation requirements similar to Pennsylvania's, [FN419] for situations where landowners' water or land has been harmed by fracturing, and in the meantime, companies should diligently address valid landowner concerns and, ideally, prevent pollution before it occurs.

Some oil and gas companies are already taking the initiative to work with communities and listen to their concerns about environmental effects: one production company at an unconventional gas production conference in Canada communicated the importance of, "[a]t an early stage," giving the community "project-specific information, offering the "opportunity to voice concerns," and "understand[ing] community values/vision." [FN420] In conducting a drilling project, the company "[i]nitiated [a] broad environmental and heritage resource assessment" and evaluated the "potential footprint" of production, while holding periodic open houses and fostering communications with the community along the way. [FN421]

A national report will support these types of private efforts, allowing production companies to identify the areas of high risk of pollution or groundwater depletion from fracturing and to implement strategies to avoid these risks. It could also identify projects where impacts were reduced as a result of production companies working with communities or implementing pollution prevention and water saving strategies for their fracturing operations. Such efforts should be highlighted and further encouraged by regulators and industry leaders.

*193 VI. Conclusion

Although fracking has existed for more than half a century, it has only recently boomed as a result of rising energy prices and declining production from conventional sources. With this boom, operators around the country are injecting an array of fluids into an array of formations. Some of the techniques pose grave concerns, particularly those in shallow coalbeds over drinking water sources, while others are purportedly benign. But no one knows the full range of effects because they have not been adequately researched. The EPA's report is the most comprehensive to date, but was part of a highly-charged political process and was never completed, because the EPA concluded, perhaps prematurely, that further study was unnecessary. Furthermore, the report investigated fracking in only one type of formation - coalbeds - and assessed the impacts of one stage of fracking, failing to seriously consider concerns such as groundwater depletion and surface disposal of fracking waste. The highest regulatory priority for fracking should be the instigation of a federal, scientifically rigorous report prepared by the National Academy of Sciences or a similar "neutral" body and a simultaneous regulatory risk-limiting mechanism.

Next, based on the data contained within this report, and given the risks of certain types of fracking, Congress should consider reversing its 2005 exemption of fracking from the Safe Drinking Water Act; it should not wait to commence this process pending the completion of the report, although the report will be essential for future statutory and regulatory decisions. Whatever the technical distinctions of the definition of "injection," fracking sometimes involves the pumping of toxic fluids into formations that are part of an underground source of drinking water or close to a water source, and it may present serious concerns for the quality of intra- and inter-state sources of water. The Safe Drinking Water Act was meant to address these very types of concerns, stating in the 1996 Amendments that "safe drinking water is essential to the protection of human health." [\[FN422\]](#) The Safe Drinking Water Act is also premised on the idea that a "sound scientific basis" should inform all regulations [\[FN423\]](#) - suggesting that a comprehensive report on the effects of fracking is in order. It also rests on ***194** the priority that "states play a central role in the implementation of safe drinking water programs" and need "appropriate flexibility to ensure the prompt and effective development and implementation of drinking water programs." [\[FN424\]](#) Federal regulation of fracking with respect to the injection of fluids into or near underground sources of drinking water need not be viewed primarily as an additional costly layer; in another light, it is a part of the already-existing amalgamation of regulations that govern fracking - whether those are controls on surface disposal of fracking wastes and similar drilling wastes under the National Pollutant Discharge Elimination Act, as referenced in the Pennsylvania regulations, or controls on the quantity of water used for fracking under Texas state water law. And while a federal statute certainly adds a layer to this existing amalgamation and is burdensome in some respects, [\[FN425\]](#) it is an important layer in regions where fracking may cause environmental and human health concerns.

Finally, states should use the report to re-visit and update their oil and gas regulations and to ensure that the regulations adequately cover the impacts of fracking. Specifically, they should ensure that landowners bordering a frac site receive prior notice and an opportunity to voice concerns and that regulations address fracking from cradle to grave, including the type of fluid used; the location, extent, and spacing of fracking; the quantity and source of water used; and disposal methods. Much of this regulation can, and already is, occurring through the general state permitting process, where operators are traditionally required to describe on an application the location and techniques of drilling as well as disposal methods for wastes.

The extent to which potential federal regulation and revised state regulation of fracking will in fact be burdensome and costly remains to be seen. A scientific report will inform the need for regulation and in many regions may bolster the claims that fracking does not require more regulation than already exists. But for the known risks, and the risks that emerge from a comprehensive report, regulators must not turn a blind eye. In the rush to extract essential resources, a process which itself contributes to human wellbeing, other aspects of human ***195** wellbeing - the quality of the environment and public health - must not be cast aside as a mere impediment to progress.

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[FN1]. [Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1 \(Tex. 2008\)](#).

[FN2]. See, e.g., Tom Wilber, Landowners Cry Foul over Seismic Searches, MONTGOMERY ADVERTISER, Sept. 21, 2008, available at <http://www.montgomeryadvertiser.com> (last visited Sept. 28, 2008).

[FN3]. Energy Policy Act of 2005, [Pub. L. No. 109-58, § 1\(a\), 119 Stat. 594 \(2005\)](#). Paragraph (1) of section 1421(d) of the Safe Drinking Water Act ([42 U.S.C. 300h\(d\)](#)) is amended to read as follows: (1) UNDERGROUND INJECTION - The term 'underground injection' - (A) means the subsurface emplacement of fluids by well injection; and (B) excludes - (i) the underground injection of natural gas for purposes of storage; and (ii) the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities.

[FN4]. [Coastal Oil, 268 S.W.3d at 17](#).

[FN5]. Jeffrey R. Levine, Coalification: The Evolution of Coal as Source Rock and Reservoir Rock for Oil and Gas, in AAPG Studies in Geology #38: Hydrocarbons from Coal 39, 39-77 (Ben E. Law & Dudley D. Rice, eds., 1995); see also [id. at 40-41](#) (discussing how, assuming methane were a free gas within coal, methane would make up 100 percent of the volume within the coal's interstitial areas that hold small molecules); S.A. Holditch & J.W. Ely, et al., Enhanced Recovery of Coalbed Methane Through Hydraulic Fracturing, Society of Petroleum Engineers 18250, 1 (1988) ("Coalbed methane production is viewed as a significant energy source."); I.D. Palmer & M.W. Davids et al., Analysis of Unconventional Behavior Observed during Coalbed Fracturing Treatments, 1989 PROC. COALBED METHANE SYMP. 395-411.

[FN6]. Levine, *supra* note 5, at 71.

[FN7]. U.S. Env'tl. Prot. Agency, Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs, EPA 816R04003 at 4-1 (June 2004) available at http://www.epa.gov/OGWDW/uic/pdfs/cbmstudy_attach_uic_ch04_hyd_frac_fluids.pdf (hereinafter EPA 2004).

[FN8]. *Id.*; see also *id.* at App. A-2, available at http://www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_append_a_doe_whitepaper.pdf (discussing the purposes of hydraulic fracturing, including increasing flow rate of low permeability reservoirs or damaged wells and connecting the "natural fractures and/or cleats in a formation to the wellbore"); Ian Bryant, Hello, Frac, OIL AND GAS INVESTOR (March 2007), available at http://www.slb.com/media/services/stimulation/fracturing/ori_2007031.pdf ("In unconventional reservoirs, the biggest challenge is establishing conduits from the far reaches of the reservoir to the wellbore.").

[FN9]. See Interview with Steve Sasaki, Chief Field Inspector, Montana Board of Oil and Gas Conservation (Sept. 4, 2008) (notes on file with the author) (discussing the water sand fracs used in Montana's Bakken shale formation, which typically use gel consisting of drilling mud or a polymer).

[FN10]. See, e.g., [BJ-Titan Servs. v. State Tax Comm'n, 842 P.2d 822, 823 \(Utah 1992\)](#) ("Hydraulic fracturing extends the bore laterally by injecting fluids into the well. Acidizing is an extension of hydraulic fracturing and uses hydrochloric acid in combination with other agents to improve well flow capacity.").

[FN11]. EPA 2004, *supra* note 7, at 5-2., available at http://www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_ch05_basins.pdf.

[FN12]. See Letter from Weston Wilson, EPA Employee, to Wayne Allard, Ben Nighthorse Campbell and Diana DeGette (Oct. 8, 2004) at 5, available at <http://latimes.image2.trb.com/lanews/media/acrobat/2004-10/14647025.pdf>

(explaining that the agreement is "voluntary and non-enforceable" and that the "EPA has no oversight over these companies to assure that diesel fuel is no longer used in hydraulic fracturing fluids in coalbed methane reservoirs").

[FN13]. A Memorandum of Agreement Between The U.S. Envtl. Prot. Agency and BJ Services Company, Halliburton Energy Services, Inc., and Schlumberger Technology Corp., Dec. 12, 2003, available at http://www.epa.gov/ogwdw000/uic/pdfs/moa_uic_hyd-fract.pdf.

[FN14]. EPA 2004, supra note 7, at 4-1, available at http://www.epa.gov/ogwdw000/uic/pdfs/cbmstudy_attach_uic_ch04_hyd_frac_fluids.pdf.

[FN15]. See infra note 17 and accompanying text.

[FN16]. John W. Ely & Stephen A. Holditch, Fracturing Techniques Depend on Coal Seam Characteristics, 88 OIL & GAS J. (Issue 30), July 23, 1990, available at <http://www.ogj.com/currentissue/index.cfm?p=7&v=88&i=30>.

[FN17]. EPA 2004, supra note 7, at App. A-12.

[FN18]. See, e.g., Bureau of Oil and Gas Management, Pa. Dep't of Envtl. Prot., Oil and Gas Operators Manual, Oil and Gas Management Practices, Document No. 550-0300-001, Chapter 4 at 7, available at <http://164.156.71.80/WXLogin.aspx?dp=%2fWXOD.aspx%3ffs%3d2087d8407c0e00008000027300000273%26ft%3d1> (follow "Login as our guest" hyperlink; then follow "Chapter 4 - Oil and Gas Management Practices" hyperlink) (last visited Feb. 15, 2009) (discussing how foam frac "can reduce the water requirements by more than 75% over conventional gel or water fracs").

[FN19]. Id.

[FN20]. See, e.g., Holditch & Ely, supra note 5, at 1 (discussing how "[t]he mechanical properties of coal are significantly different from conventional rocks" and how fracing in coal, unlike in conventional rocks, can "result in the creation of very wide hydraulic fractures," depending on the specific properties of the coal).

[FN21]. See, e.g., [Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 2 \(Tex. 2008\)](#) (describing a "tight" shale formation as one that is "relatively imporous and impermeable, from which natural gas cannot be commercially produced without hydraulic fracturing stimulation").

[FN22]. See, e.g., Don G. Briggs, La. Oil and Gas Ass'n, Everyone Benefits from Haynesville Shale, available at <http://www.loga.la/articles/080817.html> (last visited Feb. 25, 2009) (discussing the two types of fracing in Haynesville Shale, which involve using "water and sand under high force to break the rock and release the gas" and, alternatively, "horizontal drilling techniques"); WILLIAM P. DIAMOND & DAVID C. OYLER, EFFECTS OF STIMULATION TREATMENTS ON COALBEDS AND SURROUNDING STRATA 4 (U.S. Dept. of the Interior, Bur. of Mines 1987) (discussing coalbed stimulation using hydraulic fracturing at the Blue Creek Coalbed in Alabama. At that coalbed a vertical borehole was drilled and cased. Sand and gelled water were then injected and a "packer" was used at the top of the wellhead); Bryant, supra note 8 (discussing how "[i]n the past, most hydraulic-fracture treatments amounted to brute force application of hydraulic pressure to split the rock," but how recent treatments are more complex).

[FN23]. See, e.g., Holditch & Ely, supra note 5, at 1 ("[V]ery complex fracture systems are usually created during a hydraulic fracturing treatment. Not only are multiple vertical fractures often created, but fractures propagating in multiple directions can be quite common[.]"); Palmer & Davids et al., supra note 5, at 398-400 (identifying the factors that explain why fractures, even those created by high pressure, are sometimes limited to one coal seam and concluding that "other factors may determine whether a fracture is confined" by an adjacent layer of sandstone);

Larry Griffin, Pinnacle Technologies, Comparing Fracture Geometry in the Barnett Shale from Horizontal and Vertical Wellbores, 2003 PROC. FIFTH ANN. UNCONVENTIONAL GAS & COALBED METHANE CONF. 2-3 (discussing the various fractures that can occur, such as "T-shaped fractures," "multiple fractures dipping from vertical," and "twisting fractures" and discussing the limitations of fracture diagnostic tools).

[FN24]. See Interview with Tom Richmond, Administrator, Montana Board of Oil and Gas Conservation (Sept. 5, 2008) (notes on file with the author).

[FN25]. See Interview with Steve Sasaki, *supra* note 9.

[FN26]. See, e.g., Colby Barrett, [Fitting a Square Peg in a Round \(Drill\) Hole: The Evolving Legal Treatment of Coalbed Methane-Produced Water in the Intermountain West](#), 38 ENVTL. L. REP. NEWS & ANALYSIS 10661, 10667 (2008) (describing the water disposal methods of water produced from general coalbed methane production processes, explaining that "CBM extractors either discharge the water on the surface or inject it deep underground," and that for surface disposal "[t]ypical disposal methods include placement in lined pits (to allow for evaporation) unlined pits (to allow the water to seep into shallow aquifers) air spraying (which allows for evaporation), or traditional beneficial uses"); see also James Murphy, [Slowing the Onslaught and Forecasting Hope for Change: Litigation Efforts Concerning the Environmental Impacts of Coalbed Methane Development in the Powder River Basin](#), 24 PACE ENVTL L. REV. 399, 407 (2007) (citing Gary Bryner, Natural Res. Law Ctr., Univ. of Colo. Sch. of Law, Coalbed Methane Development in the Intermountain West 14 (2002), available at http://www.cbmclearinghouse.info/docs/nrlc/title_contents_pages.pdf (discussing how "99.9% of the water [from coalbed methane production] is discharged onto the surface" in Wyoming's Powder River Basin)).

[FN27]. See, e.g., EPA 2004, *supra* note 7, at 4-1 ("The types and use of fracturing fluids have evolved greatly over the past 60 years and continue to evolve.").

[FN28]. See, e.g., P.E. Nielsen & M.E. Hanson, Analysis and Implications of Three Fracture Treatments in Coals at the USX Rock Creek Site near Birmingham, Alabama, 1987 Proceedings COALBED METHANE SYMP. 109 (discussing how "high treatment pressures" that still lead to low gas production may be a result of "deformations" in the coalbed and concluding that "[r]ecommended alternative treatment pressures" may be superior in these situations).

[FN29]. See, e.g., Palmer & Davids et. al, *supra* note 5, at 398-400 (discussing the complicated factors involved in determining whether a fracture will be limited to one coal seam); Holditch & Ely, *supra* note 5, at 1 (discussing the complexity of fractures that may occur in a coalbed during fracturing).

[FN30]. [Coastal Oil & Gas Corp. v. Garza Energy Trust](#), 268 S.W.3d 1, 2 (Tex. 2008); see also [Crocker v. Humble Oil & Refining Co.](#), 419 P.2d 265, 271 (Okla. 1965) ("The testimony showed that sandfracing was first discovered in 1948 and was first used commercially in 1949.").

[FN31]. [U.S. Steel v. Hoge](#), 468 A.2d 1380, 1383 (Pa. 1983).

[FN32]. [Coastal Oil](#), 268 S.W. 3d at 32 (quoting TEXAS COMPTROLLER OF PUBLIC ACCOUNTS, THE ENERGY REPORT 2008, at 68 (2008), available at <http://www.window.state.tx.us/specialrpt/energy>).

[FN33]. See, e.g., Clifford Krauss, Drilling Boom Revives Hopes for Natural Gas, N.Y. TIMES, Aug. 24, 2008, available at <http://www.nytimes.com/2008/08/25/business/25gas.html> (last visited Feb. 15, 2009) (hereinafter Drilling Boom) (observing that "American natural gas production is rising at a clip not seen in half a century, pushing down prices of the fuel and reversing conventional wisdom that domestic gas fields were in irreversible decline" and that "[d]omestic gas production was up 8.8 percent in the first five months" of 2008 compared to the same period in 2007 - "a rate of increase last seen in 1959").

[FN34]. Holditch & Ely, *supra* note 5, at 1.

[FN35]. Palmer & Davids et al., *supra* note 5, at 395.

[FN36]. EPA 2004, *supra* note 7, at App. A-1.

[FN37]. *Id.* at 1-2 (presenting the EPA's "Locus Map of Major United States Coal Basins" where large basins extend through a substantial portion of Montana, Wyoming, Utah, Colorado, New Mexico, Iowa, Missouri, Kansas, Oklahoma, Arkansas, Texas, Michigan, Illinois, Indiana, Ohio, Pennsylvania, West Virginia, Kentucky, Tennessee, and Alabama. The map also shows smaller basins in Washington, Oregon, California, Idaho, Arizona, and Virginia).

[FN38]. *Id.* at 5-1, available at http://www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_ch05_basins.pdf.

[FN39]. These basins include the San Juan in Colorado and New Mexico; the Black Warrior in Alabama and Mississippi; the Piceance in Colorado; the Uinta in Utah and a small corner of Colorado; the Powder River in Wyoming and Southern Montana; the Central Appalachian in Kentucky, Tennessee, Virginia, and West Virginia; the Northern Appalachian in Pennsylvania, Virginia, Ohio, Kentucky, and Maryland, the Western Interior Region in Arkansas, Iowa, Kansas, Missouri, Nebraska, and Oklahoma, the Raton in Colorado and New Mexico, the Sandwash in Colorado and Wyoming, and the Pacific Coal Region in Washington and Oregon. *Id.* at 5-1 - 5-13.

[FN40]. *Id.* at 5-7, 5-10, 5-11.

[FN41]. [Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 16 \(Tex. 2008\)](#) (citing Demand for Workers in the Barnett Shale on the Rise, DALLAS BUS. J. (2006)); Mary Fallin, Hail the Shale, NAT'L REV., July 2, 2008; Clifford Krauss, There's Gas in Those Hills, N.Y. TIMES, APR. 8, 2008, at C1, available at <http://www.nytimes.com/2008/04/08/business/08gas.html> (discussing the boom in Pennsylvania); see also Krauss, Drilling Boom, *supra* note 33 (discussing how "American natural gas production is rising at a clip not seen in half a century" and how "[m]ost of the gain is coming from shale, particularly the Barnett Shale region around Fort Worth, which has been under development for several years").

[FN42]. Texas Railroad Commission, Newark, East (Barnett Shale), Drilling Permits Issued (1993-2007), available at <http://www.rrc.state.tx.us/barnettshale/drillingpermitsissued1993-2007.pdf>.

[FN43]. See Interview with Tom Richmond, *supra* note 24.

[FN44]. See Tom Wilber, Water Consumption an Issue in Natural Gas Drilling: More than 1,500 Wells Expected to be Dug per Year, THE ITHACA JOURNAL (Aug. 13, 2008), available at <http://www.theithacajournal.com/apps/pbcs.dll/article?AID=/20080813/NEWS01/808130326/1002> (last visited Feb. 15, 2009).

[FN45]. See United States Geological Survey, Assessment of Undiscovered Carboniferous Coal-Bed Gas Resources of the Appalachian Basin Province, 2002, available at <http://pubs.usgs.gov/fs/fs-009-03/FS-009-03-508.pdf> (calculated as a mean).

[FN46]. See Krauss, Drilling Boom, *supra* note 33.

[FN47]. Bryant, *supra* note 8.

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[FN48]. See, e.g., Nicole Branan, Exploration and Innovation: Geoscientists Push the Frontiers of Unconventional Oil (Apr. 2008), http://www.jsge.utexas.edu/news/feats/2008/exploration_innovation.html (last visited Feb. 15, 2009) (observing that "[e]nergy analysts now routinely accept that the world's unconventional hydrocarbons, such as gas hydrates, tight gas sandstones, and oil and gas shales, hold more fuel than undiscovered conventional energy sources" and that "the world is increasingly turning its attention to unconventional oil and gas"); Oxford Analytica, Unconventional Oil and Gas No Solution, INT'L HERALD TRIBUNE (Mar. 12, 2007) (discussing how "US unconventional gas reserves are large and represent a long-term resource" and how "US unconventional gas production is already on the rise, while conventional gas output is falling"); id. at 6 (discussing how "[p]roductive capacity in the United States [for natural gas] peaked in 1994, and it's lower than that today," and how "[t]his time, it appears that the drilling rig, by itself, will not solve the problem. We will continue to see a very high degree of spending and effort by the industry, and that's very important .").

[FN49]. Cassandra Sweet, Natural-Gas Prices May Fall Next Year on Supply Surge, WALL ST. J., Aug. 4, 2008 at section C (observing that Waterborne Energy forecasts overseas production of liquefied natural gas should rise by about one-third to 11 trillion cubic feet by end of next year.); see also Krauss, Drilling Boom, supra note 33 (observing that "domestic natural gas prices have already plunged 42 percent since early July in part because the rapid [domestic] supply growth has begun to influence the market" and attributing most of the domestic supply boom to fracking).

[FN50]. See, e.g., Statement of Daniel Yergin, Ph.D., Chairman, Cambridge Energy Research Associates; Cambridge, Massachusetts, Hearing Before the Joint Economic Committee Congress of the United States, 108th Congress, Second Session at 5-6 (Oct. 7, 2004), available at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=108_senate_hearings&docid=f:97866.pdf (discussing how "[n]atural gas is almost a quarter or our total energy supply in the United States" and how we "have built in a rising demand" for natural gas, "are on a course of rising demand," and are "going to see a growing gap between supply and demand." Yergin also stated that "[o]ver the last few years, this country has added something like 200,000 megawatts of electric power capacity" and "most all of that is based upon natural gas"); see also Hearing Before the Subcommittee on Energy and Resources of the Committee on Government Reform, Meeting America's Natural Gas Demand: Are we in a Crisis? at 1-2, 109th Congress, 1st Session (Sept. 14, 2005), available at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_house_hearings&docid=f:24769.pdf (discussing the "ongoing tight supply and demand situation [for natural gas] in the United States" and how "[s]ince the 1900's almost every new electric power plant is powered by natural gas"); Krauss, Drilling Boom, supra note 33 ("While the recent production increase is indisputable, not everyone is convinced the additional supplies can last for decades. 'The jury is still out how big [the] shale is going to be,' said Robert Ineson, a natural gas analyst at Cambridge Energy Research Associates, a consulting firm.").

[FN51]. See, e.g., Robert Howard, VP ChevronTexaco North American Upstream, Balancing Natural Gas Policy: Fueling the Demands of a Growing Economy, 2003 PROC. FIFTH ANN. UNCONVENTIONAL GAS & COAL-BED METHANE CONF., available at http://www.fossil.energy.gov/programs/oilgas/publications/npc/03gasstudy/NG_Vol1_9-25.pdf (concluding with respect to natural gas that "demand is diverse and power generation will drive growth"); Mark Trumbull, Inflation Surge puts Feds in a Quandary, CHRISTIAN SCI. MONITOR (July 17, 2008) (discussing how "rising oil prices have been a global phenomenon, driven largely by demand in emerging markets"); David Jolly, Industries Joining Rush to Raise Prices with 25% Increase, Dow Chemical Adds to a "Global Trend," INT'L HERALD TRIBUNE (June 25, 2008) (discussing how Dow "saw energy and raw material costs rise 40 percent in the first half of 2008 from a year earlier" and raised its prices, warning of a 'relentless' rise in energy and raw materials costs. Dow's chairman and chief executive observed, "Even since our last announcement, the cost of hydrocarbons has continued to rise, and that trajectory shows no sign of changing").

[FN52]. See Jacqueline Lang Weaver, The [Traditional Petroleum-Based Economy: An "Eventful" Future](#), 36 CUMB. L. REV. 505, 518 (2006) ("The production of natural gas from conventional domestic sources in the United

States peaked in 1973, just two years after the peak in domestic oil.").

[FN53]. United States Senator James M. Inhofe & Frank Fannon, [Energy and the Environment: The Future of Natural Gas in America](#), 26 ENERGY L.J. 349, 370 (2005).

[FN54]. Timothy Riley, [Wrangling with Urban Wildcatters: Defending Texas Municipal Oil and Gas Development Ordinances against Regulatory Takings Challenges](#), 32 VT. L. REV. 349, 354 (2007).

[FN55]. Railroad Commission of Texas, Barnett Shale Information, available at <http://www.rrc.state.tx.us/barnettshale/index.html> (last visited Feb. 25, 2009).

[FN56]. See, e.g., id. (discussing how most of the increased domestic natural gas production has come from horizontal wells and fracing of shales).

[FN57]. Riley, supra note 54, at 354.

[FN58]. Id. at 2-5.

[FN59]. EPA 2004, supra note 7, at 5-12.

[FN60]. See supra note 44 (discussing proposed well numbers and how "[l]andowner advocates are asking companies to use a process called 'closed loop drilling' to recycle waste water at drilling sites").

[FN61]. Wilber, supra note 2.

[FN62]. [Legal Envtl. Assistance Found., Inc. v. U.S. Envtl. Prot. Agency](#), 118 F.3d 1467, 1471 (11th Cir. 1997).

[FN63]. Ground Water Protection Council, Survey Results on Inventory and Extent of Hydraulic Fracturing in Coalbed Methane Wells in the Producing States 3 (Dec. 15, 1998), available at http://www.gwpc.org/e-library/e-library_documents/e-library_documents_general/Hydraulic%20fracturing%20methane%20coal%20beds.pdf (hereinafter "GWPC Survey").

[FN64]. Id. at 9-10. The Council was preparing a similar survey, but the results were not yet complete as of Fall 2008. See Richmond, supra note 24.

[FN65]. EPA 2004, supra note 7, at App. A-2, A-4, A-11-14.

[FN66]. Id. at App. A-1.

[FN67]. Id.

[FN68]. Id. at 7-5.

[FN69]. Id. at 1-1.

[FN70]. Id. at 1-4, (quoting [40 C.F.R. § 144.3](#)).

[FN71]. Id. at 1-5.

[\[FN72\]](#). Id. at 1-6.

[\[FN73\]](#). Id.

[\[FN74\]](#). Id. at 6-2.

[\[FN75\]](#). Id. at 6-3.

[\[FN76\]](#). Id. at 6-7.

[\[FN77\]](#). Id.

[\[FN78\]](#). Id.

[\[FN79\]](#). Id. at 6-3, 6-4.

[\[FN80\]](#). Id. at 6-4.

[\[FN81\]](#). Id.

[\[FN82\]](#). Id. at 6-8.

[\[FN83\]](#). Id. at 6-9.

[\[FN84\]](#). Id.

[\[FN85\]](#). Id. at 6-10; see also [Legal Envtl. Assistance Found., Inc. v. U.S. Envtl. Prot. Agency, 118 F.3d 1467, 1471 \(11th Cir. 1997\)](#) (discussing foundation members' claims that their water quality was diminished after fracking).

[\[FN86\]](#). EPA 2004, *supra* note 7, at 6-10.

[\[FN87\]](#). Id.

[\[FN88\]](#). Id. at 6-10, 6-11.

[\[FN89\]](#). Id. at 6-11.

[\[FN90\]](#). Id.

[\[FN91\]](#). Id.

[\[FN92\]](#). Id. at 6-14.

[\[FN93\]](#). Id. at 6-15.

[\[FN94\]](#). For example, in Alabama, where a woman complained of strong odors in her drinking water as well as

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black coal fines and a milky substance, water analyses by the Oil and Gas Board, the Alabama Department of Environmental Management, and EPA Region 4 "indicated that the water well had not been contaminated as a result of the fracturing operation." Id. at 6-11.

[FN95]. For example, "[o]ne [BLM] study reported that 34 percent of the 205 domestic wells tested in the county showed measurable concentrations of methane." Id. at 6-6; see also id. at 6-7 (discussing how the San Juan Regional Authority "confirmed" a man's "report of methane contamination" and found other contaminated wells in the area); id. at 6-6. (discussing how BLM sampling showed that "Fruitland produced water" - water from wells in a shallow aquifer that is "in hydraulic communication" with coalbeds in a formation in the San Juan Basin - showed that the water "contained 680 ppm" total dissolved solids, "primarily bicarbonate," and that "other domestic wells in the area did not").

[FN96]. Another individual in Alabama reported that her well was hissing and full of methane gas. The EPA observed that Alabama's Oil and Gas Board "tested this drinking water well, but only looked for naturally occurring contaminants. EPA also sampled and tested this drinking water well, but not until 6 months after the event. No mention is made of the analytical results obtained from the drinking water well by these agencies." Id. at 6-11.

[FN97]. Id. at 6-14.

[FN98]. Id. at 6-3.

[FN99]. Id. at 6-16.

[FN100]. Id. at 7-5.

[FN101]. Id. at 7-3.

[FN102]. Id. at 7-5.

[FN103]. Id. at 2-1.

[FN104]. Id. at 2-1 - 2-3, 2-6.

[FN105]. Id. at 2-7.

[FN106]. EPA employees and Members of Congress have questioned the validity of the report itself and its precursors. See, e.g., Wilson, *supra* note 12, at 1, 5 (referring to the EPA's fracturing report as "scientifically unsound and contrary to the purposes of the law," including a technical critical analysis of the report, and stating that "five of EPA's seven-member Peer review Panel appear to have conflicts-of-interest"); Letter from Henry Waxman, Tom Lantos, Major R. Owens, Edolphus Towns, Paul E. Kanjorski, Patsy T. Mink, Carolyn B. Maloney, Eleanor Holmes Norton, Elijah E. Cummings, Dennis J. Kucinich, Rod R. Blagojevich, Danny K. Davis, John F. Tierney, Jim Turner, Thomas H. Allen, Janice D. Schakowsky, Wm. Lacy Clay, Diane E. Watson and Stephen F. Lynch to Christine Todd Whitman (Oct. 1, 2002), available at <http://oversight.house.gov/documents/20040827104747-13515.pdf> (writing "to protest that the Administration once again appears to be altering scientific and policy conclusions to accommodate Halliburton's interest in promoting the oil and gas drilling practice of 'hydraulic fracturing'" and arguing that "[s]pecifically, it appears that technical information that the Administration provided to Congress last week during the energy conference was manipulated to change data on the risk that hydraulic fracturing could contaminate underground drinking water supplies").

[FN107]. EPA 2004, supra note 7, at 6-9.

[FN108]. Id. at 6-4, 6-15.

[FN109]. See id. at 6-1 ("This study is specifically focused on assessing the potential for contamination of USDWs from the injection of hydraulic fracturing fluids into coalbed methane wells, and determining based on these findings, whether further study is warranted.").

[FN110]. Id. at 6-1, 6-2.

[FN111]. Some associations have reached this conclusion based on the EPA's report. See, e.g., American Exploration and Production Council, Hydraulic Fracturing: Action Needed to Remove Regulatory Uncertainty (Oct. 10, 2003), available at <http://axpc.org/policy/031010.pdf> (finding that "a 2002 draft comprehensive EPA study of coalbed methane hydraulic fracturing environmental risks found no contamination problems and no need for any further study of the matter. Again, no environmental risks of proper hydraulic fracturing have been identified").

[FN112]. EPA 2004, supra note 7, at 6-16.

[FN113]. EPA 2004, supra note 7, at 6-8.

[FN114]. NATURAL RESOURCES DEFENSE COUNCIL, HYDRAULIC FRACTURING OF COALBED METHANE WELLS: A THREAT TO DRINKING WATER 2 (Jan. 2002), available at http://www.earthworksaction.org/pubs/200201_NRDC_HydrFrac_CBM.pdf.

[FN115]. EPA 2004, supra note 7, at 6-8.

[FN116]. Id. at 2-3, available at http://www.epa.gov/ogwdw000/uic/pdfs/cbmstudy_attach_uic_ch02_methodology.pdf.

[FN117]. See Wilson, supra note 12.

[FN118]. LISA SUMI, OUR DRINKING WATER AT RISK: WHAT EPA AND THE OIL AND GAS INDUSTRY DON'T WANT US TO KNOW, OIL AND GAS ACCOUNTABILITY PROJECT vii-viii (Apr. 2005), available at <http://www.earthworksaction.org/pubs/DrinkingWaterAtRisk.pdf>.

[FN119]. Id. at viii (In September 2003, the Council's Board signed a resolution declaring that "the Ground Water Protection Council supported and continues to support USEPA's position that hydraulic fracturing is not underground injection under the [Safe Drinking Water Act]").

[FN120]. Committee on Oversight and Gov't Reform, Oil and Gas Exemptions in Fed. Envtl. Prots., Video of the Hearing, available at <http://oversight.house.gov/story.asp?ID=1586> (select transcripts of testimony on file with the author).

[FN121]. Id.

[FN122]. See supra note 64 and accompanying text.

[FN123]. Jim Moscou, A Toxic Spew?: Officials Worry About Impact of 'Fracking' of Oil and Gas, NEWSWEEK Web Exclusive, Aug. 20, 2008, available at <http://www.newsweek.com/id/154394> (last visited Feb. 27, 2009).

[FN124]. Ground Water Protection Council, Resolution 03-5, Requesting Legislative Clarification of the Definition of "Underground Injection" in the Safe Drinking Water Act, available at <http://www.gwpc.org/advocacy/documents/resolutions/RES-03-5.htm> (last visited Feb. 27, 2009).

[FN125]. Ground Water Protection Council, Resolution 02-2, Concerning the Use of Diesel Fuel in Fracturing Fluids in Underground Sources of Drinking Water, available at http://www.gwpc.org/advocacy/documents/resolutions/resolution__02-2.htm (last visited 8/26/2008).

[FN126]. See supra note 13 and accompanying text.

[FN127]. See infra note 154 and accompanying text.

[FN128]. See, e.g., Interstate Oil and Gas Compact Comm'n, Hydraulic Fracturing, available at <http://www.ioGCC.state.ok.us/hydraulic-fracturing> (last visited Feb. 25, 2009) (urging that "[e]ffective state regulation has made hydraulic fracturing a safe and environmentally-sound way to maximize and conserve our nations [sic] natural resources"); American Exploration and Production Council, supra note 111 (urging that in 1974, when Congress enacted the Safe Drinking Water Act, "[b]y then hydraulic fracturing had been used for 25 years with no environmental problems" and that "no environmental risks of proper hydraulic fracturing have been identified"); American Petroleum Institute, Hydraulic Fracturing at a Glance, available at http://www.api.org/policy/exploration/upload/HYDRAULIC_FRACT_INDIVID_PAGES.pdf ("Current industry well design practices ensure multiple levels of protection between any sources of drinking water and the production zone of an oil and gas well.").

[FN129]. See Richmond, supra note 24.

[FN130]. Id.

[FN131]. See Sasaki, supra note 9.

[FN132]. See Telephone Interview with Ted Loukides, Mineral Resources Specialist, N.Y.S. Dep't of Envtl. Conservation, Div. of Mineral Resources (Sept. 10, 2008) (notes on file with author).

[FN133]. See, e.g., supra note 69 and accompanying text.

[FN134]. EPA 2004, supra note 7, at 1-6, available at http://www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_ch01_intro.pdf.

[FN135]. Id. at 6-6, 6-7, available at http://www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_ch06_water_qual_incidents.pdf.

[FN136]. In 1990, for example, an EPA report found that "there is a growing potential for contamination of drinking water aquifers," primarily due to fracing; [Legal Envtl. Assistance Found., Inc. v. U.S. Envtl. Prot. Agency, 118 F.3d 1467, 1471 \(11th Cir. 1997\)](#) (quoting UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, GROUND WATER STUDY COMMITTEE: REPORT G11-STUDY WELL CONTAMINATION PROBLEMS; PARTICULARLY PROBLEMS RELATED TO COAL BED METHANE 1 (1990), appearing at R3-211).

[FN137]. [Legal Envtl. Assistance Found., 118 F.3d at 1469.](#)

[FN138]. [Id. at 1469-70.](#)

[FN139]. [Id. at 1470](#) (quoting [42 U.S.C. § 300h\(d\)\(1\)](#), citing [40 C.F.R. § 145.11\(a\)\(5\)](#)).

[FN140]. [Id. at 1469-70](#) (quoting [40 C.F.R. § 144.6\(b\)](#)).

[FN141]. [Id. at 1470.](#)

[FN142]. [Id. at 1471.](#)

[FN143]. [Id. at 1470.](#)

[FN144]. [Id. at 1471.](#)

[FN145]. [Id.](#)

[FN146]. [Id.](#)

[FN147]. [Id. at 1472.](#)

[FN148]. [Id. at 1474](#) (quoting [2 U.S.C. § 300h\(b\)\(1\)\(A\)](#)).

[FN149]. [Id. at 1475](#) (quoting [United States v. Gonzales, 520 U.S. 1, 6 \(1997\)](#)).

[FN150]. [Id. at 1474.](#)

[FN151]. [Id. at 1478.](#)

[FN152]. See Murphy, *supra* note 26, at 431-32; see also Markus G. Puder & Michel J. Paque, [Tremors in the Cooperative Environmental Federalism Arena: What Happens When a State Wants to Assume Only Portions of a Primacy Program or Return a Primacy Program? - The Underground Injection Control Program Under the Safe Drinking Water Act as a Case Study](#), 24 TEMP. J. SCI. TECH. & ENVTL. L. 71, 88, 163 (2005) (discussing the [approval of Alabama's Class II UIC Program Revision 65 Fed. Reg. 2889 \(codified at 40 C.F.R. § 147\)](#), and [Legal Env'tl. Assistance, 276 F.3d 1253 \(11th Cir. 2001\)](#) (affirming approval of Alabama's program under Section 1425 of the Safe Drinking Water Act)).

[FN153]. See, e.g., American Exploration and Production Council, *supra* note 111 (stating that "[i]ndustry, working primarily through both its Washington and state based trade associations, has pressed for a legislative resolution of the issue" and urging that legislation should "allow states to continue their effective regulation of hydraulic fracturing"); Independent Petroleum Association of America, Testimony of the Independent Petroleum Association of America and the National Stripper Well Association before the Environmental Protection Agency Regarding Underground Injection Control (UIC) (Aug. 25, 2000), available at http://www.ipaa.org/issues/testimony/Hydraulic_Fracturing.asp (last visited Feb. 25, 2009) (urging that "[t]he sheer magnitude of fracturing jobs is indicative that no environmental problem exists that is not already controlled under existing state programs," opposing a "study of the magnitude EPA is proposing," and arguing that "EPA does not need an 18 month or 2 year or 3 year effort to assess the 'reports' of alleged problems associated with hydraulic fracturing").

[FN154]. The Wilderness Society, Too Wild to Drill: Hydraulic Fracturing Threatens Drinking Water, available at [http://www.wilderness.org/Library/Documents/upload/Too-Wild-to-Drill-Hydraulic-Fracturing-Threatens-](http://www.wilderness.org/Library/Documents/upload/Too-Wild-to-Drill-Hydraulic-Fracturing-Threatens)

Drinking-Water.pdf (arguing that exemption of fracing from the Safe Drinking Water Act "is bad environmental policy").

[FN155]. Energy Policy Act of 2005, H.R. 6, 109th Cong. (Jan. 4, 2005).

[FN156]. See, e.g., Earthworks, Hydraulic Fracturing of Oil and Gas Wells, available at <http://www.earthworkSACTION.org/hydrfracking.cfm> (last visited Feb. 25, 2009) (arguing that "[t]he oil and gas industry is the only industry in America that is allowed by EPA to inject known hazardous materials - unchecked - directly into or adjacent to underground drinking water supplies").

[FN157]. Railroad Commission of Texas, Testimony Submitted to the House Committee on Energy and Commerce by Victor Carrillo, Chairman, Texas Railroad Commission Representing the Interstate Oil and Gas Compact Commission (Feb. 10, 2005), available at <http://www.rrc.state.tx.us/commissioners/carrillo/press/energytestimony.html> (last visited Feb. 25, 2009).

[FN158]. Independent Petroleum Association of America, Turning the Page on Energy Policy, available at http://www.ipaa.org/issues/factsheets/energy_policy/TurningthePageonEnergyPolicy10-2005.pdf.

[FN159]. The Endangered Species Act and Clean Water Act could potentially apply. See, e.g., [N.M. ex rel. Richardson v. Bureau of Land Mgmt., 459 F.Supp. 2d 1102, 1107, 1114, 1131 \(D.N.M. 2006\)](#) (memorandum opinion) (discussing plaintiffs' Endangered Species Act claim when challenging BLM's approval of a Resource Management Plan and an oil and gas lease for an operation that included hydraulic fracturing); [Tex. Oil and Gas Ass'n v. EPA, 161 F.3d 923, 928-29 \(5th Cir. 1998\)](#) (discussing plaintiffs' challenges, under the Clean Water Act, to EPA regulations for the Coastal Subcategory of the Oil and Gas Extraction Point Source Category, which addressed, among other pollutants, "slurried particles that surface from hydraulic fracturing" and from other parts of the production operation); see also infra note 282 and accompanying text.

[FN160]. See supra note 15 at 33 ("[f]racture treatment technology in coals seams is just now starting to evolve").

[FN161]. [Hegarty v. Board of Oil, Gas & Mining, Dep't of Natural Res., 57 P.3d 1042, 1044 \(Utah 2002\)](#).

[FN162]. Id.

[FN163]. Id. at 1045.

[FN164]. Id.

[FN165]. Id.

[FN166]. Id. at 1048 (quoting [UTAH CODE ANN. § 40-6-2\(11\)](#) (1993)).

[FN167]. Id. at 1046.

[FN168]. Id. at 1050.

[FN169]. Id. at 1051 (quoting [UTAH CODE ANN. § 40-6-7\(1\)](#) (1998)).

[FN170]. Id. at 1051-52.

[\[FN171\]](#). *Id.* at 1051.

[\[FN172\]](#). [U.S. Steel Corp. v. Hoge, 450 A.2d 162 \(Pa. Super. Ct. 1982\)](#) (rev'd by [U.S. Steel Corp. v. Hoge, 468 A.2d 1380 \(Pa. 1983\)](#)). For discussion of reversal, see *infra* notes 178-180 and accompanying text.

[\[FN173\]](#). *Id.* at 163-64.

[\[FN174\]](#). *Id.* at 164.

[\[FN175\]](#). *Id.*

[\[FN176\]](#). *Id.* at 165.

[\[FN177\]](#). *Id.* at 172.

[\[FN178\]](#). [U.S. Steel v. Hoge, 468 A.2d 1380, 1383 \(Pa. 1983\)](#).

[\[FN179\]](#). *Id.* (emphasis original).

[\[FN180\]](#). *Id.* at 1384.

[\[FN181\]](#). [Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1 \(Tex. 2008\)](#).

[\[FN182\]](#). *Id.* at 13.

[\[FN183\]](#). *Id.* at 29 (Willett, J., concurring).

[\[FN184\]](#). *Id.* at 5.

[\[FN185\]](#). *Id.* at 9.

[\[FN186\]](#). *Id.* at 5.

[\[FN187\]](#). *Id.* at 6.

[\[FN188\]](#). *Id.*

[\[FN189\]](#). *Id.*

[\[FN190\]](#). *Id.* at 7.

[\[FN191\]](#). *Id.*

[\[FN192\]](#). *Id.* at 9.

[\[FN193\]](#). *Id.* at 8.

[\[FN194\]](#). Id. at 13.

[\[FN195\]](#). Id. at 14.

[\[FN196\]](#). Id.; see also Daniel F. Sullivan, Annotation, [Implied Duty of Oil and Gas Lessee to Prot. Against Drainage, 18 A.L.R.4th 14 § 14 \(1982\)](#) (discussing the "pooling" cases that support the principle that "in appropriate circumstances, the implied duty of an oil and gas lessee to protect the leased premises against drainage of oil or gas by wells operated on other lands includes a duty to attempt to create a pool or unit whereby some or all of the lessor's land is combined with the land on which the draining well or wells are located and the oil or gas produced by such wells is allocated among the lands included in the pool or unit").

[\[FN197\]](#). [Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 14 \(Tex. 2008\)](#).

[\[FN198\]](#). Id.

[\[FN199\]](#). Id. at 15 (quoting [Seagull Energy E & P, Inc. v. R.R. Comm'n of Tex., 226 S.W.3d 383, 389 \(Tex. 2007\)](#)).

[\[FN200\]](#). Id.

[\[FN201\]](#). Id. at 14.

[\[FN202\]](#). Id. at 44 (Johnson, J., concurring in part and dissenting in part).

[\[FN203\]](#). Id. at 43 (Johnson, J., concurring in part and dissenting in part).

[\[FN204\]](#). Id. at 43-44 (Johnson, J., concurring in part and dissenting in part).

[\[FN205\]](#). Id. at 44 (Johnson, J., concurring in part and dissenting in part).

[\[FN206\]](#). Id. at 9.

[\[FN207\]](#). Id. at 9, 11, 13.

[\[FN208\]](#). [Crawford v. Hrabe, 44 P.3d 442, 448 \(Kan. 2002\)](#).

[\[FN209\]](#). Id. at 446.

[\[FN210\]](#). Id. at 453.

[\[FN211\]](#). Id. at 448.

[\[FN212\]](#). Id. at 449.

[\[FN213\]](#). Id. at 453.

[\[FN214\]](#). [R.R. Comm. of Tex. v. Manziel, 361 S.W.2d 560 \(Tex. 1962\)](#).

[FN215]. [Crawford v. Hrabe](#), 44 P.3d 442, 450 (Kan. 2002) (citing [Manziel](#), 361 S.W.2d at 568).

[FN216]. [Manziel](#), 361 S.W.2d at 568-69 (emphasis added).

[FN217]. [Coastal Oil & Gas Corp. v. Garza Energy Trust](#), 268 S.W.3d 1, 11 (Tex. 2008).

[FN218]. [Id.](#) at 13 ("[Salinas] does not claim that the hydraulic fracturing operation damaged his wells or the Vicksburg T formation beneath his property. In sum, Salinas does not claim damages that are recoverable.").

[FN219]. [Id.](#) at 16-17.

[FN220]. [Manziel](#), 361 S.W. 2d at 568.

[FN221]. [Id.](#)

[FN222]. [Coastal Oil](#), 268 S.W. 3d at 29 (Willett, J., concurring).

[FN223]. See, e.g., Riley, *supra* note 54, at 398-402 (discussing nuisance actions against drilling companies in urban areas and suburbs).

[FN224]. [Id.](#) at 402 (citing [Trail Enterprises, Inc. v. City of Houston](#), 957 S.W.2d 625, 635 (Tex. App. Houston 1997)).

[FN225]. [Id.](#) (quoting [Helton v. City of Burkburnett](#), 619 S.W.2d 23, 24 (Tex. Civ. App.-Fort Worth 1981) (quoting City of Burkburnett, Ordinance No. 375)).

[FN226]. [Id.](#) at 367 (quoting [Tysco Oil Co. v. R.R. Comm'n of Tex.](#), 12 F. Supp. 195 (S.D. Tex. 1935)).

[FN227]. [Id.](#) at 9.

[FN228]. [Id.](#) at 10.

[FN229]. See [Coastal Oil & Gas Corp. v. Garza Energy Trust](#), 268 S.W.3d 1, 17 (Tex. 2008).

[FN230]. [16 TEX. ADMIN. CODE § 3.5 \(2008\)](#).

[FN231]. R.R. Comm'n of Tex., Barnett Shale Information (July 30, 2008), <http://www.rrc.state.tx.us/barnettshale/index.html> (follow "Is an oil or gas operator required to perform an environmental study or something similar?" hyperlink).

[FN232]. Tex. Comm'n on Envtl. Quality, Requesting a Surface Casing Letter, http://www.tceq.state.tx.us/permitting/waste_permits/surface_casing/surf_casing.html (last visited Feb. 25, 2009).

[FN233]. Tex. Comm'n on Envtl. Quality, Surface Casing to Protect Groundwater: Am I Regulated?, http://www.tceq.state.tx.us/permitting/waste_permits/surface_casing/surf_casing_AIR.html (last visited Sept. 10, 2008).

[FN234]. [16 TEX. ADMIN. CODE § 3.8\(d\)\(1\) \(2008\)](#).

[FN235]. Id. § 3.8(b).

[FN236]. Id. § 3.8(d)(6)(A).

[FN237]. Id. § 3.8(d)(5).

[FN238]. See Telephone Interview with Steve Sasaki, *supra* note 9.

[FN239]. Id.

[FN240]. Id.

[FN241]. Id.

[FN242]. Id.

[FN243]. See Montana Board of Oil and Gas Conservation, Sundry Notices and Report of Wells, available at <http://bogc.dnrc.state.mt.us/PDF/Form2.pdf>.

[FN244]. Id.

[FN245]. See Telephone Interview with Steve Sasaki, *supra* note 9.

[FN246]. See Telephone Interview with Ted Loukides, *supra* note 132.

[FN247]. Id.; see also Wilber, *supra* note 60 (describing how New York is currently completing a "Comprehensive Environmental Review" of fracking in the Marcellus Shale).

[FN248]. Otsego County Planning Comm'n, available at http://www.otsegocounty.com/depts/pln/documents/Aug6unansweredquestions_001.pdf (last visited Feb. 25, 2009).

[FN249]. N.Y.S. Dep't of Envtl. Conservation, Well Permitting Process: Well Permitting Requirements to Drill, Deepen, Plug Back and Convert for Oil, Gas, Solution Salt Mining and Other Regulated Wells, available at <http://www.dec.ny.gov/energy/1772.html> (last visited Feb. 27, 2009).

[FN250]. N.Y.S. Dep't of Envtl. Conservation Div. of Mineral Resources, Envtl. Assessment Form, Attachment to Drilling Permit Application, No. 85- 16-5, available at http://www.dec.ny.gov/docs/materials_minerals_pdf/eaf_dril.pdf (last visited Feb. 27, 2009).

[FN251]. Id.

[FN252]. Id.

[FN253]. See Telephone Interview with Ted Loukides, *supra* note 132.

[FN254]. 2 COLO. CODE REGS. §§ 303(a)(1), [404-1 \(303\)\(c\)\(2\), \(18\) \(2008\)](#).

[\[FN255\]](#). Id. §§ 404-1(303)(k).

[\[FN256\]](#). Id. §§ 404-1(305)(b)(2).

[\[FN257\]](#). Id. § 401(4-1(401)(a).

[\[FN258\]](#). Id. § 404-1(401)(b).

[\[FN259\]](#). Id. § 404-1(401)(b)(4)(F).

[\[FN260\]](#). Id. § 404-1(907)(e).

[\[FN261\]](#). Id. § 404-1(907)(e)(1), (2).

[\[FN262\]](#). Id. § 404-1(307)(e)(2)(F).

[\[FN263\]](#). Oil and Gas Conservation Comm'n State of Colo., In the Matter of Changes to the Rules and Regulations of the Oil and Gas Conservation Comm'n of the State of Colo., Cause No. IR, Docket No. 0803-RM-02, Rule Language Compilation, 300-Series Rules, at 39, available at <http://cogcc.state.co.us/>, "Staff Alternative Language for 300 and 900 Series," available at COGCC-300- Series Rule Language Compilation-090408.pdf.

[\[FN264\]](#). Id. at 39.

[\[FN265\]](#). Id. at 51.

[\[FN266\]](#). N.M. CODE R. § 19.15.17.13 (Weil 2008).

[\[FN267\]](#). Pa. Dep't of Envtl. Prot., supra note 17, at ch. 3 p. 1.

[\[FN268\]](#). 58 PA. CONS. STAT. ANN. § 601.201(a)(2)(b)(West 2008).

[\[FN269\]](#). Pa. Dep't of Envtl. Prot., supra note 18, at ch. 3 p. 3.

[\[FN270\]](#). 58 PA. CONS. STAT. ANN. § 601.201 (a)(2)(e)(1).

[\[FN271\]](#). Id. at § 202(a).

[\[FN272\]](#). Id. at §§ 202(a), 208(b).

[\[FN273\]](#). Id. at § 208(c).

[\[FN274\]](#). [25 PA. CODE § 78.55 \(2008\)](#).

[\[FN275\]](#). [25 PA. CODE § 91.34 \(2008\)](#).

[\[FN276\]](#). Pa. Dep't of Envtl. Prot., supra note 18, at ch. 4 p. 2.

[\[FN277\]](#). Id. at 3.

[\[FN278\]](#). Id. at 3-4.

[\[FN279\]](#). Id. at 7-8.

[\[FN280\]](#). Id. at 45.

[\[FN281\]](#). Id. at 73.

[\[FN282\]](#). Id. at 80.

[\[FN283\]](#). Pa. Dep't of Env'tl Prot., Application Addendum and Instructions for Marcellus Shale Gas Well Dev., Form 5500-PM-OG0083 (2008) (on file with author).

[\[FN284\]](#). Id. at 3.

[\[FN285\]](#). See *infra* note 288.

[\[FN286\]](#). See Rule 400-4-2-01(1)(a), (d), available at <http://www.ogb.state.al.us/ogb/rules.aspx> (last visited Feb. 27, 2009) ("Injection shall mean the introduction of fluids into a subsurface stratum or formation.").

[\[FN287\]](#). Id. at 400-4-2-01(3)(a); 400-4-2-01(3)(b).

[\[FN288\]](#). Ala. Oil and Gas Board, In re: Order No. 2007-133 (Sept. 7, 2007), available at <http://www.gsa.state.al.us/ogb/ogb.html> (follow "Hearings" hyperlink; then follow "Orders" hyperlink; select the year "2007" from the drop-down menu; go to page 7 of the Board Order File Name; follow the "Order No. 2007-133" hyperlink) (last visited Feb. 25, 2009).

[\[FN289\]](#). State Oil and Gas Board Admin. Code, § 400-3-8-03, available at <http://www.gsa.state.al.us/ogb/rules.aspx> (last visited Feb. 27, 2009).

[\[FN290\]](#). Id.

[\[FN291\]](#). Id.

[\[FN292\]](#). See, e.g., EPA 2004, *supra* note 7.

[\[FN293\]](#). See, e.g., Wilson, *supra* note 12, at 2 ("Coal bed hydraulic fracturing may introduce toxic materials such as acids, benzene toluene, ethyl benzene, xylene, formaldehyde, polyacrylamides, chromates, and other toxic components into underground sources of drinking water.").

[\[FN294\]](#). EPA 2004, *supra* note 7, at 7-2, available at http://www.epa.gov/OGWDW/uic/pdfs/cbmstudy_attach_uic_ch07_conclusions.pdf.

[\[FN295\]](#). See *supra* note 106.

[FN296]. See supra note 68 and accompanying text.

[FN297]. See supra note 3.

[FN298]. See, e.g., Thomas McGarity, [MTBE: A Precautionary Tale](#), 28 HARV. ENVTL L. REV. 281, 282 (2004) (hereinafter MTBE) (discussing the modern environmental regulatory regime and how MTBE "represents one of its most striking failures").

[FN299]. Id.

[FN300]. See id. at 293-94.

[FN301]. Id. at 296-97 (citing [42 USC § 7545 \(f\)\(4\)](#) (allowing the Administrator to waive the prohibition of the marketing of fuel used in vehicles with catalytic converters if the fuel was dissimilar to the fuels used in emissions certification of vehicles "if he determines that the applicant has established that such fuel or fuel additive or a specified concentration thereof, and the emission products of such fuel or fuel additive or specified concentration thereof, will not cause or contribute to a failure of any emission control device or system").

[FN302]. Id. at 297; see also [42 U.S.C. § 7545 \(c\)](#) (providing that "[n]o fuel or fuel additive [could] be prohibited by the Administrator" unless he conducted a thorough scientific and economic study and made formal findings).

[FN303]. McGarity, MTBE, supra note 298, at 297 ("Because the waiver was mandatory for any new fuel that did not interfere with pollution control devices, the agency did not consider any possible adverse effects on air or groundwater quality when it granted the waiver.").

[FN304]. Id. at 299.

[FN305]. Id. at 301.

[FN306]. See supra note 3.

[FN307]. See generally supra, Part II.

[FN308]. See, e.g., McGarity, MTBE, supra note 298, at 317-18.

[FN309]. See, Patrick A. Fuller, [How Peer Review of Agency Science can Help Rulemaking: Enhancing Judicial Deference at the Frontiers of Knowledge](#), 75 GEO. WASH. L. REV. 931, 935 (2007) (discussing how "[p]art of the industry response to [the government's] new focus on public health and environmental regulation was to criticize agencies' use of science in regulatory decisions" and how "avoidance of responsibility (and liability) by questioning the validity of data is a classic tactic of industries whose products may be causing harm").

[FN310]. Id.

[FN311]. See, e.g., Thomas McGarity, [Our Science is Sound Science and Their Science is Junk Science: Science-Based Strategies for Avoiding Accountability and Responsibility for Risk-Producing Products and Activities](#), 52 U. KAN. L. REV. 897, 897-98 (2004) (discussing FDA Commissioner Veneman's dismissal of "consumer group demands for more testing [of cattle for mad cow disease] on the ground that additional testing would not be based on 'sound science'").

[\[FN312\]](#). [Id. at 898](#).

[\[FN313\]](#). McGarity, MTBE, *supra* note 298, at 320.

[\[FN314\]](#). *Id.*

[\[FN315\]](#). See, e.g., *supra* note 153 and accompanying text.

[\[FN316\]](#). EPA, *supra* note 7, at 2-1 to 2-2, available at http://www.epa.gov/ogwdw000/uic/pdfs/cbmstudy_attach_uic_ch02_methodology.pdf.

[\[FN317\]](#). THOMAS MCGARITY AND WENDY WAGNER, *BENDING SCIENCE: HOW SPECIAL INTERESTS CORRUPT PUBLIC HEALTH RESEARCH 1* (Harvard Univ. Press 2008).

[\[FN318\]](#). *Id.* at 183.

[\[FN319\]](#). *Id.*

[\[FN320\]](#). Wilson, *supra* note 12.

[\[FN321\]](#). *Id.* at 14.

[\[FN322\]](#). *Id.*; see also EPA, Underground Injection Control Program, Peer Review Panel for the Coalbed Methane Study, available at http://www.epa.gov/ogwdw000/uic/wells_coalbedmethanestudy_peerreview.html (last visited Feb. 25, 2009) (listing the peer review panelists and providing brief biographies).

[\[FN323\]](#). *Id.*

[\[FN324\]](#). Federal Advisory Committee Act, 5 U.S.C. app. § 5(b)(2) (2000); see also Joe G. Conley, Note: [Conflict of Interest and the EPA's Science Advisory Board, 86 TEX. L. REV. 165, 168 \(2007\)](#) (discussing the Act).

[\[FN325\]](#). See, e.g., GAO, EPA'S SCIENCE ADVISORY BOARD PANELS: IMPROVED POLICIES AND PROCEDURES NEEDED TO ENSURE INDEPENDENCE AND BALANCE (June 2000), available at <http://www.gao.gov/new.items/d01536.pdf>.

[\[FN326\]](#). *Id.* at 13.

[\[FN327\]](#). *Id.* at 14.

[\[FN328\]](#). Conley, *supra* note 324, at 176-179 (discussing the Scientific Advisory Board reforms).

[\[FN329\]](#). *Id.* at 187, 186.

[\[FN330\]](#). See EPA 2004, *supra* note 7, at MR-5, available at http://www.epa.gov/ogwdw000/uic/pdfs/cbmstudy_attach_uic_references.pdf (citing the Gas Technology Institute Web site and Halliburton, Inc. site visits and personal communications).

[\[FN331\]](#). McGarity and Wagner, *supra* note 317, at 97, 123.

[FN332]. McGarity and Wagner, *supra* note 317, at 125-26.

[FN333]. *Id.* at 126 (discussing how the meta-analysis suppressed by senior FDA officials "showed that children given [antidepressant drugs] were almost twice as likely to become suicidal as children on placebos").

[FN334]. Letter from Representative Henry Waxman to Administrator Christine Todd Whitman (Oct. 1, 2008), available at <http://oversight.house.gov/documents/20040827104747-13515.pdf>.

[FN335]. Letter from Administrator Christine Todd Whitman to Representative Henry Waxman (Oct. 3, 2002), available at <http://oversight.house.gov/documents/20040827104826-35062.pdf>.

[FN336]. Letter from Representative Henry Waxman to Christine Todd Whitman (Oct. 8, 2002), available at <http://oversight.house.gov/documents/20040827104706-52254.pdf>.

[FN337]. *Id.*

[FN338]. *Id.*

[FN339]. *Id.*

[FN340]. EPA 2004, *supra* note 7, at 4-3, available at http://www.epa.gov/ogwdw000/uic/pdfs/cbmstudy_attach_uic_ch04_hyd_frac_fluids.pdf.

[FN341]. *Id.*

[FN342]. *Id.* at 4-9-4-10.

[FN343]. Testimony of Theo Colborn, Ph.D., Environmental Health Analyst, before the House Committee on Oversight and Government Reform (Oct. 25, 2007), available at <http://oversight.house.gov/documents/20071031104835.pdf>.

[FN344]. *Id.*

[FN345]. EPA 2004, *supra* note 7, at 4-3, available at http://www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_ch04_hyd_frac_fluids.pdf.

[FN346]. *Id.* at 4-4.

[FN347]. See *id.* at 4-15 (discussing a report by Palmer, which found that "61 percent of fracturing fluids were recovered based on samples collected from coalbed methane wells over a 19-day period" and by Steidl, which discussed "gel clumps" within many fractures (citing P.F. Steidl, *Inspection of Induced Fractures Intercepted by Mining in the Warrior Basin, Alabama*, 1991 Proc. Coalbed Methane Symp. 181-191; I.D. Palmer & R.T. Fryar, et al., *COMPARISON BETWEEN GEL-FRACTURE AND WATER-FRACTURE STIMULATIONS IN THE BLACK WARRIOR BASIN*, 1991 Proc. Coalbed Methane Symp. 233-242); see also *id.* at 3- 11-3-14, available at http://www.epa.gov/ogwdw000/uic/pdfs/cbmstudy_attach_uic_ch03_cbm_practices.pdf (discussing studies on fluid recovery)).

[FN348]. Id. at 3-11-3-14.

[FN349]. Id. at 3-12-3-13.

[FN350]. Id. at 1-1, available at [http:// www.epa.gov/ogwdw000/uic/pdfs/cbmstudy_attach_uic_ch01_intro.pdf](http://www.epa.gov/ogwdw000/uic/pdfs/cbmstudy_attach_uic_ch01_intro.pdf).

[FN351]. Whitman, supra note 335.

[FN352]. EPA, supra note 7, at 4-9-4-10, available at [http:// www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_ch04_hyd_frac_fluids.pdf](http://www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_ch04_hyd_frac_fluids.pdf).

[FN353]. See supra note 68 and accompanying text.

[FN354]. Id. at 4-9 to 4-10 (listing methanol and ethylene glycol as "[c]hemicals [f]ound in [h]ydraulic [f]racturing [f]luids"); EPA, Drinking Water Contaminant Candidate List and Regulatory Determinations, Contaminant Candidate List 3 (hereinafter [CCL 3](#)), available at [http:// www.epa.gov/safewater/ccl/ccl3.html#chemical](http://www.epa.gov/safewater/ccl/ccl3.html#chemical) (last visited Feb. 25, 2009).

[FN355]. EPA 2004, supra note 7, at 4-17, available at [http:// www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_ch04_hyd_frac_fluids.pdf](http://www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_ch04_hyd_frac_fluids.pdf).

[FN356]. Id. (discussing EPA's understanding of fracturing fluids based on "conservations with field engineers").

[FN357]. Id. at 4-18.

[FN358]. Data from Halliburton and Schlumberger and a site visit to Virginia, for example, indicated that dilution for slurried diesel and gel "is approximately 4 to 10 gallons of concentrated liquid gel (guar slurried in diesel) per 1,000 gallons of make-up water." Id. at 4-4.

[FN359]. Specific citations to dilution relate only to brief discussion of dilution of chemicals within the fracturing fluid itself (discussions of concentrations of diesel slurry and microbiocides in fracturing water). See id. at 4-4, 4-7.

[FN360]. Id. at 4-17.

[FN361]. Id. at 3-14, available at [http:// www.epa.gov/ogwdw000/uic/pdfs/cbmstudy_attach_uic_ch03_cbm_practices.pdf](http://www.epa.gov/ogwdw000/uic/pdfs/cbmstudy_attach_uic_ch03_cbm_practices.pdf) (Stating, without citation, that "[a]dsorption and chemical reactions can prevent the fluid from being recovered").

[FN362]. Id.

[FN363]. Id. at 4-16, available at [http:// www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_ch04_hyd_frac_fluids.pdf](http://www.epa.gov/safewater/uic/pdfs/cbmstudy_attach_uic_ch04_hyd_frac_fluids.pdf).

[FN364]. Id. at 4-17.

[FN365]. Id. at 4-12.

[FN366]. McGarity, MTBE, supra note 298, at 325-26; see also RANDALL BARTLETT, ECONOMIC FOUNDA-

TIONS OF POLITICAL POWER 155 (Springer Netherlands 1973) (discussing public choice theory, which suggests that industry groups - the groups likely to suffer the greatest losses or reap the greatest benefits - have a strong interest in influencing policy).

[FN367]. Interstate Oil and Gas Compact Commission (hereinafter IOGCC), About Us, available at <http://www.iogcc.state.ok.us/about-us> (last visited Feb. 25, 2009).

[FN368]. IOGCC, What We Do, available at <http://www.iogcc.state.ok.us/what-we-do> (last visited Feb. 25, 2009).

[FN369]. See Independent Petroleum Ass'n of Am. *supra* note 153.

[FN370]. Judy Pasternak, Bush's Energy Plan Bares Industry Clout, L.A. TIMES, Aug. 26, 2001 at A-1 available at <http://articles.latimes.com/2001/aug/26/news/mn-38530>.

[FN371]. Am. Exploration and Prod. Council, *supra* note 111.

[FN372]. IOGCC, Congress Passes IOGCC's Legislative Fix for Hydraulic Fracturing: Historical Overview, COMPACT COMMENTS (Sept. 2005), available at http://www.iogcc.state.ok.us/Websites/iogcc/docs/September_2005.pdf.

[FN373]. Julie Murphy, Coal Bed Methane Wastewater: Establishing a Best Available Technology Standard for Disposal Under the Clean Water Act, 14 S.E. ENVTL. L.J. 333, 344 (2006) (arguing that "[w]here chemical solvents are used in the fracturing process, any introduced contaminants should be removed from the wastewater prior to disposal").

[FN374]. Senator James M. Inhofe & Frank Fannon, [Energy and the Env't: The Future of Natural Gas in Am., 26 ENERGY L.J. 349, 370-71 \(2005\)](#).

[FN375]. [Id. at 370](#).

[FN376]. GWPC Survey, *supra* note 63, at 10.

[FN377]. EPA 2004, *supra* note 7, at 3-11, available at http://www.epa.gov/ogwdw000/uic/pdfs/cbmstudy_attach_uic_ch03_cbm_practices.pdf.

[FN378]. *Id.*

[FN379]. *Id.* at 4-16, available at http://www.epa.gov/ogwdw000/uic/pdfs/cbmstudy_attach_uic_ch04_hyd_frac_fluids.pdf.

[FN380]. *Id.* at 3-12, available at http://www.epa.gov/ogwdw000/uic/pdfs/cbmstudy_attach_uic_ch03_cbm_practices.pdf.

[FN381]. *Id.* at 3-13.

[FN382]. *Id.* at 4-16.

[FN383]. *Id.*

[FN384]. H.R. 7231, 110th Cong. 2d Session (Sept. 29, 2008), available at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h7231ih.txt.pdf.

[FN385]. Thomas, the Library of Congress, H.R. 7231, Bill Status, available at <http://thomas.loc.gov/cgi-bin/bdquery/D?d110:26:./temp/~bdo2Di:~@X>.

[FN386]. See, e.g., supra note 281 (discussing Pennsylvania regulations requiring drillers to describe "streams, wetlands, and other bodies of water" near the proposed drilling site); supra note 251, and accompanying text (requiring the driller to describe whether the site is "over a primary or principal aquifer; whether it is within a certain distance of a public water supply well, surface municipal water supply, or "lake, stream, or other public surface water body").

[FN387]. See, e.g., Lawrence Ng, [A Drastic Approach to Controlling Groundwater Pollution](#), 98 YALE L.J. 773, 776 (1989) (arguing that "[d]ue to significant limitations in the mapping and monitoring of aquifers [sic], it is difficult to determine accurately the full extent of groundwater contamination" and that "[o]nce contaminants enter an aquifer it is hard to predict precisely how those contaminants will be dispersed throughout the body of groundwater").

[FN388]. State Oil and Gas Board Administrative Code, § 400-4-2-01(3)(b), available at <http://www.gsa.state.al.us/ogb/rules.aspx> (last visited Feb. 25, 2009).

[FN389]. See, e.g., Ng, supra note 387, at 778 (discussing how "[o]nce an aquifer is polluted it may remain polluted indefinitely").

[FN390]. William E. Cox, [Evolution of the Safe Drinking Water Act: A Search for Effective Quality Assurance Strategies and Workable Concepts of Federalism](#), 21 WM. & MARY ENVTL. L. & POL'Y REV. 69, 75 (2006) (discussing how prior to the enactment of the Safe Drinking Water Act, "[c]oncern about pesticides and a wide range of chemicals with unknown long-range effects, together with lingering episodes of waterborne disease, caused doubt concerning the adequacy of drinking water management programs").

[FN391]. See [H.R. REP. NO. 93-1185, at 6454 \(1974\)](#) ("The purpose of the legislation is to assure that water supply systems serving the public meet minimum national standards for protection of public health.").

[FN392]. Cox, supra note 390, at 79; see also [H.R. REP. NO. 93-1185](#), supra note 294 (expressing concern that "it appears that the Federal Water Pollution Control Act may not authorize any regulation of deep well injection of wastes which is not carried out in conjunction with a discharge into navigable waters" and that "the Federal Water Pollution Control Act's restrictive definition of pollutant may prevent any Federal control system from adequately protecting underground drinking water sources").

[FN393]. See Pa. Dep't of Envtl. Prot., supra note 282.

[FN394]. See, N.Y.S. Dep't of Envtl. Conservation, supra note 251, and accompanying text.

[FN395]. See, e.g., American Petroleum Institute, supra note 128 (arguing that the "current balanced management approach serves the nation well [T]he current approach retains the effective state regulatory programs that protect the environment"); Nat'l Energy Technology Laboratory, U.S. Dep't of Energy, Policy Facts: More Restrictive Regulation (Hydraulic Fracturing) Could Impact Natural Gas Supply, available at <http://www.netl.doe.gov/publications/factsheets/policy/Policy001.pdf> ("More restrictive regulation of hydraulic fracturing, which may not increase the protection of underground drinking water, could have a deleterious effect on the supply

of natural gas in the U.S. ").

[FN396]. See, e.g., supra note 157.

[FN397]. See, e.g., Angela Neese, Comment: The [Battle Between the Colo. Oil and Gas Conservation Comm'n and Local Gov'ts: A Call for a New and Comprehensive Approach](#), 76 U. COLO. L. REV. 561, 574 (2005) (describing "Colorado's oil and gas industry" as "one of the most heavily regulated in the United States").

[FN398]. [42 U.S.C. § 300h\(b\)\(1\)](#).

[FN399]. Ibid.

[FN400]. Some oil and gas associations agree with this approach, although they do not argue for federal involvement. The Division of Professional Affairs of the American Association of Petroleum Geologists, for example, argues that "[s]cientifically designed, state-based environmental oversight of hydraulic fracturing treatments for those coalbed methane and other hydrocarbon wells that may occur near zones of potable water is a reasonable approach." Division of Professional Affairs, American Association of Petroleum Geologists, Position Statement: Hydraulic Fracturing, available at http://dpa.aapg.org/gac/statements/hydraulic_fracturing.pdf.

[FN401]. See, Richmond, supra note 130.

[FN402]. See supra notes 263-265 and accompanying text; 276-284 and accompanying text.

[FN403]. See, Ground Water Protection Council, supra note 114; EPA 2004, supra note 7; Energy Policy Act of 2005, supra note 116.

[FN404]. EPA 2004, Executive Summary, supra note 7, at ES-2, available at http://www.epa.gov/OGWDW/uic/pdfs/cbmstudy_attach_uic_exec_summ.pdf.

[FN405]. Id.

[FN406]. Memorandum of Agreement, supra note 13, at 5.

[FN407]. H.R. 6, § 322, 109th Cong. (1st Sess. 2005), available at <http://www.govtrack.us/congress/billtext.xpd?bill=h109-6>.

[FN408]. [40 C.F.R. § 145.1 \(1994\)](#) (explaining how implemented provisions of a state underground injection control program must "establish requirements at least as stringent as the corresponding provisions" in the EPA regulations).

[FN409]. [40 C.F.R. § 144.12\(a\)](#) (1987), available at http://edocket.access.gpo.gov/cfr_2002/julqtr/pdf/40cfr144.12.pdf.

[FN410]. See, e.g., Mary Griffiths, Coalbed Methane Development in Alberta: An Environmental Perspective, 2008 PROC. FIFTH ANN. UNCONVENTIONAL GAS AND COALBED METHANE CONF. 7 (listing as a "best practice" the avoidance of "hydrocarbon or other toxic additives, where fracturing in or near [a] non-saline zone").

[FN411]. EPA 2004, supra note 7, at 7-3, available at http://www.epa.gov/OGWDW/uic/pdfs/cbmstudy_attach_uic_ch07_conclusions.pdf.

[FN412]. See, e.g., Wilson, *supra* note 12, at 4 (observing that "only in the last few years has the industry begun the injection of fluids to conduct hydraulic fracturing in aquifers that supply, or could supply, community and individually-owned drinking wells").

[FN413]. See STW Resources, Inc., Executive Summary, available at <http://www.stwresources.com/about.html> (last visited Feb. 27, 2009).

[FN414]. See *id.*

[FN415]. *Id.*

[FN416]. Society of Petroleum Engineers, New Collaboration Aims to Recover Hydraulic Fracturing Wastewater, J. PETROLEUM TECH. (2008), available at <http://updates.spe.org/index.php/2008/08/18/new-collaboration-aims-to-recover-hydraulic-fracturing-wastewater/> (last visited Feb. 27, 2009).

[FN417]. See, 58 PA. CONS. STAT. ANN. § 601.201(a)(2)(b) (West 2008).

[FN418]. See, e.g., Larry Charach, Executive Director, Gas Markets and Utilities Business Unit, Alberta Department of Energy, NGC Consultation Process and Observations, in 2003 PROC. FIFTH ANN. UNCONVENTIONAL GAS & COAL BED METHANE CONF. 8 (explaining that there is "no formal established compensation to land owners" in Wyoming's coal basins).

[FN419]. See *supra* notes 271-273 and accompanying text.

[FN420]. K. Heffernan, Trident Exploration Corp., Remarks at the Unconventional Coal Bed Methane Conf.: Living the Philosophy - Community and Environment Practices at the Fort Assiniboine Joint Venture, 2003 PROC. FIFTH ANN. UNCONVENTIONAL GAS & COALBED METHANE CONF. 7.

[FN421]. *Id.* at 14, 16-19.

[FN422]. Safe Drinking Water Act Amendments of 1996, [Pub. L. 104-182 § 3\(1\)](#), [110 Stat 1613, 1614](#).

[FN423]. Safe Drinking Water Act Amendments of 1996, [Pub. L. 104-182 § 3\(5\)](#), [110 Stat 1613, 1615](#).

[FN424]. Safe Drinking Water Act Amendments of 1996, [Pub. L. 104-182 § 3\(4\)](#), [110 Stat 1613, 1615](#).

[FN425]. See, e.g., American Exploration and Production Council, *supra* note 104 (stating that "many attorneys believe that cases [similar to LEAF] would produce similar results - a forced federal regulation in each state" and that the "issue presents the worst of the governance process").

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