

FRACKING AND CRACKING: STRICT LIABILITY FOR EARTHQUAKE DAMAGE DUE TO WASTEWATER INJECTION AND HYDRAULIC FRACTURING

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I. INTRODUCTION

The ability to extract oil and gas through the process of hydraulic fracturing (fracking) has produced tremendous benefits. As noted by President Barack Obama in his 2013 State of the Union Address, “no area holds more promise than our investments in American energy. After years of talking about it, we’re finally poised to control our own energy future.”² There is also, however, a significant downside. Fracking and related disposal activities pose serious threats to human health, air quality, water supplies, and the land itself. The escalation of hydraulic fracturing and waste injection has been accompanied by a corresponding increase in litigation.³ Landowners and other affected

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2. *State of the Union Address*, THE WHITE HOUSE (Feb. 12, 2012), available at <http://1.usa.gov/ljYhfKY>.

3. This article uses terms such as “wastewater,” “waste,” and “frack fluids” to describe the byproduct of oil and gas drilling and production activities. Conventional operations and horizontal hydraulic fracturing both bring large amounts of saline “produced” water to the surface. Horizontal

individuals have sought damages based on a variety of legal claims, including the common law torts of trespass, negligence, nuisance, and strict liability for abnormally dangerous activities.

Plaintiffs claim that hydraulic fracturing and the underground injection of wastes have contaminated air, land, and water. In addition, fracking and waste injection have allegedly triggered earthquakes which have caused injuries and property damage. Many of these cases have been dismissed, but in some instances plaintiffs have obtained settlements or favorable judgments.⁴ In no case to date, however, has a court held that either fracking or the injection of fracking wastes is an abnormally dangerous activity.⁵ A federal district court in Pennsylvania reached the opposite conclusion in 2014 with regard to the former issue, holding that “natural gas drilling operations and hydraulic fracturing are not abnormally hazardous activities on the basis of the record developed in this case”⁶

This article examines whether courts should impose strict liability for earthquake damage caused either by hydraulic fracturing or the underground injection of frack fluids. Part II of the article presents a primer on the strict liability cause of action in tort for abnormally dangerous activities. In determining whether a specific activity is abnormally dangerous, most courts have been guided by the six factors set forth in Section 520 of the Restatement (Second) of Torts. Part III of the article summarizes cases that have addressed whether oil and gas operations other than hydraulic fracturing are abnormally dangerous activities. Part IV describes two recent cases from Pennsylvania

hydraulic fracturing is an extraction process that pumps large amounts of water, along with a mix of water, sand, and various chemicals, into wells at high pressure in order to create fissures in shale and other underground formations that contain oil and natural gas. The “flow-back” water that must be disposed is predominantly produced water, and is sometimes referred to as production waste.

4. To view online summaries of fracking-related lawsuits, see Barclay R. Nicholson, *Analysis of Litigation Involving Shale & Hydraulic Fracturing*, FULBRIGHT & JAWORSKI LLP (June 1, 2014), <http://bit.ly/1LxUBUL> (providing a chronological summary of all types of litigation involving hydraulic fracturing), and Blake A. Watson, *Hydraulic Fracturing Litigation Summary*, UNIV. OF DAYTON (Dec. 14, 2015), <http://bit.ly/1Ysm5Vd> (providing a state-by-state summary of hydraulic fracturing litigation).

5. In addition to the cases that allege that hydraulic fracturing and the injection of fracking wastewater are abnormally dangerous activities, there is a separate group of cases in which plaintiffs assert that the operation of natural gas compressor stations is an abnormally dangerous activity. In these cases, plaintiffs allege that compressor stations produce noise, vibrations, and emissions that cause contamination, property damage, personal injury, and mental distress. *See, e.g.*, *Bartlett v. Frontier Gas Serv., LLC*, No. 4:11-cv-00910 (E.D. Ark. Oct. 18, 2012) (dismissed); *Smith v. Sw. Energy Co.*, No. 4:12-CV-00423, 2013 WL 2002216, at *1 (E.D. Ark. May 13, 2013) (dismissed); *Pruitt v. Sw. Energy Co.*, No. 4:12-CV-00690, 2013 WL 588998, at *4 (E.D. Ark. Feb. 13, 2013) (dismissed); *Ramsey v. DeSoto Gathering Co., LLC*, No. 23CV-14-258 (Faulkner Cty. Cir. Ct., Ark. Apr. 24, 2014) (pending); *Ginardi v. Frontier Gas Servs., LLC*, No. 4:11-CV-00420, 2012 WL 1377052, at *1 (E.D. Ark. Apr. 19, 2012) (pending). In the *Pruitt* case, prior to its dismissal for failure to join a necessary party, the court denied a motion to dismiss the strict liability claim because the defendant had not shown that the actions taking place at the compressor station are of common usage, and because the claim “may turn on evidence that has yet to be developed, such as expert testimony.” *Pruitt*, 2013 WL 588998 at *4.

6. *Ely v. Cabot Oil & Gas Corp.*, 38 F.Supp. 3d 518, 520 (M.D. Pa. 2014); *see also Kamuck v. Shell Energy Holdings*, No. 4:11-CV-1425, 2015 WL 1345235 at *17 (M.D. Pa. Mar. 25, 2015) (“We find that the natural gas drilling activities challenged in this particular case are not abnormally dangerous, and strict liability should not apply.”).

rejecting strict liability claims for groundwater contamination caused by fracking operations.

Application of the six factors set forth in the Section 520 of the Restatement (Second) of Torts is contextual. Consequently, even if hydraulic fracturing is not an abnormally dangerous activity with respect to groundwater contamination, it may constitute an abnormally dangerous activity with regard to injuries and property damage caused by earthquakes. Part V turns to the issue at hand, and describes recent scientific studies on “induced seismicity” (human-caused earthquakes). Although hydraulic fracturing has been connected to minor seismic activity in only a handful of instances, there is a much stronger link between the underground disposal of frack wastewater and significant seismic activity.

In Part VI of the article, I argue that courts should impose strict liability for earthquake damage caused by hydraulic fracturing or underground injection. In rejecting strict liability claims for groundwater contamination, the United States District Court for the Middle District of Pennsylvania in *Ely v. Cabot Oil* held that natural gas drilling operations and hydraulic fracturing create “relatively low risk to water supplies” and concluded that “such risks are substantially mitigated when due care is exercised.”⁷ In support of its holding—which did not address the permanent injection of fracking wastes—the court emphasized that the plaintiffs were unable to “identify any examples where a gas well was *properly constructed* and completed, and nevertheless fluid migration or water contamination occurred.”⁸

Even if groundwater contamination claims should be considered “under traditional and longstanding negligence principles,”⁹ the application of the six factors of Section 520 of the Restatement (Second) of Torts leads to a different conclusion with respect to earthquake damage claims. Earthquakes sometimes occur when subsurface formations are properly fractured. Likewise, the risk of earthquake damage is not substantially mitigated by the exercise of due care when frack fluids are injected into the ground. Furthermore, there are both judicial and statutory precedents for imposing strict liability for surface disturbances caused by oil and gas operations.

II. STRICT LIABILITY FOR ABNORMALLY DANGEROUS ACTIVITIES

Section 519 of the Restatement (Second) of Torts states that “[o]ne who carries on an abnormally dangerous activity is subject to liability for harm . . . of another resulting from the activity, although he exercised the utmost care to prevent the harm.”¹⁰ Section 520 sets forth six factors that courts should consider in determining whether an activity is abnormally dangerous:

7. *Ely*, 38 F.Supp. 3d at 529, 531.

8. *Id.* at 523 (emphasis in original).

9. *Id.* at 534.

10. RESTATEMENT (SECOND) OF TORTS § 519(1) (1977).

- (a) existence of a high degree of risk of some harm to the person, land, or chattels of others;
- (b) likelihood that the harm that results from it will be great;
- (c) inability to eliminate the risk by the exercise of reasonable care;
- (d) extent to which the activity is not a matter of common usage;
- (e) inappropriateness of the activity to the place where it is carried on; and
- (f) extent to which its value to the community is outweighed by its dangerous attributes.¹¹

In the famous English case of *Rylands v. Fletcher*,¹² a landowner was held strictly liable for damages that resulted when his reservoir failed and water traveled through coal shafts and flooded a neighboring mine.¹³ Judge Richard Posner, however, suggests that *Guille v. Swan*¹⁴ is a “more illuminating” example of an abnormally dangerous activity and “a paradigmatic case for strict liability.”¹⁵ The 1822 case was brought by a New York City landowner who suffered damages to his vegetable garden when a crowd assisted a hot-air balloonist who had inadvertently landed on the property. In the view of Judge Posner, the fact pattern presents a “best-case scenario” for imposition of strict liability pursuant to the six factors set forth in Section 520 of the Restatement:

- (a) The risk (probability) of harm was great, and (b) the harm that would ensue if the risk materialized could be . . . great (the balloonist could have crashed into the crowd rather than into the vegetables). The confluence of these two factors established the urgency of seeking to prevent such accidents. (c) Yet such accidents could not be prevented by the exercise of due care; the technology of care in ballooning was insufficiently developed. (d) The activity was not a matter of common usage, so there was no presumption that it was a highly valuable activity despite its unavoidable riskiness. (e) The activity was inappropriate to the place in which it took place—densely populated New York City. The risk of serious harm to others . . . could have been reduced by shifting the activity to the sparsely inhabited areas that surrounded the city in those days. (f) Reinforcing (d), the value to the community of the activity of recreational ballooning did not appear to be great enough to offset its

11. *Id.* § 520.

12. *Rylands v. Fletcher*, 1 L.R.-Ex. 265 (1866), *aff'd* by L.R. 3 H.L. 330 (1868).

13. *See id.* at 279 (“the person who for his own purposes brings on his lands and collects and keeps there anything likely to do mischief if it escapes, must keep it in at his peril, and . . . is prima facie answerable for all the damage which is the natural consequence of its escape.”); *see also* Joe Schremmer, Comment, *Avoidable “Fraccident”*: An Argument Against Strict Liability for Hydraulic Fracturing, 60 U. KAN. L. REV. 1215, 1226 (2012) (explaining that the *Rylands* rule imposes liability on a defendant who damages his neighbor “by thing or activity unduly dangerous and inappropriate to the place where it is maintained, in the light of the character of that place and its surroundings, even if the defendant was not negligent”) (quoting W. PAGE KEETON *ET AL.*, PROSSER AND KEETON ON TORTS 547–48 (5th ed. 1984)).

14. *Guille v. Swan*, 19 Johns. 381 (N.Y. 1822).

15. *Ind. Harbor Belt R.R. Co. v. Am. Cyanamid Co.*, 916 F.2d 1174, 1177 (7th Cir. 1990).

unavoidable risks.¹⁶

Although all six factors supposedly carry equal weight,¹⁷ courts tend to focus on the first three factors: the probability of harm, the amount of harm, and the ability to eliminate the risk of harm by the exercise of reasonable care.¹⁸ Judge Posner emphasized factor (c) in *Indiana Harbor Belt Railroad Co. v. American Cyanamid Co.*, noting that when “the hazards of an activity can be avoided by being careful (which is to say, nonnegligent), there is no need to switch to strict liability.”¹⁹ The question before the court of appeals was whether the shipper of a hazardous chemical by rail should be strictly liable for the consequences of a spill or release.²⁰ In contrast to the hot-air balloonist, the Seventh Circuit determined that it was inappropriate to hold American Cyanamid strictly liable for the costs of cleaning up and decontaminating the railroad yard:

[We] have been given no reason . . . for believing that a negligence regime is not perfectly adequate to remedy and deter, at reasonable cost, the accidental spillage of acrylonitrile from rail cars. . . . [N]o one suggests . . . that the leak in this case was caused by the *inherent* properties of acrylonitrile. . . . [A]ccidents that are due to a lack of care can be prevented by taking care; and when a lack of care can . . . be shown in court, such accidents are adequately deterred by the threat of liability for negligence.²¹

As discussed in Part IV *infra*, Magistrate Martin Carlson and Judge John Jones in *Ely v. Cabot Oil* rejected strict liability on similar grounds, concluding that the plaintiffs failed to prove that hydraulic fracturing operations “inherently carry the existence of a high degree of risk” for groundwater contamination.²² However, as discussed in Part V *infra*, recent studies suggest that there is an inherent risk that non-negligent hydraulic fracturing and waste injection can cause earthquake damage.

16. *Id.*

17. See RESTATEMENT (SECOND) OF TORTS § 520 cmt. f (1977) (“In determining whether the danger is abnormal, the factors . . . are all to be considered, and are all of importance. Any one of them is not necessarily sufficient of itself in a particular case, an ordinarily several of them will be required for strict liability.”).

18. Gerald W. Boston, *Strict Liability for Abnormally Dangerous Activity: The Negligence Barrier*, 36 SAN DIEGO L. REV. 597, 622 (1999) (“[C]ourts have treated factors (a), (b), and (c), and especially (c), as indispensable, whereas (d), (e), and (f) have received more mixed applications.”).

19. *Ind. Harbor Belt R.R. Co.*, 916 F.2d at 1177.

20. *Id.* at 1176.

21. *Id.* at 1179 (emphasis in original).

22. *Ely v. Cabot Oil and Gas Corp.*, 38 F.Supp. 3d 518, 530 (M.D. Pa. 2014); see also *id.* at 520 (“Plaintiffs have failed to substantiate their contention that the natural gas drilling activities, including hydraulic fracturing at issue in this case, are so *inherently dangerous* that they should be deemed ultrahazardous activities subject to strict liability.”) (emphasis added).

III. STRICT LIABILITY CLAIMS INVOLVING OIL AND GAS OPERATIONS OTHER THAN HYDRAULIC FRACTURING

Although horizontal hydraulic fracturing is a recent development, courts have been asked since the nineteenth century to impose strict liability for damages due to oil and gas extraction activities. On September 7, 1887, nitroglycerine was used to “shoot” a vertical well in Cygnet, Ohio. This early attempt to fracture the subsurface caused a fire that was followed by an explosion of several bottles of nitroglycerine left on a nearby wagon. Six spectators died, numerous people were injured, two warehouses were destroyed, many residential homes were damaged, and all the plate glass in the business district was shattered.²³ One of the individuals injured by the mishap sued and argued that the defendant was liable “wholly irrespective of the question of negligence, because it was keeping and handling a dangerous substance.”²⁴ The Ohio Supreme Court, however, affirmed the judgment based on negligence, and thus expressed no opinion on the issue of strict liability.²⁵ In subsequent decisions, however, Ohio courts have declared the use of explosives to be an abnormally dangerous activity and have imposed liability without fault.²⁶

In states that have applied strict liability theories to oil and gas operations,²⁷ the results have been mixed. Some courts have imposed liability without fault under trespass and nuisance theories,²⁸ while other courts have focused on

23. Jeff A. Spencer & Mark J. Camp, *IMAGES OF AMERICA: OHIO OIL AND GAS* 41 (2008).

24. *Ohio & Ind. Torpedo Co. v. Fishburn*, 56 N.E. 457, 461 (Ohio 1900).

25. *Id.* In *E. I. Du Pont De Nemours & Co. v. Cudd*, 176 F.2d 855, 856 (10th Cir. 1949), the court held that the doctrines of *res ipsa loquitur* and liability without fault were inapplicable to assist the plaintiff injured by a premature explosion of glycerin in a well shooting operation. With respect to the strict liability claim, the court held that the doctrine of liability without fault as applied to ultra hazardous occupations “is restricted to injury to adjoining property and to persons on adjoining property, and does not apply to cases where injury results to those who have reason to know of the risk which makes the undertaking ultra hazardous, take therein, and bring themselves within the area which will be endangered by its miscarriage.” *Id.* at 860. The plaintiff participated in the well shooting operations, and consequently the defendant was liable to him only for actionable negligence. *Id.* at 856.

26. In *Bradford Glycerine Co. v. St. Marys Woolen Mfg. Co.*, 54 N.E. 528 (Ohio 1899), the defendant was found strictly liable for damages due to an explosion of nitroglycerine. In *Metzger v. Penn., Ohio & Detroit R.R. Co.*, 66 N.E.2d 203 (Ohio 1946), the Ohio Supreme Court differentiated between an absolute nuisance, to which strict liability applies, and the maintenance of a qualified nuisance, which requires the proof of negligence. The court described absolute nuisance in a case involving the handling of nitroglycerine and described a qualified nuisance in a case involving an explosion during the negligent operation of a sawmill.

27. The Texas Supreme Court has rejected strict liability for abnormally dangerous activities. See *Turner v. Big Lake Oil Co.*, 96 S.W.2d 221 (Tex. 1936) (contamination caused by release of briny water stored in conjunction with operation of oil wells); see also *Doddy v. Oxy USA*, 101 F.3d 448, 461–62 (5th Cir. 1996) (migration of chemicals from oil and gas well). Louisiana recognizes the abnormally dangerous activity doctrine, but restricts its application to blasting and pile driving. See Keith B. Hall & Lauren E. Godshall, *Hydraulic Fracturing Litigation*, 57 *THE ADVOCATE* 13, Winter 2011 at 14 (citing LA. CIV. CODE art. 667).

28. Eighteen homeowners and the Town of DISH, Texas, filed lawsuits alleging that noise, light, odors, and chemical particulates connected with oil and gas operations caused a nuisance and constituted a trespass. The trial court dismissed the trespass and nuisance claims, but the court of appeals reinstated the claims. See *Sciscoe v. Enbridge Gathering*, No. 07-00391-CV, 2015 WL 3463490, at *10 (Tex. App.—Amarillo 2015) (“Just because Appellees are operating their natural gas compression facilities

whether the damages were the result of abnormally dangerous activities.

A. Cases Favoring Strict Liability for Damages from Oil and Gas Operations

In 1928 the California Supreme Court, in *Green v. General Petroleum Corp.*,²⁹ affirmed an award of damages against a defendant who drilled a well that erupted and deposited large amounts of oil, gas, mud, and rocks onto the property of the plaintiff. The trial court expressly found that the defendant was not guilty of negligence, but nevertheless imposed liability for the trespass and injury to the premises. On appeal, the oil company argued that it was absolved from liability because it had exercised due care and caution in its drilling operations. The state supreme court disagreed, holding that “[t]he fact that the act resulting in the ‘blow-out’ was lawful, and not negligently done, does not, in our opinion, make the covering of respondents’ property with oil, sand, mud, and rocks any less an actual invasion of and a trespass upon the premises.”³⁰

In *Mowrer v. Ashland Oil & Refining Co., Inc.*,³¹ an Indiana landowner sued for damages when waterflooding operations on adjoining land caused crude oil to leak and contaminate the plaintiff’s water well. Waterflooding is similar to hydraulic fracturing insofar as water is injected at high pressure into the substrata to force oil and gas to the surface.³² The defendant argued that the case should be tried under a theory of negligence, but the court of appeals held that the trial court correctly applied the doctrine of nuisance.³³ In dicta, the court observed that “liability could have been supported by the facts of this case on either . . . nuisance or abnormally dangerous activity.”³⁴ In particular, the court noted that the waterflooding (1) “introduced a risk of serious harm to the land of others which could not be eliminated by the exercise of care;” (2) was not a matter of common usage, and (3) “was accordingly an abnormally dangerous activity for the conduct of which defendant would have been strictly liable had plaintiff chosen to proceed on that theory.”³⁵

In *Branch v. Western Petroleum, Inc.*,³⁶ property owners in Utah sued for

within the applicable regulatory guidelines does not mean that Appellants have not suffered compensable injuries as a result of those operations. . . . Stated another way, just because you are allowed by law to do something, does not mean that you are free from the consequences of your action.”).

29. *Green v. Gen. Petroleum Corp.*, 205 Cal. 328 (Cal. 1928).

30. *Id.* at 334 (“[W]e are of the view that . . . where an injury arises out of, or is caused directly and proximately by the contemplated act or thing in question, without the interposition of any external or independent agency which was not or could not be foreseen, there is an absolute liability for the consequential damage, regardless of any element of negligence either in the doing of the act or in the construction, use, or maintenance of the object or instrumentality that may have caused the injury.”); see also Gerald W. Boston, *Strict Liability for Abnormally Dangerous Activity: The Negligence Barrier*, 36 SAN DIEGO L. REV. 597, 608–09 (1999).

31. *Mowrer v. Ashland Oil & Ref. Co.*, 518 F.2d 659 (7th Cir. 1975).

32. See Schremmer, *supra* note 13, at 1247–48.

33. *Mowrer*, 518 F.2d at 661.

34. *Id.*

35. *Id.* at 662.

36. *Branch v. W. Petroleum*, 657 P.2d 267 (Utah 1982).

damages after wastewater from the defendant's oil production operations migrated and polluted their water wells. In contrast to *Green* and *Mowrer*, the plaintiffs in *Branch* did not allege nuisance or trespass, but instead argued that "the law of strict liability controls" because Western Petroleum "created an abnormally dangerous condition by collecting contaminated water on its land for the purpose of having it seep or percolate into the groundwater."³⁷ The Utah Supreme Court found that strict liability was appropriate "because the ponding of the toxic formation water in an area adjacent to the Branches' wells constituted an abnormally dangerous and inappropriate use of the land in light of its proximity to the Branches' property and was unduly dangerous to the Branches' use of their well water."³⁸

B. Cases Opposing Strict Liability for Damages from Oil and Gas Operations

The Kansas Supreme Court, in *Williams v. Amoco Production Co.*,³⁹ held that the drilling and operation of a natural gas well is not an abnormally dangerous activity. The issue was whether strict liability should apply to the escape of natural gas from a producing well into underground water formations and irrigation water. The court applied the six factor test of Section 520 of the Restatement (Second) of Torts and determined that "the drilling and operation of natural gas wells is not an abnormally dangerous activity in relation to the type of harm sustained by appellees."⁴⁰ In support of its conclusion, the court found that natural gas is not a 'harmful agent' once it is raised to the surface of the earth, and does not ruin drinking water, destroy vegetation, or injure livestock.⁴¹ The court also concluded that "the drilling and operation of natural gas wells is a common, accepted, and natural use of the land."⁴²

In *Bolivar v. R & H Oil & Gas Co.*,⁴³ a federal district court in Mississippi declined to impose strict liability in a wrongful death action

37. *Id.* at 272.

38. *Id.* at 274. The Utah Supreme Court noted that other jurisdictions had applied strict liability due to the abnormal danger of the polluting activity. *Id.* (citing, among other cases, *Mowrer v. Ashland Oil & Ref. Co.*, 518 F.2d 659 (7th Cir. 1975) (leakage of crude oil and salt water into water well); *Yommer v. McKenzie*, 257 A.2d 138 (Md. 1969) (seepage of gasoline from an underground tank into an adjoining well); *Cities Serv. Co. v. Fla.*, 312 So.2d 799 (Fla. App. 1975) (escape of phosphate into a creek and river); *Bumbarger v. Walker*, 164 A.2d 144 (Pa. Super. Ct. 1960) (well pollution caused by mine blasting)).

39. *Williams v. Amoco Prod. Co.*, 734 P.2d 1113 (Kan. 1987).

40. *Id.* at 1116.

41. *Id.* at 1123. See also Hannah Coman, Note, *Balancing the Need for Energy and Clean Water: The Case for Applying Strict Liability in Hydraulic Fracturing Suits*, 39 B.C. ENVTL. AFF. L. REV. 131, 150-51 (2012) ("[I]n *Williams v. Amoco Production Co.*, part of the reason why strict liability was not applied was because the natural gas that leaked into the irrigation well did not permanently damage the fertility of the soil, crops, or livestock. Instead, the presence of natural gas in the water only reduced the amount of water available for irrigating the plaintiff's crops. Since the harm in this particular case was minimal, the court determined that the company should not be held strictly liable."). Opponents of hydraulic fracturing would dispute the court's conclusion that natural gas does not ruin drinking water, destroy vegetation, or injure livestock.

42. *Williams*, 734 P.2d at 1123.

43. *Bolivar v. R & H Oil & Gas Co.*, 789 F.Supp. 1374 (S.D. Miss. 1991).

following an explosion that occurred during an attempt to return a gas well to production. The court held that “Mississippi authorities have uniformly required proof of negligence against the operator of an oil or gas well as a prerequisite to the imposition of liability for damages caused to the property.”⁴⁴

In addition to cases involving drilling and production, courts have also held that that oil refining and the transportation of oil and gas by pipelines are not abnormally dangerous activities.⁴⁵ Most jurisdictions have likewise held that the storage and removal of gasoline in underground tanks is not an abnormally dangerous activity,⁴⁶ although a few courts have imposed strict liability for damages due to leaks.⁴⁷

IV. HYDRAULIC FRACTURING AND STRICT LIABILITY FOR CONTAMINATION

Dimock Township, in Susquehanna County, Pennsylvania, was described in

44. *Id.* at 1383; *see also id.* at 1383 n.15 (“[T]here are devices to prevent the release of hydrogen sulfide and other gases, which, if properly used and in proper working order, should eliminate the possibility of release of gas from the well.”). A Pennsylvania state judge in 2014 reached the opposite conclusion in litigation involving similar facts. Following the death of their son in an explosion at a gas well, Denise and Robert McKee claimed Chevron was strictly liable because of the unusual level of danger involved in natural gas drilling. In a one-page order, Allegheny County Court of Common Pleas Judge Judith Friedman rejected Chevron’s contention that natural gas drilling is not an inherently dangerous activity. *See McKee v. Chevron Appalachia*, No. GD-14-10554 (Allegheny Cnty. Ct. of Common Pleas, PA); Dan Packel, *Pa. Judge Keeps Strict Liability in Gas Well Death Suit*, LAW360 (Oct. 8, 2014), <http://bit.ly/1LyAshA>. The case was settled. *See Alex Wolf, Chevron Settles Pa. Gas Well Explosion Death Suit for \$5M*, LAW360 (May 27, 2015), <http://bit.ly/1N7aKBC>.

45. *See Hall v. Amoco Oil Co.*, 617 F.Supp. 111, 112 (S.D. Tex. 1984) (applying Section 520 of the Restatement (Second) of Torts and concluding that operation of an oil refinery in an industrial community does not constitute an ultrahazardous activity); *Mahowald v. Minn. Gas Co.*, 344 N.W.2d 856, 862 (Minn. 1984) (en banc) (holding that the trial court properly refused to instruct the jury that the defendant was strictly liable for the damages resulting from the escape of gas from its lines located underneath a public street); *New Meadows Holding Co. v. Wash. Water Power Co.*, 687 P.2d 212, 215–17 (Wash. 1984) (en banc) (applying Section 520 of the Restatement (Second) of Torts and concluding that the underground transmission of natural gas is not an abnormally dangerous activity); *Melso v. Sun Pipe Line Co.*, 576 A.2d 999, 1003 (Pa. Super. Ct. 1990) (holding that the lower court erred in determining that the operation of a petroleum pipeline in an urban area was an abnormally dangerous activity); *Foster v. City of Keyser*, 501 S.E.2d 165, 175 (W. Va. 1997) (“We believe that the combination of the high standard of care which must be observed in the transmission of natural gas . . . , coupled with the availability of the doctrine of *res ipsa loquitur* in appropriate cases to a party seeking to prove negligence in the conduct of such transmission . . . , should ordinarily make it unnecessary to apply the doctrine of strict liability in cases involving explosions caused by leaking natural gas transmission lines.”); *Fletcher v. Conoco Pipe Line Co.*, 129 F.Supp. 2d 1255, 1259 (W.D. Mo. 2001) (holding that the operation of a petroleum pipeline is not an abnormally dangerous activity).

46. *See, e.g., Hudson v. Peavey Oil Co.*, 566 P.2d 175, 178 (Or. 1977); *Arlington Forest Assoc. v. Exxon Mobil Corp.*, 774 F.Supp. 387, 388–91 (E.D. Va. 1991); *Smith v. Weaver*, 665 A.2d 1215, 1220 (Pa. Super. Ct. 1995); *Grube v. Daun*, 570 N.W.2d 851, 857 (Wis. 1997); *see generally Douglas A. Henderson & Mack McGuffey, Leaking Underground Storage Tanks as Abnormally Dangerous Activities*, 14 PENN ST. ENVTL. L. REV. 643 (2006).

47. *See Yommer v. McKenzie*, 257 A.2d 138, 140–41 (Md. 1969) (placing a large underground gasoline tank in close proximity to a residence and well was an abnormally dangerous activity); *Harthman v. Texaco*, 846 F.Supp. 1243, 1269 (D.VI 1993) (operating and owning service stations is a matter of common usage, but locating the storage tanks above the community’s primary source of drinking water created an abnormally dangerous and inappropriate use of the land); *Peters v. Amoco Oil Co.*, 57 F.Supp. 2d 1268, 1285–87 (M.D. Ala. 1999) (holding that plaintiffs sufficiently plead a cause of action for strict liability for damage from a leaking storage tank).

2009 as “ground zero for drilling the Marcellus Shale.”⁴⁸ On January 1, 2009, the water well of Norma Fiorentino exploded due to accumulation of methane gas. On November 19, 2009, Fiorentino and other Dimock residents filed suit in the United States District Court for the Middle District of Pennsylvania to recover damages for injuries and property damage suffered as a result of drilling operations conducted by Cabot Oil & Gas Corporation and Gas Search Drilling Services Corporation.⁴⁹ Plaintiffs asserted several claims, including negligence, nuisance, and strict liability. With regard to the strict liability claim, plaintiffs contended that (1) the chemicals and gases used, processed, and stored by defendants are ultra-hazardous and abnormally dangerous; and (2) the use, processing, and storage of hydro-fracturing fluids adjacent to or on residential properties is an abnormally dangerous and ultra-hazardous activity.⁵⁰ By engaging in such activities, defendants were alleged to be strictly liable for all the damages and injuries to plaintiffs proximately caused by the spills, releases, and contamination.⁵¹

On November 15, 2010, the district court denied a motion to dismiss the strict liability claim, but held that the defendants could reassert their argument in a summary judgment motion based upon a more fully developed record.⁵² In 2013, after most of the plaintiffs were dismissed, Nolen Scott Ely became the lead plaintiff.⁵³ The case was referred to a magistrate, who recommended granting the defendants’ motion for summary judgment on the strict liability claims. On April 23, 2014, District Court Judge John Jones adopted the report and recommendation of Magistrate Judge Martin Carlson.

48. Abraham Lustgarten, *Officials in Three States Pin Water Woes on Gas Drilling*, PROPUBLICA (Apr. 26, 2009), <http://bit.ly/1IIPHiZ>. The impact of fracking in Dimock is featured in *Gasland*—a 2010 American documentary written and directed by Josh Fox—and is also discussed in TOM WILBER, *UNDER THE SURFACE: FRACKING, FORTUNES, AND THE FATE OF THE MARCELLUS SHALE* (2012) and SEAMUS MCGRAW, *THE END OF COUNTRY: DISPATCHES FROM THE FRACK ZONE* (2012).

49. Complaint, *Fiorentino v. Cabot Oil & Gas Corp.*, (No. 09-cv-02284), 2010 WL 931974.

50. *Id.* at paragraphs 77–78.

51. *Id.* at paragraph 79.

52. See *Fiorentino v. Cabot Oil & Gas Corp.*, 750 F.Supp.2d 506, 512 (M.D. Pa. 2010) (“While we understand that there is case law that suggests that other activities, such as the operation of a pipeline, are not subject to strict liability, we believe it improvident to automatically extend this reasoning to drilling activities without more thorough consideration. Plainly, the record at this early juncture is insufficiently developed for the Court to render an informed decision as to whether this line of cases and the logic expressed therein should apply to the gas-well drilling activities at bar.”).

53. Shortly after the motion to dismiss the strict liability claim was denied, the Pennsylvania Department of Environmental Protection settled an enforcement action against Cabot Oil on December 16, 2010. Pursuant to the settlement, Dimock residents received \$4.1 million and Cabot resumed its hydraulic fracturing activities after paying a \$500,000 penalty to the Pennsylvania DEP. See Greenwire, *Pa., Cabot Reach Settlement Over Methane Contamination*, E&E PUBLISHING (Dec. 16, 2010), <http://www.eenews.net/stories/1059943280>. In May of 2012, the U.S. Environmental Protection Agency (EPA) announced that its well water test results “did not show levels of contaminants that would give EPA reason to take further action.” The test results were both praised and criticized. Michael Winter, *EPA: Pa. Village’s Water Not Polluted by Gas Fracking*, USA TODAY (May 11, 2012), <http://usat.ly/1T2rSxa>. Most of the plaintiffs settled in August of 2012. See Michael Rubinkam, *Pa. Drilling Town Agrees to Settlement in Fracking Federal Lawsuit*, CHRISTIAN SCIENCE MONITOR (Aug. 15, 2012), <http://bit.ly/1T2rZIT>. On September 18, 2013, the case was captioned as *Nolen Scott Ely v. Cabot Oil & Gas Corporation*.

The Magistrate's Report concludes that, "on the basis of the record developed in this case," the plaintiffs "failed to substantiate their contention that the natural gas drilling activities, including hydraulic fracturing at issue in this case, are so inherently dangerous that they should be deemed ultrahazardous activities subject to strict liability."⁵⁴ The decision places great importance on the fact that the plaintiffs' expert, Anthony Ingraffea, focused on negligence insofar as he suggested the contamination was due to lack of due care relating to the design and construction of the gas wells:

[A]lthough Ingraffea's report focuses on *improper* well completion and faulty casing, or other negligent failings, it does not contain any examples where a gas well was *properly constructed* and completed, and nevertheless fluid migration or water contamination occurred.⁵⁵

The court used the six factors identified in Section 520 of the Restatement (Second) of Torts to predict that Pennsylvania courts would not label the defendants' operations as ultra-hazardous activities. As previously noted, courts tend to give more weight to the first three factors: the probability of harm, the amount of harm, and the ability to eliminate the risk of harm by the exercise of reasonable care. With respect to whether natural gas drilling operations present a high degree of risk of harm, the court concluded that "a properly drilled, cased and hydraulically fractured gas well" creates a "relatively low risk to water supplies."⁵⁶ Turning to the second factor, the court held that the plaintiffs failed to show a sufficient likelihood that harm resulting from properly conducted drilling operations will be great.⁵⁷ Most critically, the court found that the risk of harm to groundwater supplies is substantially mitigated when due care is exercised. Once again, the court noted that the focus by the plaintiffs' expert on negligent conduct "undermines the . . . assertion that . . . even the exercise of due care cannot eliminate risks."⁵⁸ Consequently, the court concluded that the plaintiffs' claims "should be considered under traditional and longstanding negligence principles, and not under a strict liability standard."⁵⁹

The precedent established in *Ely v. Cabot Oil and Gas* was followed in March of 2015 in *Kamuck v. Shell Energy Holdings GP, LLC*,⁶⁰ which

54. *Ely v. Cabot Oil & Gas Corp.*, 38 F.Supp. 3d 518, 520 (M.D. Pa. 2014).

55. *Id.* at 523 (emphasis in original).

56. *Id.* at 529.

57. *Id.* at 530–31.

58. *Id.* at 531. The remaining factors of Section 520 of the Restatement (Second) of Torts focus on the extent to which the activity is a matter of common usage; the inappropriateness of the activity to the place where it is carried on; and the extent to which its value to the community is outweighed by its dangerous attributes. The court in *Ely* held that the natural gas drilling and hydraulic fracturing are not "novel" activities in Pennsylvania; the operations were conducted in appropriate areas subject to permitting and setback requirements; and the economic value to the community exceeded any dangers posed by the gas drilling operations. *Id.* at 531–34.

59. *Id.* at 534.

60. *Kamuck v. Shell Energy Holdings*, No. 4:11-CV-1425, 2015 WL 1345235 (M.D. Pa., Mar. 25, 2015).

concerned hydraulic fracturing operations in Tioga County, Pennsylvania. Magistrate Judge Martin Carlson held that “the natural gas drilling activities challenged in this particular case are not abnormally dangerous and strict liability should not apply.”⁶¹ The claim in *Kamuck* was characterized as “identical” to the strict liability claims rejected in *Ely*.⁶²

To date, the United States District Court for the Middle District of Pennsylvania is the only court to hold that hydraulic fracturing is not an abnormally dangerous activity.⁶³ The *Ely* court found that hydraulically fractured wells “create, at most, relatively low risk to water supplies.”⁶⁴ Even if other courts ultimately agree that hydraulic fracturing is not an abnormally dangerous activity with respect to groundwater contamination,⁶⁵ such decisions

61. *Id.* at *16–*17.

62. *Id.* at *17.

63. In *Armes v. Petro-Hunt*, the court suggested that hydraulic fracturing is not an abnormally dangerous activity. *Armes v. Petro-Hunt*, No. 4:10-cv-078, 2012 WL 1493740, at *3 (D. N.D., Apr. 27, 2012). The lawsuit did not involve any allegations of contamination, but instead was brought after an individual was injured when an explosion occurred during fracking operations. The district court noted that the North Dakota Supreme Court has yet to recognize a claim premised on abnormally dangerous activities, and would likely dismiss the claim. The court further noted that the North Dakota Supreme Court has adopted a rule that an entity (such as the defendant) that employs an independent contractor is generally not liable for acts or omissions of the independent contractor. The court then stated (without analysis) that—assuming strict liability is a viable claim in North Dakota—the plaintiffs failed to present sufficient evidence to show there are genuine issues of material fact as to whether hydraulic fracturing is an abnormally dangerous activity. *Id.*

In addition to the Middle District of Pennsylvania, two other district courts have denied motions to dismiss strict liability claims in lawsuits alleging that hydraulic fracturing contaminated water supplies. See *Tucker v. Sw. Energy Co.*, Nos. 1:11-cv-44-DPM, 1:11-cv-45-DPM, 2012 WL 528253, at *3 (E.D. Ark., Feb. 17, 2012) (“The legal adequacy of the strict-liability claim should be decided on a full record at the summary-judgment stage.”); *Boggs v. Landmark 4*, No. 1:12 CV 614, 2013 WL 944776, at *2 (N.D. Ohio, Mar. 11, 2013) (“The Second Amended Complaint alleges sufficient facts and information to raise a question as to whether fracking, even in the absence of negligence should be considered an abnormally dangerous activity.”); *Mangan v. Landmark 4*, No. 1:12 CV 613, 2013 WL 950560, at *2 (N.D. Ohio, Mar. 12, 2012) (same). All three cases were settled.

64. *Ely v. Cabot Oil and Gas Corp.*, 38 F.Supp.3d 518, 529 (M.D. Pa. 2014) (emphasis added).

65. The debate continues as to whether contamination of groundwater by hydraulic fracturing operations can be prevented by the exercise of due care. In May of 2015, in a letter published by the British Medical Journal, twenty doctors, pharmacists, and public health academics opined that hydraulic fracturing is an “inherently risky” industry and should be prohibited in the United Kingdom. See Karl Mathiesen, *Doctors and Academics Call for Ban on ‘Inherently Risky’ Fracking*, THE GUARDIAN (Mar. 30, 2015), <http://bit.ly/19oTuf4>. One of the authors of the report, Dr. David McCoy, said “there’s an exaggeration of the extent to which fracking is safe and can be effectively regulated.” *Id.*; see also Robin Stott et al., *Public Health England’s Draft Report on Shale Gas Extraction*, THE BMJ (Mar. 27, 2015), <http://www.bmj.com/content/348/bmj.g2728/rr>.

In June of 2015, the EPA issued its draft report on the relationship between hydraulic fracturing and drinking water. See EPA, *Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources*, U.S. ENVTL. PROT. AGENCY (June 2015), <http://cfpub.epa.gov/ncea/hfstudy/recordisplay.cfm?deid=244651>. The assessment will be reviewed by the EPA’s Science Advisory Board and subject to public review and comment before it is finalized. In its report, EPA concludes that “hydraulic fracturing activities have the potential to impact drinking water resources,” but states that no evidence was found that such activities “have led to widespread, systemic impacts on drinking water resources in the United States.” *Id.* The report cites examples where drinking water resources were impacted due to inadequate cement casing of hydraulically fractured wells, and notes that surface spills of produced water from hydraulically fractured wells have occurred. *Id.* The EPA study was immediately endorsed by both sides of the fracking debate, with proponents emphasizing the reported absence of systemic impacts on drinking water, and the opponents focusing on the study’s description of specific instances where fracking has contaminated drinking water. See Sarah

should not control the entirely different issue of whether fracking and the injection of fracking wastes are abnormally dangerous activities with respect to induced earthquakes.

V. WASTE INJECTION, HYDRAULIC FRACTURING, AND INDUCED SEISMICITY

Although not as numerous as the groundwater contamination cases involving hydraulic fracturing, plaintiffs have also asserted strict liability claims for injuries and property damage from earthquakes that were allegedly caused by waste injection.⁶⁶ Several lawsuits have been filed in Arkansas, including *Davis v. Chesapeake Operating, Inc.*,⁶⁷ where landowners claimed that disposal operations were “ultra-hazardous activities” that triggered “thousands of earthquakes in mini-clusters and swarms in central Arkansas in 2010 and 2011.”⁶⁸ In a pending lawsuit in Texas, *Finn v. EOG Resources, Inc.*, landowners allege their homes were damaged when hydraulic fracturing caused ground subsidence, earthquakes, and other seismic activity.⁶⁹ Residents of Prague, Oklahoma, filed similar lawsuits in 2014 and 2015, claiming that the injection of oil and gas wastewater caused several earthquakes that damaged

Caspari, *Did the EPA Just Say Fracking is Safe? Depends Who You Ask*, CHRISTIAN SCIENCE MONITOR (June 8, 2015), <http://bit.ly/1MBHaXV>.

66. In addition to “injection” cases involving allegations of damages due to earthquakes, in two Arkansas cases where injected wastes allegedly migrated, plaintiffs claimed wrongful occupation of the subsurface. See *Hill v. Sw. Energy Co.*, No. 4:12-CV-500-DPM, 2013 WL 5423847, at *3 (dismissing the strict liability claim because the “injury alleged makes this case primarily, if not exclusively, a matter of trespass”); *Kay v. Peak Water Sys., LLC*, No. 4:13-cv-487 (E.D. Ark., Nov. 15, 2013) (dismissing strict liability claim for the reasons stated in *Hill v. Southwestern Energy*).

67. Complaint, *Davis v. Chesapeake Operating*, No. 4:14-cv-81-JLH, 2014 WL 644601 (E.D. Ark. Feb. 12, 2014) (dismissed).

68. *Id.* at 1. See also Complaint, *Sheatsley v. Chesapeake Operating, Inc.*, No. 4:11-cv-00353-JLH, (E.D. Ark. Apr. 22, 2011); Complaint, *Lane v. BHP Billiton Petroleum*, No. 4:11-cv-477, (E.D. Ark. June 9, 2011); Complaint, *Frey v. BHP Billiton Petroleum*, No. 4:11-cv-475, (E.D. Ark. June 9, 2011); Complaint, *Hearn v. BHP Billiton Petroleum*, No. 4:11-cv-474, (E.D. Ark. June 9, 2011); Complaint, *Palmer v. BHP Billiton Petroleum*, No. 4:11-cv-476, (E.D. Ark. June 9, 2011); Complaint, *Miller v. Chesapeake Operating*, No. 4:13-cv-131, (E.D. Ark. Mar. 11, 2013); Complaint, *Thomas v. Chesapeake Operating*, No. 4:13-cv-182, (E.D. Ark. Apr. 1, 2013); Complaint, *Sutterfield v. Chesapeake Operating*, No. 4:13-cv-183, (E.D. Ark. Apr. 1, 2013); Complaint, *Mahan v. Chesapeake Operating*, No. 4:13-cv-184, (E.D. Ark. Apr. 1, 2013); Complaint, 2010-2011 Guy-Greenbrier Earthquake Swarm Victims v. Chesapeake Operating, No. 23CV-14-84, (Faulkner Cnty. Cir. Ct. Ark. Feb. 11, 2014). All of the above cases have been dismissed. See *Nicholson*, *supra* note 4, at 44–46.

In a case that did not involve seismic activity, Ruby Hiser of White County, Arkansas, sued XTO Energy Inc. in state court for damages to her home allegedly caused by vibrations resulting from nearby drilling activity. After XTO removed the action to federal court, a trial was held in September of 2012. The jury found XTO liable for negligence, nuisance, and trespass, and awarded \$100,000 in compensatory damages and \$200,000 in punitive damages. When XTO learned that jurors discussed fracking and earthquakes during deliberations, it moved for a new trial, but was unsuccessful. On appeal, the United States Court of Appeals for the Eighth Circuit held that the denial of a new trial was not an abuse of discretion because “XTO has not shown a reasonable possibility that the [fracking and earthquake] discussions prejudiced it or altered the verdict.” *Hiser v. XTO Energy Inc.*, 768 F.3d 773, 778 (8th Cir. 2014).

69. *Finn v. EOG Resources Inc.*, No. C2013-00343, (Johnson Cnty. 18th Dist. Ct. Tex. 2013); see also *Nicholas Sakelaris, Quakes Caused by Frack Water Disposal Damaged Homes*, DALL. BUS. J., Aug. 2, 2013, <http://bit.ly/1HILwDD>. The case, which asserts claims of negligence, nuisance, and strict liability, may become a class action lawsuit.

structures and injured at least one homeowner.⁷⁰

Homeowners often do not insure for earthquakes, and it is not entirely clear whether policies that include such coverage apply to induced seismic events.⁷¹ Consequently, property owners near fracking and injection sites may resort to litigation to recover their costs of repairing and replacing structures damaged by ground movement. According to one commentator, recent research about the relationship between hydraulic fracturing, underground injection, and earthquakes “could lead to massive new lawsuits against oil and gas producers.”⁷² Courts and juries will be required to address difficult issues at the intersection of science and law, including (1) whether the apparent increase of seismic events in parts of the United States is due to hydraulic fracturing and wastewater injection; (2) whether hydraulic fracturing and underground disposal of related wastes should be held, as a matter of law, to be abnormally dangerous activities; and (3) whether plaintiffs seeking to impose strict liability can prove their damages were in fact caused by such activities.

Plaintiffs seeking to establish a causal connection between fracking, injection, and earthquakes will point to the increase of earthquakes and tremors in areas where hydraulic fracturing takes place and drilling wastes are injected underground. In recent years, American seismologists and public officials have focused in particular on Arkansas, Colorado, Kansas, Ohio, Oklahoma, and Texas.⁷³ The results are alarming: as reported in the journal *Science* in June

70. See Complaint, *Ladra v. New Dominion LLC*, No. CJ-2014-00115, (Lincoln Cnty. Dist. Ct. Okla. Aug. 4, 2014), *appeal docketed*, No. SD-113396 (Okla. Nov. 17, 2014), *available at* <http://bit.ly/1SjdNvh>. Sandra Ladra was injured in November 2011 when her chimney toppled and bricks struck her legs. On October 16, 2014, the district court dismissed her case on the grounds that it should be heard by the Oklahoma Corporation Commission. See Associated Press, *Oklahoma Judge Throws Out Lawsuit over Earthquake, Disposal Wells*, *INS. J.* (Oct. 29, 2014), <http://bit.ly/1MBHINC>. On June 30, 2015, the Oklahoma Supreme Court reversed and remanded, and on December 18, 2015, the district court denied the defendants’ motion to dismiss. In a related case, Jennifer Cooper is seeking class action status for people in Lincoln County and eight surrounding counties whose homes were damaged by the November 2011 earthquakes. See Complaint, *Cooper v. New Dominion LLC*, No. CJ-2015-0024, (Lincoln Cnty. Dist. Ct. Okla. Feb. 10, 2015); Associated Press, *Oklahoman Sues Energy Companies for Earthquake Damage*, *BAKKEN.COM* (Feb. 11, 2015), <http://bit.ly/1OfHmyw>.

71. In March of 2015 the Oklahoma Insurance Department announced that it may investigate whether the “extraordinary denial rate” by insurers of earthquake claims is “based on the unsupported belief that these earthquakes were the result of fracking or injection well activity.” See Miguel Bustillo & Daniel Gilbert, *Energy’s New Legal Threat: Earthquake Suits*, *WALL ST. J.*, (Mar. 30, 2015), *available at* <http://on.wsj.com/1Hgb00i>. On April 11, 2015, the Pennsylvania Insurance Department issued a notice telling insurance companies that earthquake endorsements to homeowner insurance policies in Pennsylvania cannot exclude coverage for earthquakes that may be caused by “human activity” such as fracking. See Young Ha, *Penn.: Fracking Exclusion Not Allowed in Homeowners Earthquake Endorsements*, *INS. J.* (Apr. 15, 2015), <http://bit.ly/1liexvq>; Alice Holbrook, *How Will Fracking Affect Your Homeowners Insurance?*, *NERD WALLET* (Oct. 7, 2014), <http://nerd.me/1kSLCso>.

72. Daniel Jennings, *Possible Fracking-Earthquake Link Could Challenge Oil and Gas Industry*, *SEEKING ALPHA* (June 7, 2014), <http://bit.ly/1P82VIZ>; see also *id.* (“It is not hard to imagine juries siding with property owners that claim their homes or businesses were damaged by earthquakes caused by fracking.”); see also Bustillo & Gilbert, *supra* note 71 (“[T]he prospect of facing juries over quake-related claims is reverberating throughout the energy industry, which fears lawsuits and tighter regulations could increase costs and stall drilling.”).

73. The issue has also been studied outside of the United States. In the United Kingdom, researchers have concluded that two small earthquakes in 2011, which occurred near Blackpool,

2015, “[s]cientists have documented an astronomical rise in seismic activity across the central and eastern United States, linking it to wastewater pumped into the ground from burgeoning oil and gas production.”⁷⁴

Arkansas. — After a surge of minor earthquakes north of Little Rock in 2010, the Arkansas Oil and Gas Commission in July 2011 imposed a moratorium on drilling new disposal wells in the area and ordered four active wells to be plugged.⁷⁵ According to a U.S. Geological Survey study in April 2015, once the wastewater injection stopped, earthquake frequency fell to near zero in central Arkansas.⁷⁶ In addition to the moratorium, the state commission also revised its regulations, mandating that existing well operators install flow meters and submit volume and pressure information, and requiring permit applicants to comply with new siting, spacing, and geological disclosure requirements.⁷⁷

Colorado. — Colorado has experienced induced earthquakes long before the advent of horizontal hydraulic fracturing. In 1962, when the United States Army pumped liquid wastes from its Rocky Mountain Arsenal chemical

England, were induced by hydraulic fracturing, but that the probability of future induced seismic events “is quite low.” The authors of a second report concurred and recommended that the shale gas exploration be allowed to continue, but also noted that “it is not possible to state categorically that no further earthquakes will be experienced during a similar treatment in a nearby well.” See C.J. DE PATER & S. BAISCH, *GEOMECHANICAL STUDY OF BOWLAND SHALE SEISMICITY: SYNTHESIS REPORT* (2011), available at <http://bit.ly/1OaWx7h>; CHRISTOPHER A. GREEN ET AL., *PREESE HALL SHALE GAS FRACTURING: REVIEW & RECOMMENDATIONS FOR INDUCED SEISMIC MITIGATION* (2012), available at <http://bit.ly/1Oc7Z97>. In April 2013, a study funded by two English universities concluded that hydraulic fracturing is not a significant mechanism for inducing earthquakes that can be felt. The study, entitled “Induced Seismicity and the Hydraulic Fracturing of Low Permeability Sedimentary Rocks,” did state that fracking can reactivate dormant faults. See Mike Tsikoudakis, *Fracking Not a Significant Earthquake Risk*, BUSINESS INSIDER (Apr. 12, 2013), <http://bit.ly/1OaWx7h>.

In August 2015, a 4.6 magnitude earthquake caused by fracking operations occurred in British Columbia, Canada. *Earthquake in Northern B.C. caused by fracking, says regulator*, CBC News (Dec. 16, 2015), at <http://www.cbc.ca/news/canada/british-columbia/earthquake-northeastern-b-c-progress-energy-fracking-1.3367081>. Other seismic events in Canada have been linked to fracking, and data from November 2006 to December 2011 for the Horn River Basin in British Columbia suggests “that the total injected volume from hydraulic fracturing is a more significant factor affecting the pattern of local seismicity than injection pressure is.” Amir Mansour Farhbod, Honn Kao, John F. Cassidy, and Dan Walker, *How did hydraulic-fracturing operations in the Horn River Basin change seismicity patterns in northeastern British Columbia, Canada?*, *The Leading Edge*, page 658 (June 2015), at <https://scits.stanford.edu/sites/default/files/tle340606582e1.pdf>.

In September 2015, Dutch landowners were awarded damages for the devaluation of their properties located in an area where earthquakes have been linked to gas production. *Dutch Court Says Gas Producer Must Compensate Homeowners in Quake Zone* (Sept. 2, 2015), at http://www.nytimes.com/2015/09/03/business/international/dutch-court-says-gas-producer-must-compensate-homeowners-in-quake-zone.html?_r=0.

74. Julia Rosen, *Pumped Up to Rumble*, 348 SCIENCE 1299, 1299 (2015).

75. See Nicholson, *supra* note 4, at 44–47.

76. Mark D. Peterson et al., *Incorporating Induced Seismicity in the 2014 U.S. Nat. Seismic Hazard Model—Results of 2014 Workshop and Sensitivity Studies*, U.S. DEPT. OF THE INTERIOR U.S. GEOLOGICAL SURVEY, 12 (2015), <http://on.doi.gov/119N1Fd> (“[T]he injection wells that were considered to be the cause of the Guy-Greenbrier earthquakes stopped injecting in March 2011, and the seismicity decayed to background levels not long thereafter.”).

77. See Peter Folger & Mary Tiemann, *Human-Induced Earthquakes from Deep-Well Injection: A Brief Overview*, CONG. RESEARCH SERV., 18 (May 12, 2015), <https://www.fas.org/sgp/crs/misc/R43836.pdf>.

weapons plant, the surrounding area experienced over a thousand earthquakes, mostly small in nature but one large enough to shake chandeliers at the state Capitol and cause \$1 million damage in Commerce City.⁷⁸ Likewise, when the Bureau of Reclamation began injecting salty water underground to reduce the salt content in the Colorado River, thousands of seismic events occurred, including one 4.3 magnitude earthquake in 2000.⁷⁹ The U.S. Geological Survey has concluded that a 5.3 magnitude earthquake on August 23, 2011, which caused bricks and stones to fall from buildings in Trinidad, Colorado, was probably caused by the disposal of waste water produced by the oil and gas industry.⁸⁰ Further south, in the Raton Basin of northern New Mexico and southern Colorado, the number of documented earthquakes of 4.0 magnitude increased from just one between 1972 and July 2001, to twelve between August 2001 and 2013. According to seismologists who studied the data, “[m]any lines of evidence indicate that this earthquake sequence was induced by wastewater injection.”⁸¹ A single injection well in Weld County, north of Denver, was linked in 2014 to 500 minor earthquakes over a seven-week period. The Colorado Oil and Gas Conservation Commission stopped the disposal activities in June after a 3.4 magnitude earthquake occurred in the Greeley area that was felt in Golden and Boulder.⁸²

Kansas. – In the thirty years prior to 2011, Kansas experienced a total of thirty recorded earthquakes, in sharp contrast to the 127 earthquakes recorded in 2014 and the fifty-one recorded earthquakes in the first three months of 2015.⁸³ In January of 2015, after an earthquake of 3.9 magnitude struck in Harper County, a geophysicist with the Kansas Geological Survey stated that “there is a strong correlation between the disposal of saltwater and the earthquakes.”⁸⁴ Shortly thereafter, in March, the state Corporation Commission

78. Kevin Simpson, *Colorado Finds Itself an Earthquake Lab Amid Gas Boom*, THE ASSOCIATED PRESS (Sept. 1, 2014), <http://bit.ly/1XpXoXc>; Patrick J. Kiger, *Could Fracking Cause a Major Earthquake?*, DISCOVERY NEWS (Jan. 16, 2015), <http://bit.ly/1DbRldC>.

79. Simpson, *Colorado Finds Itself an Earthquake Lab Amid Gas Boom*, THE ASSOCIATED PRESS (Sept. 1, 2014), <http://bit.ly/1XpXoXc>.

80. Kiger, Patrick J. Kiger, *Could Fracking Cause a Major Earthquake?*, DISCOVERY NEWS (Jan. 16, 2015), <http://bit.ly/1DbRldC>.

81. J.L. Rubinstein et al., *The 2001—Present Induced Earthquake Sequence in the Raton Basin of Northern New Mexico and Southern Colorado*, 104 BULL. OF THE SEISMOLOGICAL SOC’Y OF AM. 2162, 2162 (Oct. 2014).

82. Alan Prendergast, *Single Fracking Waste Well Blamed for Hundreds of Low-Level Quakes*, WESTWORD (July 30, 2014), <http://bit.ly/1LyE4QD> (noting that the COGCC lifted the ban in July after restricting on the amount of daily injection). The Colorado Oil and Gas Conservation Commission has subsequently set limits on injection volume, rate, and pressure. Folger & Tiemann, *supra* note 77. Of the seventeen induced seismicity zones in the central and eastern United States identified in 2014 by the U.S. Geological Survey, five are located in Colorado: the Rocky Mountain Arsenal near Denver (4.8 earthquake in 1967); Rangely in northwest Colorado (4.3 earthquake in 1970); Paradox in southwest Colorado (3.9 earthquake in 2013); Greeley, Colorado (3.2 earthquake in 2014); and the Raton Basin on the New Mexico border (5.2 earthquake in 2011). The earthquakes noted are the largest earthquakes in each respective area. Peterson, *supra* note 76, at 13.

83. Order Reducing Saltwater Injection Rates at 2, No. 15-CONS-770CMSC (Mar. 19, 2015), available at <http://1.usa.gov/1QHhgA> [hereinafter Order].

84. *Kansas Geological Survey Links Earthquakes to Fracking Waste Disposal*, THE WICHITA

found that “the increased number of recorded earthquakes in Kansas coincides with an increase in the number of injection wells and the amounts of injected saltwater in Harper and Sumner Counties,” and ordered a reduction of wastewater injection in the two counties.⁸⁵

Ohio. – Although not part of the “shakes on the plains,” Ohio has also been a focal point of the ongoing debate regarding induced earthquakes. Both Ohio and Pennsylvania have experienced extensive hydraulic fracturing of underlying shale formations, but unlike its eastern neighbor, Ohio is also the site of numerous injection wells that dispose large amounts of wastewater from oil and gas operations.⁸⁶ In 2011, the Youngstown, Ohio, area experienced twelve low-magnitude seismic events within one mile of the “Northstar 1” disposal well, culminating on December 24, 2011, with a 2.7 magnitude earthquake.⁸⁷ On March 9, 2012, the Ohio Department of Natural Resources (ODNR) announced stricter standards for the transport and injection of drilling wastes. On the same day the ODNR released a preliminary report which concluded that “all the evidence indicates that properly located Class II injection wells will not cause earthquakes.”⁸⁸

Despite such assurances and increased state regulation,⁸⁹ seismic activity continues in Ohio. Two injection wells were identified as the cause of a 2.1 magnitude earthquake near Warren, Ohio, in September 2014.⁹⁰ Hydraulic fracturing has also triggered earthquakes. In March of 2014, dozens of minor earthquakes—including one “felt” event of 3.0 magnitude—were caused by

EAGLE (Jan. 20, 2015), <http://www.kansas.com/news/state/article7540583.html> (remarks of Rick Miller).

85. Order, *supra* note 83, at 3; see Anastasia Pantsios, *Staggering Rise in Fracking Earthquakes Triggers Kansas to Take Action*, ECOWATCH (Apr. 2, 2015), <http://ecowatch.com/2015/04/02/kansas-fracking-earthquakes/>. After the number of earthquakes decreased, the Commission extended the disposal limits to March 2016. *Kansas extending fracking limits over earthquakes* (Oct. 29, 2015), at <http://fuelfix.com/blog/2015/10/29/kansas-extending-fracking-limits-over-earthquakes/#2572101=0>.

86. See Bob Downing, *Ohio's Volume of Drilling Waste Going into Injection Wells Grows by 15 Percent*, AKRON BEACON J. (May 23, 2014), <http://bit.ly/1mbJr3e>; Katelyn Ferral, *Pa. spared earthquakes from deep-shale drilling*, TRIBLIVE (June 27, 2105), <http://bit.ly/1OaWOXV> (“Geological differences from neighboring Ohio and few disposal wells for fracking wastewater keep Pennsylvania from experiencing earthquakes related to deep-shale drilling for natural gas, experts say.”).

87. OHIO DEP’T OF NATURAL RES., PRELIMINARY REPORT ON THE NORTHSTAR 1 CLASS II INJECTION WELL AND THE SEISMIC EVENTS IN THE YOUNGSTOWN, OHIO, AREA 3 (Mar. 2012), available at <http://bit.ly/1RVJooM>.

88. *Id.* at 4. In August of 2013, the *Journal of Geophysical Research* published a study of the Youngstown quakes by Dr. Won-Young Kim of the Lamont-Doherty Earth Observatory at Columbia University. Dr. Kim concluded that the seismic events were “induced by the fluid injection at Northstar I deep injection well due to increased pore pressure along the preexisting . . . faults located close to the wellbore in the Precambrian basement.” Won-Young Kim, *Induced Seismicity Associated with Fluid Injection into a Deep Well in Youngstown, Ohio*, 118 J. OF GEOPHYSICAL RES.: SOLID EARTH (Issue 7) 3506, 3506–18 (2013), available at <http://stanford.io/1TTPFEy>. When asked to comment on his study, Dr. Kim said that “if there are hidden subsurface faults near the injection wells, then sooner or later they can trigger earthquakes.” NBC News, *Confirmed: Fracking Practices to Blame for Ohio Earthquakes*, NBC NEWS (Sept. 4, 2013), <http://nbcnews.to/1NsDfgv>.

89. See BARCLAY R. NICHOLSON, ANALYSIS OF LITIGATION INVOLVING SHALE & HYDRAULIC FRACTURING (June 1, 2014), available at <http://bit.ly/1LxUBUL>; Folger & Tiemann, *supra* note 77.

90. Julie Carr, *Ohio Halts Injections at two Wells for Fracking Wastewater After Quake*, COLUMBUS DISPATCH (Sept. 6, 2014), <http://bit.ly/1mGbx1>.

hydraulic fracturing near Poland, Ohio, in Mahoning County.⁹¹ In Harrison County, located south of Youngstown, nearly 400 small earthquakes occurred in the last four months of 2013, including ten “positive” magnitude earthquakes (1.7 to 2.2) that coincided with hydraulic fracturing operations at nearby wells.⁹² To date, there are five known instances of earthquakes induced by hydraulic fracturing: two in Ohio, one in Oklahoma, one in England, and one in British Columbia, Canada.⁹³

Oklahoma. — In August 2011 the Oklahoma Geological Survey reported that “there is a possibility” that several earthquakes in Garvin County “were induced by hydraulic-fracturing” but warned that “the uncertainties in the data make it impossible to say with a high degree of certainty whether or not these earthquakes were triggered by natural means or by the nearby hydraulic-fracturing operation.”⁹⁴ A few months later, in November 2011, three earthquakes of 5.0, 5.7, and 5.0 magnitude struck near Prague, Oklahoma, located between Tulsa and Oklahoma City. The 5.7 quake, which is the largest recorded in Oklahoma, destroyed fourteen homes, injured two people, buckled a federal highway, and toppled a turret at St. Gregory’s University.⁹⁵ A 2013 study in the journal *Geology*, authored by seismologists from the University of Oklahoma, Columbia University, and the United States Geological Survey (USGS), concludes that there was a relationship between the 2011 Oklahoma

91. Robert J. Skoumal et al., *Earthquakes Induced by Hydraulic Fracturing in Poland Township, Ohio*, 105 BULL. OF THE SEISMOLOGICAL SOC’Y OF AM. 189, 189 (Jan. 2015) (“77 earthquakes were identified in Poland Township, Mahoning County, Ohio, that were closely related spatially and temporally to active hydraulic fracturing operations.”); see Mark Berman, *Study Links Fracking to Dozens of Small Ohio Earthquakes*, WASH. POST (Jan. 8, 2015), <http://wapo.st/1FzzDYU>. According to Robert Skoumal, the primary author of the study, “there’s no evidence of wrongdoing by the operators of this well. They just happened to be operating near a fault that’s very hard to detect.” Jillian Kay Melchior, *The Fracking Fracas over Earthquakes*, NAT’L REV. (Jan. 21, 2015), <http://bit.ly/1CUkjAP>.

92. Seismological Soc’y of Am., *News Release: Hydraulic Fracturing Linked to Earthquakes in Ohio* (Oct. 14, 2014), <http://bit.ly/22ciRbf>; see Paul A. Friberg et al., *Characterization of an Earthquake Sequence Triggered by Hydraulic Fracturing in Harrison County, Ohio*, SEISMOLOGICAL RES. LETTERS, 1 (Dec. 2014), available at <http://bit.ly/1KSfNXS>.

93. See Robert B. Jackson et al., *The Environmental Costs and Benefits of Fracking*, ANN. REV. OF ENV’T & RESOURCES, 7.1 (Aug. 2014), available at <http://bit.ly/1mbJJHs> (describing felt seismic events attributed to hydraulic fracturing in the Canada, Oklahoma, and the United Kingdom); Downing, *supra* note 86.

94. AUSTIN A. HOLLAND, EXAMINATION OF POSSIBLY INDUCED SEISMICITY FROM HYDRAULIC FRACTURING IN THE EOLA FIELD, GARVIN COUNTY, OKLAHOMA 1 (Aug. 2011), available at http://www.ogs.ou.edu/pubsscanned/openfile/OF1_2011.pdf (examining forty-three earthquakes in January 2011 that ranged from 1.0 to 2.8 in magnitude).

95. Students at a homecoming dance ran from the damaged building, Governor Mary Fallin sought a federal disaster declaration, and tremors were reportedly felt in seventeen states and as far away as Illinois. Brantley Hargrove, *Earthquakes and the Texas Miracle: Oceans of Oil and Gas are Filling State Coffers and Shaking our Region*, D MAG. (May 2014), <http://bit.ly/1RVJDjE>. One resident, Sandra Ladra, is seeking at least \$75,000 in damages in connection with the Prague 5.7 magnitude earthquake, which toppled her chimney and sent bricks tumbling down on her legs. Maria Gallucci, *Okla. Earthquake Tied to Fracking Wastewater Draws First Lawsuit*, INT’L BUS. TIMES (Aug. 8, 2014), <http://bit.ly/1RVJDjE>.

seismicity and fluid injection.⁹⁶ According to the USGS, the research “suggests that the M5.7 quake was the largest human-caused earthquake associated with wastewater injection.”⁹⁷

In July 2014, researchers from Cornell University, the University of Colorado, Columbia University, and the United States Geological Survey reported in the journal *Science* that a swarm of earthquakes in central Oklahoma was probably caused by activity at a handful of active disposal sites.⁹⁸ Seismic activity has continued, and on April 21, 2015, the Oklahoma Geological Survey (OGS) issued a remarkable statement regarding earthquake trends in the state. After noting that Oklahoma historically recorded an average of less than two earthquakes a year of 3.0 magnitude or greater, the Survey stated that the OGS observed in 2013 “on average about 2, M3+ earthquakes *each week* on average,” and is currently reporting “on average about 2 1/2, M3+ earthquakes *each day*.”⁹⁹ The Survey “considers it very likely that the majority of recent earthquakes, particularly those in central and north-central Oklahoma, are triggered by the injection of produced water in disposal wells.”¹⁰⁰ Two months after the Survey issued its statement, there were thirty-five seismic events of magnitude 3.0 or greater in a one-week period in June, including earthquakes in the Oklahoma City metropolitan area.¹⁰¹

96. Katie M. Kernan et al., *Potentially Induced Earthquakes in Okla., USA: Links Between Wastewater Injection and the 2011 M_w 5.7 Earthquake Sequence*, 41 *GEOLOGY* 699, 699–702 (June 2013), available at <http://bit.ly/1HIOSGT>. When asked to comment on the study, co-author Geoffrey Abers said the findings mean “the risk of humans inducing large earthquakes from even small injection activities is probably higher” than previously thought. Stephen C. Webster, *Study Links Fracking Wastewater to Massive 2011 Okla. Quake*, *THE RAW STORY* (Mar. 27, 2013), <http://on.doi.gov/1PUaRCT>.

97. Susan Garcia, *2011 Okla. Induced Earthquake May Have Triggered Larger Quake*, U.S. GEOLOGICAL SURVEY (Mar. 6, 2013), <http://bit.ly/1Yp1UWa>. The rate of earthquakes in Oklahoma has increased by about fifty percent since October 2013, and since 2009 has included twenty magnitude 4.0 to 4.8 quakes, in addition to the three earthquakes of 5.0, 5.7, and 5.0 magnitude in November 2011. U.S. Geological Survey, *Record Number of Oklahoma Tremors Raises Possibility of Damaging Earthquakes*, U.S. GEOLOGICAL SURVEY (Oct. 22, 2013; Updated May 2, 2014), <http://bit.ly/1IW3coZ>.

98. Katie M. Kernan, et al., *Sharp Increase in Cent. Okla. Seismicity Since 2008 Induced by Massive Wastewater Injection*, 345 *SCI.* 448, 448–51 (July 2014), available at <http://www.sciencemag.org/content/345/6195/448>; see also Hailey Branson-Potts, *Study Links Okla. Earthquake Swarm with Fracking Operations*, *L.A. TIMES* (July 3, 2014), <http://lat.ms/1kjWyI2> (nothing that researchers report that four high-rate disposal wells in southeast Oklahoma City probably induced a group of earthquakes known as the Jones swarm, which accounted for twenty percent of the seismicity in the central and eastern United States between 2008 and 2013).

99. Richard D. Andrews & Austin Holland, *Statement on Okla. Seismicity*, OKLA. GEOLOGICAL SURVEY (Apr. 21, 2015), <http://bit.ly/1DA9RNp>; see also Mary Duenwald, *Wastewater Wells are Shaking Okla.*, *BLOOMBERG VIEW* (Feb. 23, 2015), <http://bv.ms/1whPyaH> (“Last year, Oklahoma had 585 earthquakes with a magnitude 3.0 or greater (big enough for people to easily feel)—almost three times as many as California had and up from an average of just two a year before 2009.”).

100. Andrews, *supra* note 99 (“The seismicity rate is now about 600 times greater than the background seismicity rate, and is very unlikely the result of a natural process”); see also Becky Oskin, *Fracking is Not the Cause of Quakes*, *WASH. POST*, (Apr. 27, 2015), <http://wapo.st/1TeNwz1> (“More than 1.1 billion barrels of wastewater was injected in Oklahoma in 2013.”).

101. Reuters, *Okla. Drilling Regulator Calls Spike in Quakes a “Game Changer,”* *EAGLEFORDTEXAS.COM* (June 25, 2015), <http://bit.ly/1QIeGj4>. On August 4, 2015, Governor Mary Fallin noted “a direct correlation between the increase in earthquakes we’ve seen in Oklahoma and the disposal wells,” and acknowledged that “there is an earthquake problem in our state.” Adam Wilmoth,

Texas. — After earthquakes in 2008 and 2009 were felt in the Dallas-Fort Worth area, researchers from the University of Texas and Southern Methodist University investigated whether the cause was underground disposal of drilling wastes. Their March 2010 report concludes that the “spatial and time correlations are consistent with an induced or triggered source,” but also cautions that there are “thousands of injection wells in Texas, the vast majority of which produce no felt or instrumentally recorded seismicity.”¹⁰² One of the researchers, Dr. Cliff Frohlich, subsequently studied seismic activity from November 2009 to September 2011 within the Barnett Shale formation. He concluded that “injection-triggered earthquakes are more common than is generally recognized,” and hypothesized that “injection only triggers earthquakes if injected fluids reach and relieve friction on a suitably oriented, nearby fault that is experiencing regional tectonic stress.”¹⁰³

A third series of seismic events in 2013 and 2014, in an area northwest of

Governor cites ‘direct correlation’ between disposal wells (Aug. 4, 2015), at <http://newsok.com/governor-cites-direct-correlation-between-disposal-wells-earthquakes/article/5438173>. One month later a 4.5 magnitude earthquake struck near Cushing, Oklahoma, which holds one of the largest crude oil storage facilities in the world. Michael Winescot, *New Concern Over Quakes in Oklahoma Near a Hub of U.S. Oil* (Oct. 14, 2015), at http://www.nytimes.com/2015/10/15/us/new-concern-over-quakes-in-oklahoma-near-a-hub-of-us-oil.html?_r=0. On October 29, 2015, the Sierra Club gave notice to four energy companies operating in Oklahoma of its intent to bring suit under section 7002(a)(1)(B) of the Resource Conservation and Recovery Act, 42 U.S.C. 6972(a)(1)(B). See Notice of Intent to Sue, at <https://assets.documentcloud.org/documents/2500562/final-ok-earthquakes-notice-letter-with.pdf>. The Sierra Club asserts that current disposal practices constitute an imminent and substantial endangerment, and requests “reduction or abatement of the volumes of Production Wastes being injected into the ground so that earthquake risks subside to natural levels, the establishment of an independent forecasting body that could investigate, analyze and predict the cumulative effect of injecting Production Wastes, reinforcement of structures that could be vulnerable to the current elevated earthquake risks, and other appropriate relief.” *Id.* at 10.

102. Cliff Frohlich et al., *Dallas-Ft. Worth Earthquakes Coincident with Activity Associated with Natural Gas Production*, 29 *THE LEADING EDGE* 270, 270–75 (2010), available at <http://tle.geoscienceworld.org/content/29/3/270.abstract> (recommending that “more needs to be known” about how fracture stimulation, saltwater disposal, enhanced geothermal projects, and carbon sequestration activities “interact with in-situ stresses and possibly affect seismic activity”); see also Alex Mills, *Water from Fracking is the Likely Cause of Tex. Earthquakes*, *TYLER MORNING TELEGRAPH*, (Apr. 26, 2015), <http://bit.ly/1SkooY> (“The first series of felt tremors hit near DFW [Dallas-Fort Worth] International Airport between Oct. 30, 2008, and May 16, 2009. Next came a series of quakes in Cleburne between June 2009 and June 2010 In both the DFW sequence and the Cleburne sequence, the operation of injection wells used in the disposal of natural gas production fluids was listed as a ‘possible’ cause of the seismicity Prior to the DFW Airport earthquakes in 2008, an earthquake large enough to be felt had not been reported in the Fort Worth Basin since 1950. The North Texas earthquakes of the last seven years have all occurred in areas developed for natural gas extraction from a geologic formation known as the Barnett Shale.”); Max B. Baker, *Study Links Azle Earthquakes to Drilling Activity*, *FT. WORTH STAR TELEGRAM*, (Apr. 21, 2015), <http://bit.ly/1EoFLmH> (“The quakes stopped after Chesapeake Energy in August 2009 shut down one of two injection wells it operated on DFW property.”).

103. Cliff Frohlich, *Two-year Survey Comparing Earthquake Activity and Injection-Well Locations in Barnett Shale, Texas*, 109 *PNAS* 13934, 13934–38 (Aug. 28, 2012), available at <http://bit.ly/1mbJYSJ>; but see Cliff Frohlich & Michael Brunt, *Two-year Survey of Earthquakes and Injection/Production Wells in the Eagle Ford Shale*, 379 *EARTH & PLANETARY SCI. LETTERS* 56, 56–63 (Oct. 2013), available at <http://bit.ly/1Oc8qjE> (noting that, in a study of a 2011 earthquake of 4.8 magnitude in south-central Texas, Dr. Frohlich and Michael Brunt found no evidence that fluid injection was responsible and suggested instead that extraction of oil and water induced the seismic event).

Fort Worth near Azle, Texas, increased public awareness of the problem of induced earthquakes.¹⁰⁴ The Texas Railroad Commission, which oversees the oil and gas industry, hired a seismologist in March 2014 to study the cause of recent earthquakes, and in May 2014 the Texas House Subcommittee on Seismic Activity began gathering testimony from affected residents and experts.¹⁰⁵ In November 2014, the Railroad Commission published new requirements related to seismic events in connection with wastewater disposal permits, monitoring, and reporting.¹⁰⁶ Shortly thereafter, on November 22, 2014, an earthquake of 3.3 magnitude occurred near the border of the cities of Dallas and Irving.¹⁰⁷

In April 2015 researchers from Southern Methodist University, The University of Texas, and the U.S. Geological Survey published a study that concluded that, “[o]n the basis of modeling results and the absence of historical earthquakes near Azle, brine production combined with wastewater disposal represent the most likely cause of recent seismicity near Azle.”¹⁰⁸ Three days after the publication of the study, the Texas Railroad Commission issued a “show cause” order requiring owners of disposal wells in the Azle area to justify continued operations.¹⁰⁹ However, on November 3, 2015, the Commission adopted the findings of administrative hearing examiners that there was insufficient evidence that the wastewater disposal wells contributed to the seismic activity near Azle and Reno.¹¹⁰ The hearing examiners found that the SMU study established a “weak temporal correlation between injection and seismic activities,” and concluded that, in the absence of corroborating evidence, the data presented did not to prove a causal relationship.¹¹¹

104. Emily Schmall, *Kan., Okla., Tex. Exploring Possible Connection Between Fracking, Earthquakes*, TOPEKA CAP.-J., (June 25, 2014), <http://bit.ly/1mhtsZK> (researchers at Southern Methodist University recorded more than 300 quakes around Azle).

105. Rick Jervis, *Fracking Wells Possible Culprit of Tex. Earthquake*, USA TODAY (June 1, 2014), <http://usat.ly/1rDXYWB>.

106. Folger & Tiemann, *supra* note 77. Applicants for disposal well permits are required to provide information regarding the locations of any historical seismic events within 100 square miles of the proposed well site. The Commission is authorized to modify, suspend, or terminate permits “if injection is likely to be or determined to be contributing to seismic activity.” Well owners in certain areas may be asked to provide additional geologic and operating information, and may be required to conduct more frequent monitoring and reporting of disposal well injection pressures and rates.

107. Jim Forsyth, *Small Quake Shakes Dallas Area, Stirring Fracking Critics*, REUTERS (Nov. 23, 2014), <http://reut.rs/21fX7e0>. The earthquake shook the area but did not cause any damage. The epicenter was near the site of the former Texas Stadium, the previous home of the Dallas Cowboys football team. *Id.*

108. Matthew J. Hornbach et al., *Causal Factors for Seismicity Near Azle, Tex.*, NATURE COMMUNICATIONS (Apr. 21, 2015), <http://bit.ly/1LzTeoM>; *see also id.* at 7 (“A complex interplay between brine production and wastewater injection likely promotes seismic activity.”).

109. Christi Craddick & David Porter, *R.R. Comm’n Orders “Show Cause” Proceeding for Azle Disposal Wells*, R.R. COMM’N OF TEX. (Apr. 24, 2015), <http://bit.ly/1HyjKct>.

110. *Texas regulator maintains gas company permits despite earthquakes* (Nov. 4, 2015) at <http://eaglefordtexas.com/news/id/160036/texas-regulator-maintains-gas-company-permits-despite-earthquakes/>.

111. Merrill Hope, *Fracking ‘Injection Wells’ Not Causing Texas Earthquakes, Says Railroad Commission* (Nov. 5, 2015), at <http://www.breitbart.com/big-government/2015/11/05/fracking-injection-wells-not-causing-texas-earthquakes-says-railroad-commission/>.

According to some commentators, the Commission's decision suggests that it will be difficult for plaintiffs to meet their burden of proof when suing oil and gas companies for damages allegedly caused by induced seismicity.¹¹²

National studies. — In light of such events, it is not surprising that the United States Geological Survey announced in 2012 that “a remarkable increase in the rate of M 3 [magnitude 3.0] and greater earthquakes is currently in progress in the US midcontinent.”¹¹³ In June of 2012 a study by the National Research Council found that, “although only a very small fraction of injection and extraction activities at hundreds of thousands of energy development sites in the United States have induced seismicity at levels that are noticeable to the public, seismic events caused by or likely related to energy development have been measured and felt in Alabama, Arkansas, California, Colorado, Illinois, Louisiana, Mississippi, Nebraska, Nevada, New Mexico, Ohio, Oklahoma, and Texas.”¹¹⁴

On December 22, 2014, the Congressional Research Service published a study, entitled *Human-Induced Earthquakes from Deep-Well Injection: A Brief Overview*, which notes that “[t]he vast majority of deep-well injection wells and hydraulic fracturing wells do not appear to be associated with significant seismic events,” but also acknowledges that “[t]he scientific understanding of linkages between deep-well injection of waste fluids from oil and gas production, and from hydraulic fracturing operations, is rapidly evolving.”¹¹⁵ In April of 2015,

The U.S. Geological Survey published its own study, entitled *Incorporating Induced Seismicity in the 2014 United States National Seismic Hazard Model—Results of 2014 Workshop and Sensitivity Studies*.¹¹⁶ As the title indicates, the 2014 National Seismic Hazard Model was revised to take into account induced seismicity, and Table 1 of the study¹¹⁷ identifies seventeen “induced seismicity

112. See, e.g., Caroline Toole, Well runs dry for plaintiffs seeking to pin earthquakes on fracking activities (Nov. 9, 2015), at <http://www.lexology.com/library/detail.aspx?g=e33f56d1-485a-44c0-a27a-348eeeb1fd7> (“While plaintiffs might try to point to broader patterns of an increase in seismic activity in recent years, they may be unable to meet the burden of showing by even a preponderance of the evidence that a given earthquake was caused by the fracking activities of a specific defendant.”).

113. W.L. Ellsworth et al., *Are Seismicity Rate Changes in the Midcontinent Natural or Manmade?*, SEISMOLOGICAL SOCIETY OF AMERICA (Apr. 18, 2012), <http://bit.ly/1cmFWea>.

114. NAT'L RESEARCH COUNCIL, INDUCED SEISMICITY POTENTIAL IN ENERGY TECHNOLOGIES, (2012), available at <http://bit.ly/1MDogjr> (finding that (1) the process of hydraulic fracturing a well as presently implemented for shale gas recovery does not pose a high risk for inducing felt seismic events; and (2) injection for disposal of waste water derived from energy technologies into the subsurface does pose some risk for induced seismicity, but very few events have been documented over the past several decades relative to the large number of disposal wells in operation). The abstract for yet another study, published in the journal *Science*, states that the “recent dramatic increase in seismicity in the midwestern United States may be related to increases in deep wastewater injection.” Nicholas J. van der Elst et al., *Enhanced Remote Earthquake Triggering at Fluid-Injection Sites in the Midwestern U.S.*, 341 SCIENCE 164, 164 (July 2013), available at <http://www.sciencemag.org/content/341/6142/164.full.pdf>.

115. Folger & Tiemann, *supra* note 77, at 19 (stating that the “EPA plans to publish a report outlining best practices to address seismic events associated with oil and gas wastewater injection”).

116. Petersen, *supra* note 76.

117. Peterson, *supra* note 76, at 13.

zones” in the central and eastern United States:

Induced Seismicity Zone	Location	Largest Earthquake (moment magnitude)	Time Window
Rocky Mountain Arsenal	Environs of Denver, Colorado	4.8, Aug. 1967	1962-1979
Rangely	Northwestern Colorado	4.3, Apr. 1970	1957-2014
Paradox	Southwestern Colorado	3.9, Jan 2013	1991-2014
Greeley	In the Denver Basin, Colorado	3.2, Jun. 2014	2013-2014
Raton Basin	New Mexico–Colorado border	5.2, Aug. 2011	2001-2014
Dagger Draw	Southeastern New Mexico	4.1, Dec. 2005	1998-2014
Guy-Greenbrier	Central Arkansas	4.7, Feb. 2011	2009-2014
Oklahoma	Central Oklahoma	5.6, Nov. 2011	2006-2014
Oklahoma-N; Kansas-S	Oklahoma–Kansas border	4.8, Nov. 2014	2013-2014
Cogdell	West-central Texas	4.5, Jun. 1978	1976-2014
Fashing	Conventional natural gas field in southern Texas	4.6, Oct. 2011	1973-2014
Timpson	Eastern Texas	4.8, May 2012	2011-2014
Dallas-Fort Worth	Near Dallas–Fort Worth, Texas	3.2, Jun. 2012	2008-2014
Azle	Northwest of Fort Worth, Texas	3.4, Nov. 2013	2013-2014
Ashtabula	Northeastern Ohio	3.9, Jan. 2001	1987-2007
Youngstown	Northeastern Ohio	3.7, Dec. 2011	2010-2014
Brewton	Alabama–Florida border	4.9, Oct. 1997	1997-2014

The study finds that “the rates of induced earthquakes are inherently variable and nonstationary,” and acknowledges that “[p]redicting when and where induced seismicity will occur in the future is challenging.¹¹⁸ Nevertheless, the

118. Peterson, *supra* note 76, at 1 (“Forecasting the seismic hazard from induced earthquakes is fundamentally different from forecasting the seismic hazard for natural, tectonic earthquakes. This is because the spatio-temporal patterns of induced earthquakes are reliant on economic forces and public policy decisions regarding extraction and injection of fluids.”).

chief of the National Seismic Hazard Project, Mark Peterson, considers induced seismicity “to be primarily triggered by the disposal of wastewater into deep wells.”¹¹⁹

VI. FRACKING AND CRACKING: STRICT LIABILITY FOR EARTHQUAKE DAMAGE DUE TO UNDERGROUND INJECTION OR HYDRAULIC FRACTURING

In contrast to the ongoing research on fracking and water contamination, the studies described above have established a strong connection between earthquakes and the underground injection of fracking fluids. Although less frequent and intense, there are also some documented instances in which hydraulic fracturing has induced seismic activity. Courts should declare injection and fracking to be abnormally dangerous activities under the six factor test of Section 520 of the Restatement (Second) of Torts. Taking this step would not be unprecedented. As discussed in Part III, *supra*, some state courts have already declared oil and gas drilling and production to be abnormally dangerous activities. Furthermore, state courts in “concussion” and “vibration” cases have imposed strict liability for ground disturbances due to human activity. In some jurisdictions, courts have also held mineral owners strictly liable for actions that damage the surface estate.

Alternatively, state legislatures should impose strict liability for earthquake damage caused by underground injection or hydraulic fracturing. Several states have already enacted “surface damage acts” that authorize landowners to recover damages, without proving fault, for surface disturbances caused by oil and gas operations. The Maryland Senate in March 2015 approved a bill that declared hydraulic fracturing to be an “ultrahazardous and abnormally dangerous activity” and imposed strict liability. Although the legislation ultimately passed by the Maryland General Assembly took a different approach, the imposition of statutory strict liability for earthquake damage caused by underground injection or hydraulic fracturing is a viable option.

Judicial imposition of strict liability. — The six factors of Section 520 of the Restatement (Second) of Torts look at the (a) existence of a high degree of risk of some harm to the person, land, or chattels of others; (b) likelihood that the harm that results from it will be great; (c) inability to eliminate the risk by the exercise of reasonable care; (d) extent to which the activity is not a matter of common usage; (e) inappropriateness of the activity to the place where it is carried on; and (f) extent to which its value to the community is outweighed by its dangerous attributes. Application of the last three factors to induced seismic activity produces mixed results. The debate is ongoing over whether the benefits of hydraulic fracturing are outweighed by its dangerous attributes, and it should be noted that the district court in *Ely* and *Kamuck* was not asked to consider earthquakes or other problems associated with disposal of frack fluids.

119. Oskin, *supra* note 100.

The inappropriateness of where such activities are conducted depends in part on their proximity to residential areas, and in recent years injection of fracking wastewater has been associated with seismic activity near urban areas in Colorado, Ohio, Oklahoma, and Texas.¹²⁰ Underground injection is currently the most common form of disposal, but it is not the only viable option.¹²¹

The argument for strict liability becomes much stronger when the first three—and most important—factors are taken into account. The risk of some harm caused by induced earthquakes is increasing, and the likelihood is becoming higher that the harm that results will be great. Induced seismicity has already caused property damage and personal injuries, and although most induced earthquakes have been minor events to date, there have been seismic events greater than 5.0 magnitude associated with injection.¹²² Furthermore, according to William Ellsworth of the U.S. Geological Survey, “[t]he more small earthquakes we have . . . increases the odds we’re going to have a more damaging event.”¹²³ Gail Atkinson, a professor at the University of Western Ontario and one of Canada’s leading seismologists, has stated that we lack “a clear understanding of the likely induced seismicity in response to new activity,” and has speculated that larger earthquakes in the future could damage structures such as dams and nuclear power plants that were built in areas of perceived low seismicity.¹²⁴ Justin Rubinstein of the U.S. Geological Survey has characterized the potential for harm as follows: “We can’t say there’s no risk of there being significant damage and loss.”¹²⁵

120. Douglas A. Henderson & Mack McGuffey, *Leaking Underground Storage Tanks as Abnormally Dangerous Activities*, 14 PENN ST. ENVTL. L. REV. 643 (2006) (explaining that courts have characterized as an abnormally dangerous activity the placement of underground gasoline storage tanks in close proximity to private water wells or community drinking water sources).

121. Researchers at Northwestern University have recommended that fracking companies treat their wastewater rather than inject it underground. Andy Szal, *Study: Fracking Doesn't Have to be Rough on the Environment*, MANUFACTURING.NET (June 26, 2015), <http://bit.ly/1XgmXyV>. The study concludes that “[m]anaging wastewater with RO [reverse osmosis] technology onsite is . . . the best wastewater treatment option with excellent economic and environmental performance.” Jiyao Gao & Fengqi You, *Shale Gas Supply Chain Design & Operations toward Better Econ. & Life Cycle Envtl. Performance: MINLP Model & Global Optimization Algorithm*, 3 ACS SUSTAINABLE CHEMISTRY & ENGINEERING 1282, 1289 (May 2015), available at <http://pubs.acs.org/doi/pdf/10.1021/acssuschemeng.5b00122>.

122. According to one source, earthquakes of 2.5 to 5.4 magnitude are often felt, but usually only cause minor damage, earthquakes of 5.5 to 6.0 magnitude usually cause slight damage to buildings and other structures, and earthquakes of 6.1 to 6.9 magnitude may cause a lot of damage in populated areas. UPSeis, MICHIGAN TECHNOLOGICAL UNIVERSITY, <http://www.geo.mtu.edu/UPSeis/magnitude.html>. It bears repeating, however, that the 5.7 magnitude earthquake in Prague, Oklahoma, destroyed fourteen homes, injured two people, buckled a federal highway, and toppled a turret from a university building. Mike Soraghan, *In Oil-Friendly Okla., Gov. Fallin Moved Slowly on 'Awkward' Issue of Quakes*, E&E PUBLISHING (July 8, 2015), <http://www.eenews.net/stories/1060021388>.

123. Anastasia Pantisios, *Scientists Say Small Fracking Earthquakes Could Lead to Major Ones*, ECOWATCH (Feb. 17, 2015), <http://bit.ly/1BjmhO8>.

124. *Id.*

125. Kevin Simpson, *Amid Oil and Gas Boom, Colo. Continues Role as Earthquake Lab*, DENVER POST, (Aug. 31, 2014), <http://bit.ly/1Oc8qjE>. Rubinstein has also explained that injection wells have a potentially much greater seismic impact than the fracking process itself, because fracking wells tend to be short-lived whereas injection wells may last for years and receive a far greater quantity of water, and not just from fracking. Patrick J. Kiger, *Could Fracking Cause a Major Earthquake?*, DISCOVERY

The strongest argument for strict liability is grounded on the most emphasized factor: the inability to eliminate the risk by the exercise of reasonable care.¹²⁶ Seismologists are not yet able to accurately predict which wastewater injection sites are likely to pose risks, and do not yet know what operators might do to eliminate the hazard. According to Gail Atkinson, “we don’t know how to evaluate the likelihood that an operation will be a seismic source in advance.”¹²⁷ Likewise, Justin Rubenstein of the U.S. Geological Survey notes that it is “difficult to predict where wastewater injection might increase the risk of earthquakes, because researchers’ knowledge of where faults are located remains incomplete.”¹²⁸ In assessing whether either hydraulic fracturing and/or the injection of drilling wastes should be held to be abnormally dangerous activities, the ability to mitigate the risk of harm by the exercise of due care could be the dispositive issue.

In marked contrast to instances where hydraulic fracturing has been blamed for groundwater contamination, there has been no suggestion in recent studies that the hydraulic fracturing associated with seismic activity has been conducted in a negligent manner. Likewise, there has been no suggestion that the connection between waste injection and seismic activity is due to negligent behavior. Because earthquake damage occurs even when frack fluids are *properly* injected and subsurface formations are *properly* fractured, oil and gas companies should compensate injured landowners.

There are judicial precedents for imposing strict liability for surface disturbances caused by oil and gas operations. In *Mowrer v. Ashland Oil & Refining Co., Inc.*,¹²⁹ the United States Court of Appeals for the Seventh Circuit

NEWS (Jan. 16, 2015), <http://bit.ly/1DbRldC>.

126. The risk of seismic activity can be reduced by careful monitoring, avoiding areas with known fault lines, locating disposal wells in less populated areas, and slowing the injection rate. See Duenwald, *supra* note 99; M. Weingarten et al., *High-Rate Injection is Associated with the Increase in U.S. Mid-Continent Seismicity*, 348 SCIENCE 1336, 1336 (June 2015), available at <http://www.sciencemag.org/content/348/6241/1336.full.pdf> (“Managing injection rates may be a useful tool to minimize the likelihood of induced earthquakes.”). It remains to be seen whether the risk of harm can be eliminated through regulation. Darlene Cypser and Scott Davis examined the issue of liability for induced earthquakes in 1994, well before the advent of horizontal hydraulic fracturing. See Darlene A. Cypser & Scott D. Davis, *Liability for Induced Earthquakes*, 9 J. OF ENVTL. L. & LITIG. 551 (1994). In their view, factors (b), (c), and (d) “weigh heavily towards finding earthquake-inducing activities to be ‘abnormally dangerous.’” *Id.* at 574. They argue that “[a]n organization engaged in activities having the potential for triggering earthquakes also has within its power the ability to manage potential liability by insuring against it, and by evaluating and controlling the risk of triggering earthquakes. Applying strict liability to induced earthquake damage would provide an incentive to those engaged in such activities to take further steps to avoid inducing quakes.” *Id.* at 575.

127. Patrick J. Kiger, *Scientists Warn of Quake Risk From Fracking Operations*, NATIONAL GEOGRAPHIC (May 2, 2014), <http://bit.ly/1nQmfpF>.

128. *Id.* See also Vicki Smith, *Seismologist: Fracking Doesn’t Cause Earthquakes*, DENVER POST, (Sept. 9, 2013), <http://dpo.st/1R6U43p> (providing that Dr. Cliff Frohlich stated at a conference in West Virginia that it remains unclear why some injection wells cause earthquakes and others do not). According to Robert Skoumal of Miami University, there are fault lines deep underground that geologists and oil and gas companies don’t know exist. Laura Arenschield, *Fracking, Wastewater-Injection Wells Raise Ohio’s Quake Risk, Feds Say*, COLUMBUS DISPATCH, (May 4, 2015), <http://bit.ly/1F10RII>.

129. *Mowrer v. Ashland Oil & Ref. Co. Inc.*, 518 F.2d 659, 659 (7th Cir. 1975).

noted that underground waterflooding operations (1) “introduced a risk of serious harm to the land of others which could not be eliminated by the exercise of care;” (2) was not a matter of common usage, and (3) “was accordingly an abnormally dangerous activity”¹³⁰ Furthermore, some state courts in “concussion” or “vibration” cases have imposed strict liability for ground disturbances due to human activity. In an excellent and comprehensive article on this subject, Emery Richards summarizes the existing case law in Ohio, Colorado, Oklahoma, Texas, and Arkansas with respect to “concussion” liability.¹³¹ Richards concludes that Ohio, Colorado, and Oklahoma impose strict liability for damage due to explosions and vibrations, whereas Texas expressly requires that such claims be evaluated under a negligence standard, and Arkansas appears to require negligence before imposing liability for concussion damage.¹³²

In Texas, mineral owners are liable without fault in some instances for actions that damage the surface estate. This issue was addressed in *Moser v. United States Steel Corp.*,¹³³ which concerned the ownership and extraction rights set forth in a deed that reserved “oil, gas, and other minerals.” The Texas Supreme Court first held that mineral owners are not liable for damages to the surface in connection with the non-negligent extraction of minerals that were expressly granted or reserved.¹³⁴ However, with respect to surface destruction caused by the extraction of “other minerals” that were not specifically identified in the deed, the court adopted a rule of strict liability, holding that “the limitation of the dominant mineral owner’s liability to negligently inflicted damages does not control,” and “the liability of the mineral owner must include compensation to the surface owner.”¹³⁵

Statutory Imposition of Strict Liability. — In contrast to Texas, other states have imposed strict liability for surface disturbance caused by mineral exploration through the enactment of surface damage acts. The 1978 North Dakota Oil and Gas Production Damage Compensation Act requires oil and gas developers—regardless of fault—to pay surface owners for lost land value, lost use of and access to the surface owner’s land, and lost value of improvements caused by drilling operations.¹³⁶ Several other states have enacted similar legislation,¹³⁷ including Oklahoma, which imposes strict liability for surface

130. *Id.* at 662.

131. Emery Gullickson Richards, *Finding Fault: Induced Earthquake Liability & Regulation*, COLUM. J. OF ENVTL. L. (April 2015), available at <http://bit.ly/1Qto8HM>.

132. *Id.* at 18–29. With respect to Arkansas, it should be noted that a state jury recently found XTO Energy, Inc., liable for damages to a residence due to drilling vibrations. The jury did not address strict liability, but instead upheld the claims of negligence, nuisance, and trespass. *Hiser v. XTO Energy Inc.*, 768 F.3d 773, 775 (8th Cir. 2014).

133. *Moser v. U.S. Steel Corp.*, 676 S.W.2d 99, 100 (Tex. 1984).

134. *Id.* at 103 (explaining that “. . . the mineral owner is held liable to the surface owner only for negligently inflicted damage to the surface estate” where a mineral is specifically named).

135. *Id.*

136. N.D. CENT. CODE § 38-11.1-04 (2001).

137. See generally Andrew Miller, Comment, *A Journey Through Mineral Estate Dominance, the*

damages pursuant to its Surface Damage Act.¹³⁸ In its decision upholding the constitutionality of the statute, the Oklahoma Supreme Court held that “the standard of liability for damages to the surface estate flowing from the exercise of the mineral estate holder’s right to enter and use the land was a subject clearly susceptible to modification by exercise of the state’s police power.”¹³⁹ Surface damage acts should apply to earthquake damage due to hydraulic fracturing of “split” estates,¹⁴⁰ but the current statutes would not impose liability for damage to adjacent or distant properties caused by fracking or wastewater injection.

Surface damage acts are not the only examples of strict liability statutory causes of action. For example, the Comprehensive Environmental Response, Compensation, and Liability Act of 1988 (CERCLA) created a cause of action that imposes strict liability for the costs of cleaning property contaminated by the release of hazardous substances.¹⁴¹ The Clean Water Act also “established a default regime of strict liability.”¹⁴² It is within the state police power to fashion a similar rule for earthquake damages due to hydraulic fracturing and/or the injection of fracking wastes. One state has already considered this option. In the first half of 2015 the possibility of hydraulic fracturing in Maryland sparked a vigorous legislative debate. The Maryland House of Delegates favored a moratorium on fracking, whereas the Maryland Senate voted in favor of a bill that declared hydraulic fracturing to be an “ultrahazardous and abnormally dangerous activity” subject to strict liability.¹⁴³ Although the General Assembly ultimately opted for a two-year moratorium and stricter regulatory controls, the Maryland example shows that strict liability for induced earthquake damage can be based on either judicial or statutory

Accommodation Doctrine, and Beyond: Why Texas Is Ready to Take the Next Step with a Surface Damage Act, 40 Hous. L. Rev. 461 (2003).

138. OKLA. STAT. ANN. tit. 52, §§ 318.1–320 (West 2015).

139. *Davis Oil Co. v. Cloud*, 766 P.2d 1347, 1350–51 (Okla. 1986).

140. Split estates result when the mineral estate is severed and separately owned. KENDOR P. JONES ET AL., LANDMAN’S LEGAL HANDBOOK 181 (Rocky Mt. Min. L. Fdn., eds., 5th ed. 2013), available at <http://bit.ly/1Qto8HM>. In such cases, surface owners are not a party to the oil and gas lease, and thus lack the ability to insist that the lease include indemnification for damages to the surface and improvements.

141. See 42 U.S.C. § 9607(a) (2002); *Burlington N. & Santa Fe Ry. Co. v. United States*, 556 U.S. 599, 608 (2009) (“CERCLA imposes strict liability for environmental contamination upon four broad classes of PRPs [potentially responsible parties.]”). When groundwater and land contamination results from the disposal of hazardous substances, it is often difficult to assign blame and responsibility. Although CERCLA does not remove the element of causation, it does make it easier to shift remediation costs to parties responsible for the problem, particularly through the application of joint and several liability. Similar issues may arise in induced earthquake damage litigation.

142. *Piney Run Pres. Ass’n v. Cnty. Comm’rs of Carroll Cnty., Md.*, 268 F.3d 255, 265 (4th Cir. 2001) (citing 33 U.S.C. 1311(a)).

143. See Natasha Geiling, *Maryland Senate Passes Bill To Declare Fracking an ‘Ultrahazardous Activity,’* CLIMATE PROGRESS (Mar. 25, 2015), <http://bit.ly/1T5gzo6> (“[T]he Maryland Senate approved a bill that would impose strict financial liabilities on fracking companies and would declare fracking an ‘ultrahazardous and abnormally dangerous activity.’”); Lucy Nicholson, *Fracking Moratorium, Strict Liability Standards Bills Pass in Maryland*, RT (Mar. 25, 2015), <http://bit.ly/1mr9unr> (stating that the Senate bill “would create some of the country’s strictest liability standards for fracking by requiring them to carry a \$10 million insurance policy that extends six years beyond the drilling operation.”).

authority.

VII. CONCLUSION

In a letter to the Denver Post, Terry Lipstein of Loveland, Colorado, succinctly set forth a common sense argument for strict liability:

I called a couple of insurance companies for a quote. One company has a policy for earthquakes but not if caused by fracking. Another told me they had one for fracking but with a \$50,000 deductible. Something is wrong here and I can't reasonably protect myself. . . . Why should the homeowner have to take all the risk? I believe the companies that are causing the problem should have to pay into a fund. Or better yet, why not change the technique so this will not happen?¹⁴⁴

As Judge Richard Posner observed in *Indiana Harbor Belt R.R. Co. v. Am. Cyanamid Co.*,

By making the actor strictly liable . . . we give him an incentive, missing in a negligence regime, to experiment with methods of preventing accidents that involve not greater exertions of care, assumed to be futile, but instead relocating, changing, or reducing (perhaps to the vanishing point) the activity giving rise to the accident.¹⁴⁵

To borrow from Mr. Lipstein, courts should impose strict liability for earthquake damage in part to compel oil and gas companies to modify their fracking and disposal techniques “so this will not happen.”¹⁴⁶

144. Terry Lipstein, Letter to the Editor, *Fracking, Earthquakes, & Insurance*, DENVER POST, (Apr. 26, 2015), <http://dpo.st/22ck3LJ>.

145. *Ind. Harbor Belt R.R. Co. v. Am. Cyanamid Co.*, 916 F.2d 1174, 1177 (7th Cir. 1990).

146. It is not written in stone that fracking requires water, at least the amount of water currently used. Nor is it mandated that fracking fluids be disposed of by underground injection. Declaring hydraulic fracturing and underground injection to be abnormally dangerous activities could spur the development of alternatives. See Kate Galbraith, *Waterless Fracking Makes Headway in Tex., Slowly*, STATEIMPACT TEXAS (Mar. 27, 2013), <http://n.pr/1YIDyLx> (describing waterless fracking as ‘a viable technology’); Kevin Bullis, *One Way to Solve Fracking’s Dirty Problem*, MIT TECHNOLOGY REVIEW (Sept. 24, 2013), <http://n.pr/1YIDyLx> (“GE researchers say they are on track to cut the costs of treating salty fracking wastewater in half.”); Anna Drive & Terry Wade, *Fracking Without Freshwater at a West Texas Oilfield*, REUTERS (Nov. 12, 2013), <http://bit.ly/1mbKxvS> (describing how Apache Corporation meets its water needs for hydraulic fracturing by using brackish water from the Santa Rosa aquifer and recycling 100 percent of its produced water); but see Jim Malewitz & Neena Satija, *In Oil and Gas Country, Water Recycling Can Be an Extremely Hard Sell*, N.Y. TIMES, (Nov. 21, 2013), <http://reut.rs/18on2CF> (“Texas is home to about 7,500 active disposal wells, making it relatively easy and cheap for drillers to dispatch their waste.”).

If the industry does not take action, it may be forced to alter current waste disposal practices. On August 26, 2015, the Environmental Integrity Project and six other environmental groups gave notice, pursuant to Section 7002 of the Resource Conservation and Recovery Act, 42 U.S.C. 6972, of their intent to sue the United States Environmental Protection Agency for failure to revise regulations for the disposal of oil and gas wastes. See <http://bit.ly/1U6n7HB> (Aug. 26, 2015). According to the environmental groups, “[s]uch review and revision is long overdue, particularly in light of the recent dramatic changes to the industry,” including “the occurrence of earthquakes in the vicinity of the [injection] wells.” *Id.* at 19 and 14.