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Legal Causation: Hydraulic Fracturing and Groundwater Contamination

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I. INTRODUCTION

We live on a water planet. The majority of Earth is covered by water, mostly salt water, amounting to about 71% of the earth’s surface. Water can be found in all organisms; a tree is roughly 60% water by weight, whereas humans and most animals are roughly 50–65% water by weight. While we each only need about a dozen cups of water a day to survive, an abundance of water is needed to supply us with food, shelter, and other wants and needs of everyday life. Accordingly, it is easy to see how water plays a key role in our day-to-day lives.

Only a fraction of the Earth’s water is classified as fresh water. Roughly 97.4% of water, by volume, is found in the oceans and is too salty for everyday use, e.g., to drink, to use for irrigation, or to use for industry. The remaining 2.6% of water is freshwater, which is either locked up in glaciers or in groundwater too deep or salty to be used. Thus, only about .014% of the Earth’s water is available for use and consumption. To put that fraction into perspective, biologist John Todd offered an astonishing analogy: pretend the world’s water supply were only twenty-six gallons; if that were true, then our usable supply of fresh water would only be about two and one half teaspoons by comparison.

Accordingly, it is imperative for society to take care of the limited amount of freshwater available to us. In order to do so, we must accurately determine what sources are currently causing groundwater contamination, and then explore ways to improve and alter those sources to avoid contamination. The crucial step being to locate actual sources of contamination. Due, in large part, to inaccurate and misleading media coverage, hydraulic fracturing (fracking) has been labeled a major source of groundwater contamina-

* Associate, Hall, Estill, Hardwick, Gable, Golden & Nelson, P.C. I would like to thank the faculty and staff at Southern Methodist University for their helpful comments on earlier drafts of this article.

2. Id.
3. Id.
4. Id.
5. Id.
6. Id.
7. Water Resources and Water Pollution, supra note 1.
8. Id.
tion.\textsuperscript{9} As a result, members of the misinformed public have brought legal claims against oil and gas operators who utilize the fracking process, requesting damages for the alleged groundwater contamination.\textsuperscript{10}

To date, not one landowner has succeeded in proving to a court that fracking was the source of any contamination. Landowners simply cannot prove the requisite causal connection between fracking and the contamination.\textsuperscript{11} The landowners' failure to establish causation in lawsuits regarding fracking results from the geologic and scientific unlikelihood that the hydraulic fracturing process causes property damage. Other law review articles claim that the reason landowners cannot prove causation is due to the lack of scientific data on the topic.\textsuperscript{12} However, as this paper illustrates, several credible scientific studies have been done on fracking and groundwater contamination. Those studies, taken as a whole, prove—that the reason landowners struggle with proving causation is because—causation between fracking and groundwater contamination simply does not exist. The quicker the public and scientific community accepts this conclusion, the quicker research and studies can be focused on other potential sources of contamination. This paper will set forth the following:

(1) An overview of the hydraulic fracturing process, including the basic scientific and engineering principles surrounding the process and why the process is used;

(2) Landowner lawsuits regarding water contamination caused by hydraulic fracturing;

(3) The difficulty in proving causation in lawsuits related to hydraulic fracturing;

(4) The lack of scientific evidence available to link the hydraulic fracturing process to groundwater contamination;

(5) An analysis on potential sources of groundwater contamination; and

(6) The effects of ground water contamination and why finding its source of contamination is vital.


\textsuperscript{11} See, e.g., Harris, 2012 U.S. Dist. LEXIS 8848, at *2.

\textsuperscript{12} Brian J. Smith, Comment, \textit{Fracing the Environment?: An Examination of the Effects and Regulation of Hydraulic Fracturing}, 18 Tex. Wesleyan L. Rev. 129, 132 (Fall 2011).
II. HYDRAULIC FRACTURING PROCESS: AN OVERVIEW

The fracking process involves a combination of scientific and engineering principles to increase permeability in subsurface rock formations. The process includes injecting fluids (fracking fluids) underground at high pressures. One of the most controversial parts of the fracking process is the composition of the fracking fluid injected into the rock formations. The composition of the fracking fluid depends on the operator and the type of formation being fractured, but it often involves chemicals that can be harmful to the environment. However, fracking is still used because of the economic benefits it creates. This section discusses in depth: (1) basic scientific and engineering principles of fracking; (2) controversial components of fracking fluid; and (3) why fracturing is used.

A. Basic Scientific and Engineering Principles Surrounding Hydraulic Fracturing

Fracking is a process used to recover oil and gas in low permeable formations. The fracking process includes injecting fracking fluids underground at significant pressures, forcing the fluids into subsurface rock formations. The pressure at which the fracking fluid is sent into the formation creates cracks in the rock along natural fault lines, in the opposite direction of the wells. The fracking fluid pumped into the subsurface formation is mainly comprised of water, but the fluid also contains small amounts of sand and other chemical additives. The sand holds the fractures in the earth open against the enormous pressure that would otherwise force the fractures shut as soon as the fluid drained. The chemical additives include a number of different compounds and chemicals that tend to be controversial due to the harm they can cause to the environment. However, the chemical additives are necessary for “propping” open the fractures, because the additives deliver the water and sand together into the rock fractures while simultaneously allowing the fracking fluid to be removed and the sand to remain, thus “propping” open the fractures. The sand stays in the cracks that are created which

14. Id. at 118.
17. Id.
18. Id.
19. Id.
20. Id.
allows the fracking fluid and oil and gas to flow back through the cracks to the well. Once the fracking fluid and gas flows back to the well it is then pumped back to the surface. The ultimate goal of many fracking operations is to ensure that the fractures connect the wellbore to the area of the shale or coalbed in which production has been stimulated, thereby allowing the gas or oil to flow into the well.

B. Controversial Components of Hydraulic Fracturing Fluid

The fluid used in the hydraulic fracturing process typically varies in composition depending on the type of formation being fractured. As mentioned above, a typical composition includes mostly water, a proppant to keep the fractures open such as sand, and a small percentage of chemical additives. Fracking fluid is typically comprised of approximately 99% fresh water and sand, and roughly 1% of chemical additives. The exact composition of any given fracking fluid is generally unknown because most operators consider their composition to be a trade secret. However, industry-wide pressure has increasingly forced many operators to disclose their composition.

According to a report by the Environmental Protection Agency (EPA), hydraulic fracturing in coalbed methane wells may require “50,000 to 350,000 gallons of frac[ing] fluids” and “75,000 to 320,000 pounds of sand as proppant” to maintain the opening of fractures after the fracking pressure is reduced. Based on average injection volume data provided by Halliburton to the EPA, the maximum average of injection is close to “150,000 gallons” per well and the median average of injection is “57,500 gallons per well.”

21. Id.
22. Wiseman, supra note 13, at 118.
23. The wellbore is a previously drilled hole in the ground through which the oil or gas is accessed.
24. Id.
25. Id.
27. Smith, supra note 12, at 131.
28. Id.
30. Id. at 3.3.
ther, in any fracking job, whether it is coal bed, shale, or some other type of formation, some fracking fluids cannot be recovered and are thus “lost.”31 A nineteen-day study performed by the EPA found that in coal formations, 61% of stimulation fluids were recovered.32 An estimate of 68%, up to as much as 82%, of fracturing fluid will eventually be recovered over time.33 A variety of factors determine how much fracturing fluid is recovered.34 Examples of these factors include: leakoff of fluid into the coal seams and surrounding strata, the check-valve effect, adsorption and other geochemical processes, and flow through the intended fracture formation and beyond the well’s capture zone.35

Some of the more dangerous chemicals found in fracking fluid include: benzene, toluene, ethylbenzene, and xylenes.36 Negative side effects of these chemicals include a decrease in red blood cells, an increased risk of some cancers, fatigue, nausea, weakness, and confusion.37 The EPA report stated that the use of diesel fuel, particularly in fracking fluids, might introduce dangerous chemicals into underground sources of drinking water.38 The EPA has the authority to regulate hydraulic fracturing when diesel fuel is used as an additive in an operator’s fracking fluid,39 but despite holding this power, the agency has not yet adopted any specific regulations.40 Federal and state governments have discussed mandating operators to disclose their fracking fluid composition,41 and some states have passed such regulations42

Advocates of chemical disclosure laws maintain that disclosure facilitates medical professionals to better respond to medical emergencies that in-

31. Id. at 3.5.
32. Id. at 3.3.1.
33. Id.
34. Id.
35. CHARACTERISTICS OF COALBED METHANE PRODUCTION, supra note 29.
38. STUDY OF THE POTENTIAL IMPACTS, supra note 36.
41. Id. at 20.
42. Id. at 21.
volve human exposure to the chemicals used in fracking fluid. In addition, advocates argue that such disclosure would assist research on health studies pertaining to shale gas production. Manufactures of the additives, as well as other participants in the oil and gas industry, remain hesitant to support disclosure of information regarding what chemicals compose their fracking fluid. These parties worry that disclosure would reveal proprietary chemical formulas to their competitors and destroy their trade secrets. Ultimately, the EPA has stated that—while the hydraulic fracturing process can introduce these chemicals into the water table—fracking is not a significant threat to drinking water. Accordingly, there have been few regulations requiring disclosure on this matter.

C. Why is Hydraulic Fracturing Used?

Despite the potential environmental harm associated with the additives used in fracking fluid, the economic benefits of the technology increasingly promote the use of fracking. Fracking was developed in the 1940s, and has been used at increasing rates in wells since its development. Prior to 1998, the media and public largely ignored the process of fracking. Recently, however, fracking has become controversial and has received much more attention. This change is most likely the result of the rapid increase in use of the technology driven by operators’ awareness of the profitability of producing oil and gas from shale formations by using hydraulic fracturing stimulation. The increase in use has in turn caused the fracking process to receive much more attention from landowners, environmentalists, and the media.

The first and primary reason fracking stimulation is used is because fracking stimulation makes production of oil and gas more economically feasible in certain shale formations. Fracking is not a “drilling process;” the fracking process is used after the vertical or horizontal drilled hole is com-

43. Id. at 20.
44. Id.
45. Id.
46. VANN ET AL., supra note 40, at 20.
47. Id.
49. Id.
50. Id.
51. Id.
52. Id.
53. Id.
completed. As conventional sources of oil and gas production become less economically productive and energy demand and prices rise, production companies need to develop creative extraction methods, such as fracking, to tap sources that were previously not worth drilling with conventional methods.

Second, fracking not only provides the technology needed to reach oil and gas that is not economically feasible to reach with conventional methods, but it also provides the technology producers need to reach oil and gas sources that conventional methods cannot possibly reach. For regions that have been without energy production and have had to rely on other regions for oil and gas, fracking offers new opportunities to produce much-needed local energy. Using fracking technology to produce energy in these communities increases new energy supply, generates royalties, increases tax revenues, and creates new well-paying job opportunities close to home. Estimates predict that as much as 60% of the natural gas and 30% of the oil produced in the United States would be inaccessible without fracking—an astounding 80% of all wells drilled in the next decade will require fracking.

Finally, the fracking process can be used to rejuvenate old wells. The process allows operators to produce additional gas from pre-existing wells, without having to drill new wells. In fact, when the fracking process is used, "the volume of energy previously produced by ten wellbores can be captured with a single wellbore that is properly cemented, cased, and stimulated." Because fewer wells need to be drilled when fracking is often employed, the impact to the earth’s surface is limited.

Based on the discussion above, it’s easy to see why fracking is important to the nation’s economic growth. With greater energy independence comes greater economic growth, which in turn can be used to invest in developing cleaner energy sources. Accordingly, fracking produces a cleaner fuel that reduces our carbon cost, especially when compared to bituminous coal.

56. Id.
58. Id.
59. Id.
60. Id.
61. Id.
Along with the economic advantages of hydraulic fracturing, however, come environmental concerns. One of the concerns, if not the biggest concern regarding fracking stimulation, is groundwater contamination.

III. LANDOWNER LAWSUITS PERTAINING TO HYDRAULIC FRACTURING AND GROUNDWATER CONTAMINATION

Private landowners bring the majority of lawsuits involving fracking as tort lawsuits alleging a variety of harms. The landowners commonly allege harms like hydraulic fracturing causes excessive noise, increased seismic activity, groundwater and soil contamination, diminution in property value, and emotional distress. In most instances, landowners assert trespass, nuisance, negligence, or strict liability as their cause of action. This article will primarily focus on negligence claims related to groundwater contamination, as groundwater contamination and negligence are the focus in most of the current litigation. Landowners continually struggle to prove causation in their negligence claims, because to date, landowners have never successfully proved a causal link between the fracking process and groundwater contamination in courts.

This section discusses a few of the more popular cases regarding fracking and contamination, and explores the types of evidence courts are demanding to successfully prove a causal connection between the fracking process and the alleged groundwater contamination.

A. Groundwater Contamination Claims and Causation Generally

With regard to groundwater contamination claims, plaintiffs are commonly landowners who rely on the water wells on their property as their primary source of water for daily activities. For example, most landowners use the water for drinking and to provide for cattle or farming operations. Landowners who live near or around drilling operations typically bring groundwater contamination claims after drilling or fracking operations commence.


63. Id.

64. Id. at 344–45; see, e.g., Scoma v. Chesapeake Energy Corp., No. 3:10-CV-01385-N (N.D. Tex. dismissed Dec. 9, 2011).

65. See infra parts III.A–D.


67. See id.

68. See infra parts III.A–D.
fers beneath these landowners' property, making it imperative that the source of this contamination be sought out and eliminated. However, many sources of contamination besides fracking exist.

As the cases below illustrate, courts are not satisfied with the type of evidence that landowners and their expert witnesses are presenting to show that fracking caused the contamination in their water supply. The landowners simply lack scientific support to make their claim, and in fact, the science supports their opponents. Different studies by the EPA and academic institutions support the oil and gas industry, proclaiming the source of the contamination is unlikely to be the fracking process. Courts make clear that "[c]ausation cannot be established by mere guess or conjecture; it must be established by evidence of probative value." The following cases outline the unsuccessful attempts of landowners to present sufficient evidence for a jury to find a causal link between the fracking process and the contaminated water source.

**B. Anthony v. Chevron**

*Anthony v. Chevron U.S.A., Inc.* illustrates the type of evidence a court is looking for to satisfy the causation element in a groundwater contamination claim related to fracking. In *Anthony*, landowners claimed that Chevron negligently commenced oil and gas operations, and, in effect, elevated chloride levels in their water well. Chevron argued the claims had no merit and, in turn, the district court granted Chevron's motion to dismiss—the landowners failed to establish that Chevron caused the contamination. The landowners appealed, arguing sufficient evidence of causation existed for a jury to consider Chevron's liability for water contamination.

To prove that Chevron's fracking activities contaminated their water well the landowners relied on the testimony of their expert witness, Scott Epley. The court expressed concern over the quality of the expert's testimony, as well as its speculative nature. Epley attempted to explain how salt

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69. See id.
72. See *Anthony v. Chevron USA, Inc.*, 284 F.3d 578 (5th Cir. 2002).
73. Id. at 580.
74. Id. at 582.
75. Id.
76. Id. at 584.
77. Id.
water Chevron injected into their own well managed to reach the Allurosa aquifer (the aquifer connected to the landowners’ well), half of a mile above Chevron’s injection zone.78 According to the court, Epley presented descriptions of what possibly caused the contamination, but he failed to offer sufficient evidence to fully support his theory.79 The court reasoned, “without such an underlying factual basis, a reasonable jury could not conclude that it was more likely than not that Chevron actually caused the pollution in the Allurosa.”80 For landowners to succeed on similar claims in future litigation, they will apparently need to present probative evidence to support their expert witness’s theory on how the contamination occurs. The court’s analysis, detailed below, outlines specifically what type of evidence the courts are looking for.

Epley’s first theory focused on the fact that Chevron injected more salt water into its well than the oil and water mixture it eventually removed—Epley emphasized that Chevron injected twenty-one million barrels into the South Queen formation.81 Epley further presented evidence that the formation was a “closed system.”82 Accordingly, Epley argued, Chevron’s injections were increasing the pressure of the liquid stored in the underground oil container and that eventually, the formation would no longer be able to hold the excess liquid.83 Thus, Epley claimed that the pressure increase caused the salt water injections to migrate up along the well casings of the various wells in the surrounding area.84 Epley contended that the pressure was a sufficient force to drive the injected salt water more than 2,000 feet upwards and to reach the Allurosa aquifer.85

The court found the only persuasive evidence presented was the fact that Chevron injected more fluid than it removed.86 However, Epley failed to establish the size of the underground reservoir or its storage capacity.87 Further, Epley admitted that the formation could contain voids and gases that could be compressed to make additional space for the excess salt water.88 Using Epley’s own testimony, the court found the South Queen container could possibly hold the excess of twenty-one million barrels of injected water in

78. Anthony, 284 F.3d at 584.
79. Id.
80. Id.
81. Id.
82. Id.
83. Id.
84. Anthony, 284 F.3d at 584.
85. Id. at 585.
86. Id.
87. Id.
88. Id.
addition to the initial quantity of oil that it contained. In addition, the court criticized Epley’s calculations by explaining that the calculations were based solely on injection pressures recorded at the surface and not upon actual underground pressure readings. The court was seemingly concerned with the lack of probative evidence from Epley, as well as the quality of evidence asserted by Epley; this appears to be an easy problem to fix. Current technology should allow experts to present scientific data on the size and depth of a particular formation. If the data favors the plaintiff and supports the expert’s theory, such data should be relatively useful at the trial level.

Epley’s next theory of contamination focused on two wells situated to the south and to the east of the landowners’ water source. Chevron injected highly pressurized salt water into these two wells in order to fracture the rock surrounding the formation. Next, sand was injected into these wells to hold them in place. Epley presented evidence, again from Chevron’s own records, that the salt water injections resulted in fractures extending out of the South Queen formation and upwards towards the Allurosa aquifer. The court found Epley’s testimony outlined another possible way the water sources were contaminated. The court determined, once again, Epley failed to provide sufficient evidence for a reasonable jury to conclude his proposed theory was more likely to prove causation. Put simply, Epley never bridged the gap between the out-of-zone fracture and the resulting contamination of the water source. The initial injection fracture extended only 166 feet upwards from the South Queen formation. The court reasoned Epley merely speculated that these fractures extended further when Chevron injected water over the next several years. Epley based his theory on the fact that Chevron continued to inject water at higher pressures than necessary to fracture the surrounding rock, thus providing more pressure to extend the fractures and send the contamimates upward. However, the landowners’ own exhibits indicated that Chevron ceased fracking activity well before the

89. Id.
90. Anthony, 284 F.3d at 585.
91. Id. at 586.
92. Id.
93. Id.
94. Id.
95. Id.
96. Anthony, 284 F.3d at 586.
97. Id.
98. Id.
99. Id.
100. Id.
water source was contaminated. Additionally, Epley provided no evidence to show the fractures extended further than its initially observed length of 166 feet. Evidence requested to support this second theory will be much harder for landowners to provide, than the evidence the court requested for the first theory. A logical leap is required to prove that contaminates can migrate vertically for almost two thousand feet, and even larger leap is required to prove that the migration was caused by a certain fracking process. One method to establish causation would be to show that some of the chemical additives used in the fracking process were present in the groundwater aquifer, as some scientific studies have been done. However, those studies tend to show negative results, concluding that there is little to no risk of fracturing fluid contaminating underground sources of drinking water during hydraulic fracturing.

C. Devon v. Harris

In addition to cases such as Anthony, where the court found insufficient evidence to support the expert’s causation theory, there are cases illustrating voluntary withdrawal on behalf of the landowners bringing claims against oil and gas operators in an attempt to spend more time finding evidence linking fracking to the contamination. For example, in Harris v. Devon Energy, the landowners claimed that their water well was contaminated by Devon Energy Production Company (Devon), their fracking activities. Devon filed a motion for summary judgment, claiming there was no evidence that their fracking operations caused contamination in the landowner’s water wells. Instead of contesting Devon’s motion for summary judgment, the landowners filed for voluntarily dismissal of their lawsuit without prejudice; acknowledging recent tests that showed the contamination was no longer at toxic levels. After weighing the facts of the case, the district court granted

101. Id.
102. Anthony, 284 F.3d at 586.
104. E.g., id.
106. Id.
107. Id. at *2.
the voluntary dismissal. Because the court granted dismissal without prejudice, the landowners are not barred from bringing future claims regarding the alleged water contamination; thus, they can build a stronger case if they find supporting probative evidence.

D. Strudley v. Antero Resources Corp.

Another case involving a landowner’s failure to prove causation is Strudley v. Antero Resources Corp. Strudley exemplifies a hydraulic fracturing case in which a court entered a “Lone Pine” order. This order requires a plaintiff to make a prima facie showing of exposure and causation before further discovery is allowed. A “Lone Pine” order is a great tool for defendants, as they can keep defense costs down. In Strudley, the court recognized a fracking case is often associated with extensive discovery time and costs, leading the court to implement a more efficient case management procedure. Accordingly, the court ordered the landowners to make a prima facie showing of exposure and causation prior to allowing full discovery. The landowners complied within the allotted 105 days, submitting evidence such as water analysis reports and expert witness affidavits. The oil and gas companies contested the evidence by filing a summary judgment motion, arguing that the plaintiffs failed to show causation. The court granted the companies’ motion and dismissed the landowner’s claim with prejudice.

In reaching its decision, the court considered that the landowner’s sole expert witness could only establish a temporal correlation between the landowner’s alleged harm and the oil company’s fracking techniques. Requiring the plaintiff to present evidence of their prima facie case enables the defendants to preview the plaintiff’s case without needing to use formal discovery tools, e.g., interrogatories and depositions. See id.

109. Id.
111. Id.
113. Requiring the plaintiff to present evidence of their prima facie case enables the defendants to preview the plaintiff’s case without needing to use formal discovery tools, e.g., interrogatories and depositions. See id.
115. Id.
116. Id.
117. Id.
118. Id. at *5.
119. Id. at *3.
measurements. However, the Court of Appeals of Colorado, Division One reversed the district court’s dismissal. The appellate court held that (1) the pre-discovery order prevented the landowners from proving their claims; and (2) efforts to protect the oil and gas companies against frivolous claims or unreasonably burdensome discovery were unnecessary in this case.

Despite the outcome on appeal in Strudley, defendants in hydraulic fracturing cases have sought to enter a Lone Pine order early in litigation. In a possible attempt to allow landowners’ claims to make it to trial, courts often, although not always, deny such prohibitive requests by oil and gas companies.

In Roth v. Cabot Oil & Gas Corp., the defendants filed a Lone Pine order, asserting among other things, “the nature of this case, in particular the complex factual predicate and the potential for expensive and time-consuming discovery, warrants a modified case management track requiring the Plaintiffs to make a prima facie showing of exposure, injury, and causation before proceeding to discovery.” The defendant’s filing highlighted two facts: the landowner’s counsel was involved in a similar lawsuit which lasted for several years and the landowner’s counsel had represented the landowners for over one year prior to the lawsuit. The landowners’ response contended that Lone Pine orders were issued on cases focused on toxic tort litigation claims involving personal injuries, which were absent from their case.

As the parties failed to resolve the issue among themselves, the Court was forced into denying the defendant’s request for a Lone Pine order. The magistrate judge found it preferable to stay in line with the rules of civil procedure and the standard case management tract. As the above-mentioned cases highlight, there is no clear reason why some defendants can successfully request Lone Pine orders while others cannot. Most likely, because a Lone Pine order involves a fact intensive request, any ruling depends on the amount of discovery previously conducted. The fact inquiries required to grant a Lone Pine order are hindered by the difficulty in obtaining full discovery privileges in each case.

122. Id.
124. Roth, 919 F. Supp. 2d at 480.
125. Id. at 491–92.
126. Id. at 493–94.
127. Id. at 481.
128. Id.
IV. THERE IS NO EVIDENCE THAT HYDRAULIC FRACTURING CAUSES GROUNDWATER CONTAMINATION

Past and existing litigation clearly illustrate landowners and other plaintiffs struggle to prove a causal connection between fracking and groundwater contamination in shale formations. From a geological perspective, such a struggle is not surprising. Basic principles of geology support the oil and gas industry's position that fracking does not cause contamination. In addition, scientific studies by the EPA and academic institutions conclude that fracking is not the source of contamination.

A. Geology

From a geological perspective, the fracking process, which occurs thousands of feet below the groundwater aquifers, is highly unlikely to be the source of groundwater contamination. Too much vertical distance separates the groundwater aquifers and the formations where hydraulic fracturing occurs. In addition, the geological composition of the rocks "between the deep shale formations and the shallow aquifers" makes the proposition that fracking could be the source of contamination even less probable. The types of rocks between the fracking sites and aquifers—which the contaminates would have to flow through to reach the groundwater aquifers are highly permeable—absorb the injection fluids before they could reach the shallow aquifer thousands of feet above the injection point. More specifically, shale is a type of rock with very small interstitial spaces because the shale particles themselves are small. The interstitial spaces "are so small that oil, natural gas and water have difficulty moving through the rock." Therefore, shale can "serve as a cap rock for oil and natural gas traps, as well as an aquiclude that blocks or limits the flow of underground water." However, the interstitial spaces "can take up [ ] significant volume[s] of

129. See Anthony v. Chevron USA, Inc., 284 F.3d 578, 590 (5th Cir. 2002).
130. King et al., supra note 62, at 350; see infra part IV.A.
131. King et al., supra note 62, at 341; see infra part IV.B–C.
132. King et al., supra note 62, at 350.
133. Id.
134. Id. at 351.
135. Id.
137. Id.
138. An aquiclude is a formation of rock that is highly impermeable. See id.
139. Id.
Consequently, due to its low permeability, shale cannot transfer oil, natural gas, or water even though it can hold large amounts of these substances. Accordingly, the geologic principles surrounding the composition of shale strongly supports the proposition that fracking is not the cause of groundwater contamination. The combination of the vertical distance and the types of rocks that the contaminates would have to migrate through simply demonstrates that fracking is unlikely to be a problem. These basic principles of geology, in conjunction with the studies discussed in the next subsection, create difficulty for landowners attempting to present sufficient evidence.

B. EPA Scientific Studies

In 1999, the EPA began a study on hydraulic fracturing to evaluate the potential risks to underground sources of drinking water. The study focused on coal bed methane reservoirs, compared to conventional gas reservoirs, because the former reservoir types are typically closer to the surface and, therefore, underground sources of drinking water. In 2004, the EPA published a study titled "Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs." This study was subject to "internal and external peer review[] and public comment on study design and incident[al] information." The EPA concluded that fracturing fluids from coalbed methane formations posed little to no risk of contaminating underground sources of drinking water.

The study was concluded after "Phase I" based on the data collected and the conclusions reached. During Phase I of the study, the EPA:

Gather[ed] existing information to review hydraulic fracturing processes, practices, and settings; [r]equest[ed] public comment to identify incidents that have not been reported to the EPA; [r]eview[ed] reported incidents of groundwater contamination . . . ; and [made] a determination regarding whether further investiga-

140. Id.
141. Id.
143. Id.
144. Id.
145. Id.
146. Id.
147. See CHARACTERISTICS OF COALBED METHANE PRODUCTION, supra note 29.
tion is needed, based on the analysis of information gathered through the Phase I effort.\(^{148}\)

After Phase I: [The EPA] found no confirmed cases [linking] fracturing fluid injection into coal bed methane wells or subsequent underground movement of fracturing fluids. Although thousands of coalbed methane wells are fractured annually, the EPA did not find confirmed evidence that drinking water wells have been contaminated by hydraulic fracturing fluid injection into coalbed methane wells.\(^{149}\)

The EPA found no reason to suspect fracking was the cause of groundwater contamination.\(^{150}\) In fact, the EPA reached that conclusion as early as the first phase of the study.\(^{151}\) With similar studies, and in connection with basic geological principles, it will be very difficult for landowners to prove legal causation in fracking cases related to groundwater contamination.

Further, in 2011, at the U.S. Congress’ request, the EPA decided to conduct a study focusing on “improving our scientific understanding of hydraulic fracturing.”\(^{152}\) The final version of the study will be released sometime in 2016.\(^{153}\) This study will primarily focus on shale formations but, will also include formations such as coalbeds.\(^{154}\) According to the EPA, “natural gas plays a key role in our nation’s clean energy future and the process known as hydraulic fracturing is one way of accessing that vital resource.”\(^{155}\) The EPA hopes that the study will re-address any remaining concern that hydraulic fracturing may threaten human health and the environment.\(^{156}\) The agency is convinced “a transparent, research-driven approach with significant stakeholder involvement can address these concerns” while also “strengthening

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148. Id.
149. Id. at 7–6.
150. Id. at ES-16.
151. See id.
155. Study of the Potential Impacts, supra note 36.
156. Id.
our clean energy future.”\textsuperscript{157} The study will include a review of published literature, analysis of existing data, scenario evaluation and modeling, laboratory studies, and case studies.\textsuperscript{158}

The EPA released a progress report in 2012 regarding the study but, the progress report did not include any data results.\textsuperscript{159} For the most part, the progress report gave a more detailed description of the study’s plan including five principal questions:\textsuperscript{160}

\begin{enumerate}[\textsuperscript{(1)}]
\item What are the [potential] impacts of large volume water withdrawals from ground and surface waters on drinking water resources?\textsuperscript{161}
\item What are the possible impacts of hydraulic fracturing fluid surface spills on or near well pads on drinking water resources?\textsuperscript{162}
\item What are the possible impacts of the injection and fracturing process on drinking water resources?\textsuperscript{163}
\item What are the possible impacts of flowback and produced water surface spills on or near well pads on drinking water resources?\textsuperscript{164}
\item What are the possible impacts of inadequate treatment of hydraulic fracturing wastewater on drinking resources?\textsuperscript{165}
\end{enumerate}

The 2012 progress report was concerned that there is no baseline data to compare with current test results.\textsuperscript{166} One expert analogized, “[T]rying to assess the impacts of hydraulic fracturing or other aspects of natural gas development without a baseline to compare post-development results is like trying to evaluate your golf game with no par.”\textsuperscript{167} To address this concern, the progress report notes that the study will not only include studies of areas that currently have oil and gas development, but the study will also include other

\begin{itemize}
\item \textsuperscript{157} Id.
\item \textsuperscript{158} Id.
\item \textsuperscript{159} See id. at 6.
\item \textsuperscript{160} Id. at 1.
\item \textsuperscript{161} \textsc{Study of the Potential Impacts, supra} note 36, at 1.
\item \textsuperscript{162} Id.
\item \textsuperscript{163} Id.
\item \textsuperscript{164} Id.
\item \textsuperscript{165} Id.
\item \textsuperscript{167} Id.
\end{itemize}
prospective case studies following potential developmental areas from beginning to end. The report specifically states:

The EPA continues to work with industry partners to begin research activities at potential prospective case study locations, which involve sites where the research will begin before well construction. This will allow the EPA to collect baseline water quality in the area. Water quality will be monitored for any changes throughout drilling, injection of fracturing fluids, flowback, and production.

Another concern is that the EPA is “behind the curve” on what the industry standard is regarding storage of flowback and water produced. The EPA’s progress report acknowledges that recycling of flowback and produced water is taking place and the report states that such wastewater is typically stored onsite in impoundment pits or tanks. In fact, most companies now recycle up to 100% of their flowback and produced water.

Overall, the 278-page progress report offered a detailed explanation of what the study will entail. For the most part, people were receptive to the substance of the report and the EPA hopes to address any concerns in a comprehensive, unbiased report backed with scientific data. This study will presumably provide strong support for one side of the groundwater contamination cases, either the oil and gas producers or the landowners. If this EPA study results in the same conclusion as the last EPA study, the oil and gas operators’ argument that fracking is not the cause of contamination will be bolstered, which will decrease the potential for landowners to make their case.

C. Duke Scientific Study

A group of scientists, who are associated with the Nicholas School of the Environment at Duke University, conducted a study on fracking. The

168. Study of the Potential Impacts, supra note 36, at 3.
169. Id.
170. Shepstone, supra note 166.
171. Study of the Potential Impacts, supra note 36, at 18.
173. See generally Study of the Potential Impacts, supra note 36.
174. See id. at 5.
motivation behind the study came from an observed increase in “hydrocarbon production from unconventional sources” and the accompanying concerns associated with groundwater contamination. The researchers sought to distinguish “natural sources of methane from anthropogenic contamination” in an effort to locate the source of contamination in water supplies. To make the distinction, researchers examined “hydrocarbon abundance and isotopic compositions (e.g., C2H6/CH4, δ13C-CH4).” And to their knowledge, the researchers conducted “the first comprehensive analyses of noble gases and their isotopes (e.g., 4He, 2Ne, 36Ar) in groundwater near shale-gas wells.” The study “addressed two questions: (1) are elevated levels of hydrocarbon gases in drinking-water aquifers near gas wells natural or anthropogenic; and (2) if fugitive gas contamination exists, what mechanisms cause it?”

“Against a backdrop of naturally occurring salt and gas-rich groundwater,” the researchers identified eight samples of fugitive gas contamination. Seven of the samples came from Pennsylvania, and the other sample came from Texas. In the samples illustrating fugitive gas contamination, “the relative proportions of thermogenic hydrocarbon gas (e.g., CH4, 4He) were significantly higher (P < 0.01) and the proportions of atmospheric gases (air saturated water; e.g., N2, 36Ar) were significantly lower (P < 0.01) relative to background groundwater.” The researchers concluded that the noble gas isotope and hydrocarbon data linked four contamination samples to gas leaking from the incomplete cement seal. Of the remaining four samples, three of the samples were linked to production gases leaking from production casings while one was attributable to “underground gas well failure.” According to the researchers, the “noble gas data appear[ed] to rule out gas

176. Id.
177. Id.
178. Id.
179. Id.
181. Darrah et al., supra note 175, at 14076.
182. Id.
183. Id.
184. Id.
185. Id.
186. Id.
contamination by upward migration from depth through overlying geological strata triggered by horizontal drilling or hydraulic fracturing."187

The study, put simply, provides additional support to the oil and gas operators' argument. This study, in conjunction with the 2004 EPA study, potentially the 2016 EPA study, and basic geological principles provide ample support for oil and gas operators. With such support, landowners should consider looking to alternative sources as the cause of their contamination.

V. IF IT'S NOT FRACKING, WHAT IS IT?

It is undisputed that many sources of fresh groundwater have been, and continue to be contaminated. Many landowners unsuccessfully blame the oil and gas industries' use of fracking for the groundwater contamination.188 If it's not the fracking process, i.e., if those landowners are wrong, what could the source of contamination be? If the oil and gas industry happens to be at fault at all, the guilt likely lies with faulty well casings rather than fracking techniques.189 However, the source of contamination could be from other forms of human activity outside of oil and gas production or even from natural causes. Residential, municipal, commercial, industrial, and agricultural activities can all affect ground water quality.190 "Contaminants may reach ground water from activities on the land['s] surface, such as spills from stored industrial wastes or from sources below the land['s] surface but above the water table [i.e., aquifers], such as septic systems or underground petroleum storage systems leaking."191 It's also possible for the contamination to come from a "structur[e] beneath the water table, such as [a] well," but such a contamination source would also have to be in conjunction with some source of pressure to force the water to migrate upward to the water supply.192 In addition to human activity, natural occurrences such as rocks and soils dissolving and decaying organic matter can result in contamination.193

A. Well Casing

As mentioned above, hydraulic fracturing is not a drilling process, and it is one of the last processes involved in producing resources from an oil and

187. Darrah et al., supra note 175, at 14080.
188. King et al., supra note 62.
189. Id.
192. Id.
193. Id.
gas well. The first steps include the actual drilling of a well, and the imple-
mentation of the casing and cementing.\footnote{194} The purpose of implementing cas-
ing and cementing into each well is in part to protect groundwater supplies.\footnote{195} To protect water supplies, oil and gas operators need to ensure that neither the fracking fluid that will eventually be pumped through the well nor the oil or gas that will eventually be pumped back up through the well enters the water supply.\footnote{196} One of the main sources of protection comes from the way casing lines the well, consisting of a hollow steel pipe which is inserted into the well.\footnote{197} Each full line of casing is known as a casing string; the gaps between the casing strings and the drilled hole are filled with cement, protecting the groundwater from contamination at depths of between 1,000 and 4,000 feet.\footnote{198}

Cementing requires “placing a cement sheath around casing strings.”\footnote{199} Once the cement has set, the drilling continues from the bottom of the surface or intermediate cemented steel casing to the next depth.\footnote{200} This process is repeated, using small steel casing each time, until the oil and gas-bearing reservoir is reached; generally, the drilling continues until a depth of 6,000 to 10,000 feet is reached.\footnote{201}

The American Petroleum Institution (API) established the current industry standard for oil and gas casing.\footnote{202} Certain specifications are provided by the API, including “the length, thickness, tensile strength and composition of casing for a given situation and [the API specification] is the most commonly used standard for the selection of oil and gas casing.”\footnote{203} Wells generally consist of “multiple casing strings including a surface string and production string.”\footnote{204} There are “specific state requirements” for using casing strings inside a well.\footnote{205} The API has also established standards for cement types.\footnote{206} Casing strings are an important element of well completion with respect to

\begin{thebibliography}{99}
\item[194.] Hydraulic Fracturing: The Process, \textit{supra} note 54.
\item[196.] \textit{Id.}
\item[197.] \textit{Id.}
\item[198.] \textit{Id.}
\item[199.] \textit{Id.}
\item[200.] \textit{Id.}
\item[201.] \textit{Well Construction & Groundwater Protection, supra} note 195.
\item[202.] \textit{Id.}
\item[203.] \textit{Id.}
\item[204.] \textit{Id.}
\item[205.] \textit{Id.}
\item[206.] \textit{Id.}
\end{thebibliography}
the protection of groundwater resources because they provide for the isola-
tion of fresh water zones and groundwater from the inside of the well. In
this regard, surface and production casing are the first line of defense for
protection of groundwater. As important as casing is, it is the cementation
of the casing that adds a high value to the process of groundwater protec-
tion. Consequently, the quality of the initial cement job is presumably a
critical factor in the prevention of fluid movement from deeper zones into
groundwater resources.

Inherently, the well casing and cementing of a well often pass directly
through groundwater aquifers. The hydraulic fracturing process, however,
occurs thousands of feet below those aquifers. Accordingly, negligence in
constructing and maintaining the well casing and cementing, which occurs only
hundreds of feet below the surface, likely provides a better explanation of
contamination than the hydraulic fracturing process.

B. Other Sources of Human Activity, Besides Fracking, that Causes
Contamination

In addition to natural causes, human activity can also be the source of
groundwater contamination. One of the main causes of groundwater con-
tamination in the United States is the discharge from “septic tanks, cesspools,
and privies” that are improperly designed or maintained. Roughly one-
fourth “of all homes in the United States rely on septic systems to dispose of
human waste.” Although the amount of waste disposed from each individ-
ual system is relatively small, the large number of septic systems and the
wide range of use of these systems make them a “serious source of contami-
nation.” Septic systems can contaminate ground water with contaminants
such as “bacteria, viruses, nitrates, detergents, oils, and chemicals.” In ad-
dition, commercial septic systems contain synthetic organic chemicals (such
as 1,1,1-trichlorethane or Dichloromethane).

207. A “lack of cement and sporadic bonding outside casing in production consti-
tutes a major potential gas migration pathway to the depth of deep monitoring
and domestic wells.” Pavillon Gas Well Integrity Evaluation, ENV'T PROTEC-
tION AGENCY REGION 8, at *39, http://www2.epa.gov/sites/production/files/

208. Id.

209. “Instances where cement outside production casing is lacking over an exten-
sive interval providing a potential conduit for fluid migration to within 300 m
of the surface.” Id. at *30.


211. Id. at C3.

212. Id.

213. Id.

214. Id.
Another serious threat to ground water contamination is underground and aboveground storage tanks, both industrial and commercial. These tanks commonly store chemicals and petroleum products. Many commercial storage tanks "store gasoline, diesel fuel, fuel oil, or chemicals in on-site tanks." Industries use storage tanks to hold chemicals ... or to store hazardous wastes." It is estimated that "four million underground storage tanks exist in the United States." As the tanks age, the contents can leak and spill into the environment. In addition, tanker trucks and trains pose a similar threat to ground water contamination. "Each year approximately 16,000 chemical spills occur from" these types of vehicles and storage tanks. When these spills occur, "the chemicals are often diluted with water and then washed into the soil." 

In addition to natural sources of salt disposition in water resources, salt use in the United States has increased drastically. The largest use of salt has been the chloralkali processing industry that produces chlorine and sodium hydroxide. Salt used by that industry represented about 35% of the salt use across the United States. The second largest use of salt is the de-icing industry. Other industries that use salt (totaling about 25% of the end use) include "agriculture, food processing, metal processing, paper production, textiles and dyeing, petroleum production, and water treatment." 

C. Natural Causes of Contamination

An example of a natural source of contamination can be found when rocks or soils containing harmful substances dissolve. Examples of these harmful substances include iron, manganese, arsenic, chlorides, fluorides,
sulfates, or radionuclides. In Anthony, the plaintiff landowners brought a groundwater contamination claim due to increasing chloride levels in their underground aquifer. According to the plaintiffs, the water produced from the Allurosa aquifer was previously suitable for human consumption. Tests run in 1973, 1974, and 1975 showed water produced from the aquifer had chloride levels of approximately sixty parts per million (p.p.m.), and each result was below the state’s recommended maximum chloride level. By 1988, the chloride levels of the water in the aquifer had “increased dramatically.” “Tests [conducted] revealed chloride levels as high as 980 p.p.m. far in excess of the recommended maximum level of chloride for drinking water.”

The plaintiffs in Anthony unsuccessfully alleged fracking to be the cause of the contamination, seemingly because there are countless other potential sources of chloride disposition from both human activity and natural sources. According to an EPA seminar, for example, certain rocks and soils contain substances that increase chloride levels of the water. Depending on the geological composition of the rocks on and under the landowner’s property, rock and soil erosion or another natural process may cause an increase in chloride levels, rather than oil and gas production.

Other natural causes include substances found in decaying organic matter. Some of the substances “may pose a health threat if they are consumed in excessive quantities; others may simply [cause the water to] develop an undesirable odor, taste, or color.” In Scoma v. Chesapeake Energy, the plaintiffs claimed that, following hydraulic fracturing activities, the water they used from their aquifer source beneath their property “turned to an orange/yellow color, tasted bad, and gave a foul odor.” Those same plaintiffs also claimed that their water was contaminated with harmful petroleum contaminants. These plaintiffs also struggled to prove causation. Based on

230. See Anthony v. Chevron USA, 284 F.3d 578, 583 (5th Cir. 2002).
231. Id.
232. See id. at 581–82.
233. Id. at 582.
234. Id.
235. The document is adapted from a seminar. Getting Up to Speed: Groundwater Contamination, supra note 191, at C9 n.1.
236. Id. at C2.
237. Id.
238. Id.
240. Id.
the allegations of the water having developed an undesirable odor, taste, and color, the contamination could have been caused due to the natural cause of decaying organic matter. According to the plaintiffs, “ground water that contains unacceptable concentrations of these substances is not used for drinking water or other domestic water unless it is treated to remove these contaminants.”241 Presumably, the court thought the natural causes of contamination was the culprit behind the change in the water’s observable properties.242

VI. EFFECTS OF GROUND WATER CONTAMINATION

Contamination of ground water has momentous effects on our country and its citizens. Contamination can result in “poor drinking quality, loss of water supply, degraded surface water systems, high cleanup costs, high costs for alternative water supplies, and/or potential health problems.”243 Some contaminated water supplies can be recycled and cleaned easily; however, water with high levels of contamination can be too difficult or too expensive to clean up, and some will choose to abandon the water source and use an alternate supply if available.244 In addition to potentially limiting our water supply, a number of synthetic chemicals, which are often the source of contamination, can result in health problems.245 Drinking water contaminated with bacteria and viruses, for example, can result in illnesses such as “hepatitis, cholera, or giardiasis.”246 While federal and state laws attempt to regulate concentrations of known harmful substances in drinking water, many unknown chemicals exist that cause harmful effects.247 Until officials become educated on such chemicals, they cannot be regulated or well understood.248 Any means of preventing contaminants from reaching the ground water is the best way to reduce the health risks associated with poor drinking quality.

VII. CONCLUSION

Hydraulic fracture stimulation is a technique that has been used for decades in many industries, including the oil and gas industry. Recently, however, landowners have unsuccessfully brought lawsuits against oil and gas operators, claiming that fracking stimulation is causing groundwater contamination in their aquifers. All of the recent scientific studies have concluded

244. Id.
245. Id. at C8.
246. Id.
247. Id.
248. Id.
that fracking stimulation does not cause groundwater contamination in shale formations. To date, the plaintiffs who file these lawsuits against oil and gas operators have fail to prove a causal link between hydraulic fracturing and water contaminations. Basic principles of geology and the scientific studies regarding fracking prevent landowners from succeeding in groundwater contamination lawsuits. As a result, landowners and the scientific community should examine other potential sources of contamination. The quicker they discover the true source of contamination, the quicker that source of contamination can be reduced, if not eliminated altogether.
Comments