RISK RUNS THROUGH IT: THE LEGAL FRAMEWORK FOR DAM BREACH FAILURES

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ABSTRACT

When torts result from the defendant's engagement in an abnormally dangerous activity, the Restatement (Second) of Torts provides that strict liability doctrine should be used in adjudications.[1] However, the corresponding sections of the Restatement have been subject to controversy ever since their introduction in the Restatement (First) of Torts.[2] The controversy stems from the motivation and rationale for using strict liability instead of negligence theory, as well as from the formulation used to decide whether a given activity is abnormally dangerous.[3] This Article reviews the doctrine, its implementation in the first two Restatements, and its application by the courts. It concludes by applying the Restatement test for abnormally dangerous activities to a particularly challenging problem—the breach failure of water supply dams and tailings dams—to conclude whether courts should use the strict liability framework or the negligence framework for cases involving dam failures.

INTRODUCTION

Outside of contractual relationships, courts analyze most interactions between private parties resulting in an unintentional harm through the optics of tort theory. The default legal theory for liability in unintentional torts is negligence, which would not apply only in specific circumstances, such as when the defendant engaged in an "abnormally dangerous activity."[4] A party is liable to another for negligence if (1) it owed the other a duty of reasonable

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[1] RESTATEMENT (SECOND) OF TORTS § 519(1) (AM. L. INST. 1977).

[2] Gerald W. Boston, *Strict Liability for Abnormally Dangerous Activity: The Negligence Barrier*, 36 SAN DIEGO L. REV. 597, 615 (1999).

[3] *Id.*

[4] RESTATEMENT (SECOND) OF TORTS § 519(1) (AM. L. INST. 1977).

care, (2) it breached that duty, (3) the breach caused a foreseeable harm, (4) which led to damages.[5] No-fault liability, i.e., liability even in the absence of a duty to meet some standard of care, is another theory that courts use for certain torts.[6] It is referred to as "strict liability," although some publications or court opinions have also used the term "absolute liability" with the same meaning.[7]

This Article focuses on no-fault liability applied to certain activities deemed excessively risky that are typified by the *Rylands v. Fletcher* case.[8] This old case from England that many today view as the seminal case creating a strict liability cause of action for "abnormally dangerous" activities had to do with the failure of a dam built on private land to store water for use in a mill operation.[9] The failure of the dam to hold water resulted in the flooding of coal mines in a neighboring property.[10] The defendant was found liable without the need to prove that he was at fault.[11] This decision extended strict liability theory—already in existence for certain specific conduct, e.g., keeping wild animals on one's land—to the creation of a reservoir on one's land.[12] The exception consists of eliminating both the standard of care and fault elements of negligence theory so that only two elements remain: (1) the defendant's action caused a harm, and (2) the harm is quantifiable and compensable through damages; articulated in the Restatement formulation as liability despite the exercise of the "utmost care."[13]

Interestingly, there was at least some evidence that the independent contractor hired to build the dam had been aware of the presence of abandoned mine shafts and general ground conditions on the defendant's land that should have been a source of caution regarding the ability of the reservoir to hold water.[14] However, there was at the time no recognition of a party's liability for the acts of its independent contractor, which was the common law rule until 1876, when the courts created the first exception to the rule.[15] A natural question that follows—one that this Article will return to—is whether strict liability would be needed at all to fairly compensate the aggrieved party in the *Rylands* case if the theory of agency had been available

5 DAN B. DOBBS ET AL., THE LAW OF TORTS § 124 (2d ed. 2011).

6 RESTATEMENT (SECOND) OF TORTS § 504 (AM. L. INST. 1977).

7 *See* Wade R. Habeeb, *Applicability of Rule of Strict or Absolute Liability to Overflow or Escape of Water Caused by Dam Failure*, 51 A.L.R.3d 965 (1973); *see also* Clark-Aiken Co. v. Cromwell-Wright Co., 323 N.E.2d 876, 878 (Mass. 1975).

8 Rylands v. Fletcher, L.R. 3 H.L. 330 (1868).

9 *Id.*

10 *Id.*

11 *Id.*

12 *Id.*

13 RESTATEMENT (SECOND) OF TORTS § 504 (AM. L. INST. 1977).

14 *Rylands*, L.R. 3 H.L. 330.

15 RESTATEMENT (SECOND) OF TORTS § 409 cmt. b (AM. L. INST. 1965).

then.

Rylands led to a stream of court decisions in the United States that laid the groundwork for the strict liability doctrine to go mainstream. By the middle of the 20th century, a majority of states recognized strict liability as a viable path for a tort action in situations involving an "ultrahazardous" activity, in the terminology used in the early 20th century to refer to what we now refer to as an "abnormally dangerous" activity.[16] It has been suggested that this resulted, in large measure, from a string of dam failures and the impact that they had on the American public, and consequently on state courts.[17]

A dam failure, therefore, was at the center of the first court decision extending strict liability theory to a wider range of activities than the limited range of situations to which courts applied it to before, and other dam failures —such as the one leading to the horrific Johnstown flood that killed over 2,200 people in the early 20th century—have been central to the adoption by courts of strict liability in the United States.[18] Although courts extended the strict liability doctrine to cover fact patterns other than the breach of dams, the focus of this Article is on the original application in Rylands: dam or reservoir failures. This Article will use the term "dam" elastically to include any structural system designed to store or hold back water or water containing solids as suspensions, colloidal mixtures, or solutions. Most case law resulted from cases involving dams built to store water for regular industrial or consumer use or hydroelectric power generation.[19] There is a limited number of cases involving dams built to store mining tailings or other environmentally harmful substances resulting from industrial activity.[20]

The key activities related to dams are design, construction, operation, maintenance, and decommissioning (see Figure 1).[21] In design, we consider both decisions regarding siting of the dam and the geotechnical and structural design of the actual structure or structures constituting the dam.[22] Operation includes reservoir level management.[23] Maintenance includes inspection, monitoring, and repair of any defects discovered through these activities.[24] Decommissioning may take considerable time.[25] In the case of tailings dams,

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16 Jed Handelsman Shugerman, *The Floodgates of Strict Liability: Bursting Reservoirs and the Adoption of* Fletcher v. Rylands *in the Gilded Age*, 110 YALE L. J. 333, 342 (2000).

17 *Id.* at 347.

18 *Id.*

19 *See generally* Denis Binder, *Legal Liability for Dam Failures*, SSRN ELEC. J. (2009).

20 *Id.*

21 Canadian Dam Association, *infra* note 30.

22 *See generally* R.B. JANSEN, ADVANCED DAM ENGINEERING FOR DESIGN, CONSTRUCTION, AND REHABILITATION, 60–105 (R. B. Jansen, ed., 1988).

23 N.C. DEP'T ENV'T & NAT. RES., DAM OPERATION, MAINTENANCE, AND INSPECTION MANUAL 49 (2007).

24 *See generally id.* at 15–45.

25 USSD Committee on Dam Decommissioning, *Guidelines for Dam Decommission Projects*, U.S. SOC'Y

decommissioning may take up to a thousand years, which makes it, in many respects, riskier than "operation" in the common usage of the word.[26]

This Article's focus is on two classes of defendants: engineers—who are responsible for the design of the dam and will also be involved in some activities related to construction, operation, maintenance, and decommissioning[27]—and owners or operators. Plaintiffs will be those harmed by the sudden release of water or tailings by the failure of the dam, which includes anyone legally at locations impacted by the failure. "Failure" of a dam is the sudden release of water, tailings slurry, or anything else the dam might be holding in its reservoir due to the breach, collapse, or overtopping of the dam or, in the alternative, by direct release of water from the reservoir through new or latent pathways.[28] The harm may be damage to real property, damage to the environment, damage or loss of chattels, and bodily injury or loss of life.[29]

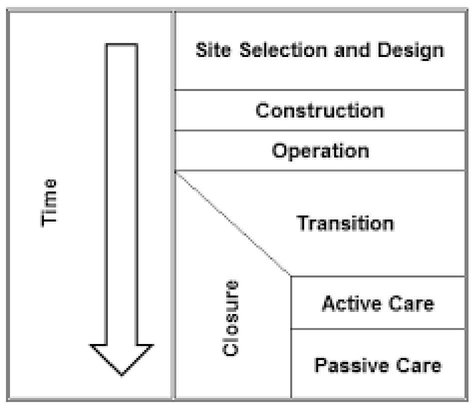

Figure 1. Life Phases of Mining Dams[30]

Case law on the topic is limited because failures of these structures are not frequent.[31] There has not been a major dam failure in the United States in decades.[32] An examination of cases reveals negligence theory and strict liability theory to coexist in this space.[33] In fact, history shows significant

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ON DAMS 27 (July 2015), https://www.ussdams.org/wp-content/uploads/2016/05/15Decommissioning.pdf.

26 *See* Can. Dam Ass'n (CDA-ACB), *CDA Mining Dams Bulletin*, BC MEND ML/ARD Workshop 7–8 (Dec. 5, 2013), https://bc-mlard.ca/files/presentations/2013-5-SMALL-cda-mining-dams-bulletin.pdf.

27 *See generally* Binder, *supra* note 19.

28 Leonardo Souza et al., *Case Study and Forensic Investigation of Failure of Dam Above Kedarnath*, INTERNATIONAL SOCIETY FOR SOIL MECHANICS AND GEOTECHNICAL ENGINEERING, 2 (2019).

29 Binder, *supra* note 19, at 44.

30 Can. Dam Ass'n, *supra* note 26, at 6.

31 *See* Nat'l Performance of Dams Program, STANFORD UNIV., http://npdp.stanford.edu/.

32 *Id.*

33 *See* Binder, *supra* note 19.

disagreement between courts, including complete U-turns in some states, in the beginning of the 20th century.[34] Which doctrine a court will apply appears to depend on jurisdiction, the role of the defendant in connection with the construction and operation of the dam, the type and magnitude of the structure, the severity of the consequences, and the use of the structure.[35]

Much time has passed since the *Rylands* failure and the failures in the early part of the 20th century. The science and engineering behind the construction and operation of dams have evolved considerably—Goodman, for example, traces the birth and development of geotechnical engineering, the core discipline in dam engineering, in the 20th century; Salgado discusses progress of the discipline into the 21st century—and it may now be the time to revisit the theory of liability in actions relating to these structures.[36] The main question that we will attempt to answer is whether application of the strict liability doctrine is justified—and indeed, whether it is needed—in adjudicating cases involving the failure of these structures. This question is also important because most cases involving dam failures are relatively old, preceding the formulation of the Restatement (Second) of Torts published in the 1970s and dam safety legislation passed by some states in the last quarter of the 20th century, after the report and dam safety guidelines produced by the *ad hoc* Interagency Committee on Dam Safety (ICODS) created by President Jimmy Carter.[37] Thus, courts today might view these precedents somewhat critically.

Section I of this Article covers the fundamentals of the doctrines of negligence and strict liability. Section II reviews the different types of dams and how they can fail. It also discusses the concepts of and estimation of the probability of failure of a dam and the risk associated with failure. It then provides an overview of the current state of the law. Section III applies the strict liability tests of the First and Second Restatements of Torts to dams. This Article then summarizes the main conclusion regarding the core question of whether the application of strict liability is required for dams and, if so, under what circumstances.

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34 *See* Shugerman, *supra* note 16.

35 *See generally* Binder, *supra* note 19.

36 *See* RICHARD GOODMAN & KARL TERZAGHI: THE ENGINEER AS ARTIST (1999); *see also* Rodrigo Salgado, *Forks in the Road: Rethinking Modeling Decisions that Defined the Teaching and Practice of Geotechnical Engineering*, INT'L SOC'Y FOR SOIL MECHS. & GEOTECHNICAL ENG'RING (2020).

37 *See* Binder, *supra* note 19; *see also* Fed. Emergency Mgmt. Agency, *Advisory Committees*, FEMA (Apr. 25, 2022), https://www.fema.gov/emergency-managers/risk-management/dam-safety/advisory-committees.

I. THE TORT ANALYSIS FRAMEWORK

This section discusses the tort analysis framework that courts would use in adjudicating a dam failure case. It starts with an overview of the two key doctrines: negligence and strict liability. The focus in the discussion of the negligence cause of action is on the standard of care. The section then discusses the origin of strict liability as applicable to dam failure cases—the *Rylands v. Fletcher* case—and then the First and Second Restatement formulations, including their departure from the *Rylands* opinion. This section concludes with a brief overview of how courts have applied or chosen not to apply the strict liability doctrine to various cases.

A. Torts in General

Modern torts typically fall into three classifications based on the defendant's mental state: intentional torts, negligence torts, and strict liability torts.[38] This classification is based on three general levels of fault of the defendant.[39] The intentional tortfeasor is usually aware of his wrongdoing.[40] "Even if he is not, however, he is always aware of his act and that may be sufficient if the act is one that is proscribed by common law or statute."[41] On the other hand, "[t]he defendant in the negligence case is sometimes aware that he is taking unreasonable risks; he is always in violation of reasonableness standards whether he is consciously aware of that fact or not."[42] Lastly, fault is not a factor in adjudicating a strict liability case.[43]

This classification clarifies the core question of this paper. The breach of a dam may result from intentional actions—such as sabotage—but these are not the subject of this Article. Courts will adjudicate a dam breach causing damage to third parties without any intent involved using either the negligence or strict liability theories.[44] Which of the two is used is a matter for courts to decide.[45] The finder of fact—either the court itself in a bench trial or the jury in a jury trial—will then apply the corresponding tort elements to the facts of the case.[46]

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38 RESTATEMENT (SECOND) OF TORTS § 6 cmt. a (AM. L. INST. 1965).
39 *Id.*
40 DAN B. DOBBS ET AL., THE LAW OF TORTS § 2, 1 (West, 2d ed. 2022).
41 *Id.*
42 *Id.*
43 RESTATEMENT (SECOND) OF TORTS § 519(1) (AM. L. INST. 1977).
44 *See* Habeeb, *supra* note 7.
45 Boston, *supra* note 2, at 630.
46 *See* RUSSELL L. WEAVER ET AL., TORTS: CASES, PROBLEMS, AND EXERCISES (5th ed, 2018).

Potential defendants in a tort action involving the breach or failure of a dam include engineers involved in the design, construction, operation, maintenance, and decommissioning of a dam.[47] The dam owner or operator are also key potential defendants.[48] A plaintiff's lawyer will likely sue all potential defendants.[49]

B. The Doctrine of Negligence

1. Elements of Negligence

A defendant will only be found liable under negligence theory if it had a duty to behave according to a standard, and it failed to meet that standard.[50] More specifically, a party is liable to another for negligence if (1) it owed the other a duty of reasonable care, (2) it breached that duty, (3) the breach in fact caused a harm to the defendant, (4) this harm was of a type foreseeable as a possible result of the negligent conduct, and (5) the harm has resulted in damages of a legally recognized type.[51]

2. Causation

In application to a case resulting from a dam failure, the causation element—element (3)—addresses whether negligence on the part of the design engineer, dam owner, or any other defendant actually caused the harm.[52] Here, the analysis must distinguish between an actual cause—or cause in fact—and a proximate cause—or legal cause—of the harm.[53] The traditional test for actual cause is the but-for test: the harm would not have occurred but for the negligence of the defendant.[54] The proximate cause analysis aims to determine whether the defendant should be found liable for his negligent action or inaction.[55] His negligence may be an actual cause of the harm, but the question is then whether it would be reasonable to expect, i.e., whether it is foreseeable, that the harm would result from the negligent

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47 Binder, *supra* note 19, at 1.
48 *Id.*
49 *Id.*
50 DOBBS, *supra* note 5.
51 *Id.*
52 Binder, *supra* note 19, at 41.
53 RESTATEMENT (SECOND) OF TORTS § 435 (AM. L. INST. 1965).
54 DAN B. DOBBS ET AL., HORNBOOK ON TORTS 316 (2d ed., 2016).
55 RESTATEMENT (SECOND) OF TORTS § 435 (AM. L. INST. 1965).

behavior in question.[56]

A design or construction defect, should a dam fail, could be an actual cause of the failure.[57] If the defect, in addition, resulted from not meeting the standard of care, and the failure was a foreseeable consequence of the defect, it would also be a proximate or legal cause of the failure, and liability would ensue for any damages.[58] Similarly, lack of maintenance might be negligent.[59] If lack of maintenance leads to the clogging of a spillway, for example, and that leads to failure of the dam, causation would be established if, but for the clogging, the dam would not have failed.

3. Causation and the Standard of Care

In applying negligence theory to the breach of a dam, it is essential to define what "reasonable care" means, because a reasonable care standard is required to decide whether there was a breach of duty—one of the elements of the tort of negligence.[60] In the absence of an intentional tort, failure of a dam may result from improper design, construction, operation, or maintenance.[61] Maintenance includes the essential activities of inspecting, monitoring, and repairing.[62] All of these activities are, at their core, engineering activities. Thus, the cause of a dam failure is best understood in engineering terms. A design failure stems from either underestimation of the loadings the system is required to sustain or overestimation of the resistances the system can offer to balance these loads.[63] Because dams are designed to retain and store water, it would be a design failure to design a dam that, even if well-constructed, would be unable to hold back water.[64] A dam failure resulting from faulty construction usually stems from failure to adhere to design specifications or poor construction practice in actions not covered by the design specifications.[65] A dam failure due to faulty operation of the dam

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56 *Id.*

57 In other words, if the dam would not have failed but for the design error or construction defect, it is an actual or factual cause of the failure using the but-for test.

58 RESTATEMENT (SECOND) OF TORTS § 435 (AM. L. INST. 1965).

59 Binder, *supra* note 19, at 11.

60 DOBBS, *supra* note 5.

61 *See* ROBIN FELL ET AL., GEOTECHNICAL ENGINEERING OF DAMS 1143 (2nd ed., 2015).

62 N.C. Dep't Env't & Nat. Res., *supra* note 23.

63 *See* RODRIGO SALGADO, THE ENGINEERING OF FOUNDATIONS, SLOPES AND RETAINING STRUCTURES 26-27 (2nd ed. 2022).

64 Fed. Emergency Mgmt. Agency, *Federal Guidelines for Dam Safety: Emergency Action Planning for Dams*, 64 FEMA I-1, III-1 (2013), https://www.fema.gov/sites/default/files/2020-08/eap_federal_guidelines_fema_p-64.pdf.

65 We know in the engineering industry that, if specifications are not in error and construction conforms to both specifications and standard construction practice, a failure will not be considered to have been caused by

usually involves failure to open spillways at times of floods or other failure to act that leads to exposure of the dam to loads that exceed those for which it was designed.[66] Maintenance failure may lead to degraded resistances over time; if these resistances become less than the loads under service, then a dam failure results.[67] Failure to clear clogging of spillways, repair defective gates and the like are also maintenance failures.[68]

Because design, construction, and operation—and even, to some extent, maintenance—of a dam are best viewed as engineering activities, the applicable standard of care under a negligence theory of liability, even for owners, might be viewed as substantially the same as that required of engineers:

> [E]ngineers … deal in somewhat inexact sciences and are continually called upon to exercise their skilled judgment in order to anticipate and provide for random factors which are incapable of precise measurement. The indeterminate nature of these factors makes it impossible for professional service people to gauge them with complete accuracy in every instance. [Thus, an engineer] cannot be certain that a structural design will interact with natural forces as anticipated. Because of the inescapable possibility of error which inheres in these services, the law has traditionally required, not perfect results, but rather the exercise of that skill and judgment which can be reasonably expected from similarly situated professionals.[69]

The court in *Aetna Insurance Co. v. Hellmuth, Obata & Kassabaum, Inc.* elaborated on the standard of care: "[t]he standard of care applicable is that of ordinary reasonable care required of a professional skilled architect under the same or similar circumstances…"[70] In other words, the standard of care is not immutable; it is a function of circumstances. Circumstances include the nature of the project;[71] the risk involved;[72] the existence of statutes setting standards or requiring certain procedures;[73] the availability of technology or

construction practices.

[66] Binder, *supra* note 19, at 13.
[67] SALGADO, *supra* note 63.
[68] Binder, *supra* note 19, at 13.
[69] City of Mounds View v. Walijarvi, 263 N.W.2d 420, 424 (Minn. 1978).
[70] Aetna Ins. Co. v. Hellmuth, Obata & Kassabaum, Inc., 392 F.2d 472, 477 (8th Cir. 1968).
[71] City of Eveleth v. Ruble, 225 N.W.2d 521, 524–25 (Minn. 1974).
[72] *Id.*
[73] Binder, *supra* note 19, at 4.

knowledge, even if not widely used in the applicable community of engineers;[74] and any applicable contractual provisions.[75] Additionally, as one court stated, due care is "in proportion to the extent of the injury which will be likely to result to third persons . . ."[76]

In evaluating what standard of care applies, there is an implicit consideration of the probability of an undesirable outcome and the magnitude of the consequences of such an outcome.[77] For example, civil engineers are often concerned with safely and functionally transferring loads between components of a structure all the way to the ground.[78] These loads are estimated, so there is a probability involved that the load estimates will exceed the actual loads acting in the structure when in service.[79] In dam design, there is an estimation of a maximum credible flood involved in the design.[80] What if a load or a flood is possible, therefore foreseeable, but very unlikely to be reached? Would an engineer fail to meet the standard of care if she did not base her design on something very unlikely but possible to happen? Would such an extreme load or flood be foreseeable? These questions relate to whether such unlikely events could be found to be proximate causes of the harm.[81] This determination would be a question of fact to be decided by the fact finder ("[C]ausation is normally a question of fact reserved for the jury"[82]) but the court in *Trout Brook Co. v Willow River Power Co.* weighed in on it.[83] The court held that the Willow River Power Co. was not required to anticipate an unprecedented flood.[84] The court defined an "unprecedented" flood as one so unusual and extraordinary that either there was no history of a comparable rain event or the flood was so intense and/or had such long duration that it could not be reasonably expected to occur again.[85] Another court took a similar view, holding that the owner must build a dam to meet only such extraordinary floods as may be reasonably anticipated.[86]

The standard of care for an engineer is that the professional keep current with engineering and scientific advances in his area of practice (an engineer must "exercise such care, skill and diligence as men engaged in that

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74 The T.J. Hooper, 60 F.2d 737, 740 (2d Cir. 1932).
75 Binder, *supra* note 19, at 4.
76 Dover v. Ga. Power Co., 168 S.E. 117, 118 (Ga. Ct. App. 1933).
77 City Water Power Co. v. City of Fergus Falls, 128 N.W. 817, 818 (Minn. 1910).
78 *See* SALGADO, *supra* note 63, at 19.
79 *Id.* at 27.
80 *See* FELL, *supra* note 61, at 674.
81 RESTATEMENT (SECOND) OF TORTS § 435 (AM. L. INST. 1979).
82 Royal Ins. Co. Am. v. Miles & Stockbridge, P.C., 133 F. Supp. 2d 747, 762 (D. Md. 2001).
83 Trout Brook Co. v. Willow River Power Co., 267 N.W. 302 (Wis. 1936).
84 *Id.* at 306.
85 *Id.* at 305.
86 Willie v. Minn. Power & Light Co., 250 N.W. 809, 811 (Minn. 1933).

profession ordinarily" would).[87] The engineer is required to perform his work as the skilled, diligent professional in his discipline would, which is different from the ordinary person standard.[88] It is important to distinguish staying current with the technological and scientific progress in the discipline from doing "what every other engineer is doing." Although there is a common belief that this is sufficient defense against this element of the tort, that is not necessarily true. "Evidence of custom in [a] trade may be admitted on the issue of the standard of care, but is not conclusive."[89] As Judge Learned Hand stated, "a whole calling may have unduly lagged in the adoption of new and available devices," meaning that the failure to keep up with progress, even if common to an entire professional community, may still mean that there was a failure to meet the standard of care.[90]

4. Application of Tort Theory to Engineering Services

Engineers are usually not strictly liable for their work, a result that has often been confirmed by courts.[91] In this regard, courts have distinguished engineers from developers or manufacturers.[92] The court in *Stuart v. Crestview Mutual Water Co.* found strict liability applicable to a developer, pointing to other cases in which strict liability applied to developers.[93] In *Kriegler v. Eichler Homes, Inc.*, a large developer of housing in Northern California was held strictly liable to an owner of a home it had built, even though the plaintiff was not the original owner, when steel tubing used in the heating system failed.[94] In another case, *Avner v. Longridge Estates*, the defendant had developed hillside property in which the plaintiff had purchased a lot and built a home.[95] Several years later, a filled slope on which the lot was located failed.[96] The developer was held strictly liable.[97] The *Stuart* court distinguished those rendering a professional service, typically billed by the hour, from manufacturers or developers, who "place products on the market and who are, therefore, in the best position to spread the cost of injuries resulting from defective products."[98] This rule is articulated as

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87 Cowles v. City of Minneapolis, 151 N.W. 184, 185 (Minn. 1915).
88 RESTATEMENT (SECOND) OF TORTS § 435 (AM. L. INST. 1979).
89 Coburn v. Lenox Homes, Inc., 186 Conn. 370, 381 (Conn. 1982).
90 The T.J. Hooper, 60 F.2d 737, 740 (2nd Cir. 1932).
91 *See, e.g.*, Stuart v. Crestview Mut. Water Co., 34 Cal. App. 3d 802, 811 (Cal. Dist. Ct. App. 1973).
92 *Id.*
93 *Id.* at 810.
94 Kriegler v. Eichler Homes, Inc., 269 Cal. App. 2d 224, 227 (Cal. Dist. Ct. App. 1969).
95 Avner v. Longridge Estates, 272 Cal. App. 2d 607, 608 (Cal. Dist. Ct. App. 1969).
96 *Id.* at 608–09.
97 *Id.* at 615.
98 *Stuart*, 34 Cal. App. 3d at 811.

follows: "where the primary objective of a transaction is to obtain services, the doctrines of implied warranty and strict liability do not apply."[99] In other words, when engineers are doing engineering, rather than producing something, like a house, they have almost always been held to a standard of care, and negligence doctrine applies.[100] Additional examples of cases with the same holding include *Gagne v. Bertran*, in which no strict implied warranty liability on the part of a borehole driller was found because

> . . . [h]e was not a seller of property who obligated himself as part of his bargain to convey property in the condition represented. The amount of his fee and the fact that he was paid by the hour also indicate that he was selling service and not insurance. Thus the general rule is applicable that those who sell their services for the guidance of others in their economic, financial, and personal affairs are not liable in the absence of negligence or intentional misconduct."[101]

Another example is *Swett v. Gribaldo, Jones & Associates*, in which a geotechnical engineering firm was found not strictly liable for harm connected with a large development.[102]

This inapplicability of strict liability to engineering services can be taken as a general rule, but some courts have found differently.[103] For example, the court in *Broyles v. Brown Engineering Co.* indicated that there are activities in which there are no significant uncertainties and whose work product would therefore be impliedly warranted by the engineer.[104] One example given by the court was the furnishing of "plans and specifications for a contractor to follow in a construction job," for which the court found that the engineer "impliedly warrants their sufficiency for the purpose in view."[105] However, it is questionable whether a strict liability rule is required to arrive at the right decision even in such situations. In this author's view, an error in drafting plans or specifications can only occur due to someone's negligence.

The question remains as to whether an engineer's participation in an abnormally dangerous activity, as defined in the Restatement (Second) of Torts, would expose them to strict liability, and whether the engineering activities related to dam construction and operation might specifically fit the

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99 Allied Props. v. John A. Blume & Assocs., 25 Cal. App. 3d 848, 855 (Cal. Dist. Ct. App. 1972).
100 *See id.*
101 Gagne v. Bertran, 275 P.2d 15, 20 (Cal. 1954).
102 Swett v. Gribaldo, Jones & Assocs., 40 Cal. App. 3d 573, 575 (Cal. Dist. Ct. App. 1974).
103 *E.g.*, Broyles v. Brown Eng'g Co., 151 So. 2d 767 (Ala. 1963).
104 *Id.* at 772.
105 *Id.*

definition of "abnormally dangerous" activity.[106] Courts do not seem to have addressed this directly.[107]

The other key parties who may be held liable to third parties who might foreseeably be injured by the sudden failure of a dam are owners and operators of dams.[108] With specific reference to the focus of the present paper—catastrophic failure of a dam—the dam owner is supposed to maintain the dam so that defects do not appear in its structure that may imperil it.[109] The owner must also have a monitoring plan in place.[110] This plan can vary in degree of sophistication, but its ultimate aim is straightforward: measure certain quantities whose values, if departing from expected values, can indicate that a failure process may be underway.[111] These are all engineering activities, not more typical or mundane activities usually thought of as those of an owner of a regular facility. Failure of the dam owner to properly maintain and monitor its structure would expose the owner to liability under negligence theory.[112]

Although these parties may themselves be engineering enterprises or, in any event, rely on engineers to accomplish most of their work, courts may hold them to a different standard. It is not clear that this would be justified. The distinction between a contractor who builds a dam and the cases in which contractors have been found strictly liable—see discussion above—is that those contractors were mass producers of homes.[113] Dams, by their nature, cannot be mass-produced, but they are, without a doubt, massive projects that may affect a large number of people and cause massive damage.[114]

C. *The Doctrine of Strict Liability*

1. The Seminal Case of *Rylands v. Fletcher*

The doctrine of strict liability for "abnormally dangerous" activities—using today's terminology—arose out of *Rylands*.[115] To fully understand it, it is important to understand how it was proposed in *Rylands* and how it evolved in the United States in the 160 years since that case.

In *Rylands*, the owner of a mill desired to construct a reservoir on his

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106 RESTATEMENT (SECOND) OF TORTS §§ 519-520 (AM. L. INST. 1979).
107 *See generally* Binder, *supra* note 19.
108 *Id.* at 1, 21.
109 *Id.* at 13.
110 *Id.* at 17.
111 *See* FELL, *supra* note 61, at 1141.
112 *See* Binder, *supra* note 19.
113 *See generally* Avner v. Longridge Estates, 272 Cal. App. 2d 607 (Cal. Dist. Ct. App. 1969).
114 *See generally* Nat'l Performance of Dams Program, *supra* note 31.
115 Rylands v. Fletcher, L.R. 3 H.L. 330 (1868).

land.[116] He hired an engineer and a contractor to do it.[117] The plaintiff operated mines in adjoining land.[118] Because of previous mining in the area, there were underground openings connecting with vertical shafts extending to the ground surface on the mill owner's property.[119] These shafts were not in use and had been filled with soil.[120] No care was taken by the engineer or the contractor to block up these shafts.[121] When water was introduced into the reservoir, it flowed through some of the shafts and old passages, flooding the plaintiff's mine.[122]

In stating his claim, the plaintiff argued that,

> [i]f the water had come into [the plaintiff's] mine from natural causes alone, he could not have complained; but it came in through the act of the Defendants in making their reservoir. They introduced there water which would not have come there in a natural way, and they were therefore bound to see that it did not produce mischief to anyone. They brought the mischief on the land, and they were bound to guard against the consequences.[123]

The defendant's response was that "[e]very man has a right to use his own land for lawful purposes, and if he does so, and does so without knowledge that he will thereby occasion injury to another, he cannot be held responsible should injury occur."[124] The trial court (the Court of Exchequer) agreed that the defendant had not acted either willfully or negligently and that there was no cause of action, but found that "reasonable and proper care and skill were not exercised by . . . [the engineer and contractor] with reference to the shafts so met with as aforesaid, to provide for the sufficiency of the said reservoir to bear the pressure of water which, when filled to the height proposed, it would have to bear."[125] However, at the time, a defendant could not be held liable for the acts of a contractor hired by him, so there was no cause of action against the defendant.[126] The judgment was reversed by the appeals court—the Court of Exchequer Chamber—and then affirmed, but with a reduction

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116 *Id.* at 330.
117 *Id.*
118 *Id.*
119 *Id.*
120 *Id.*
121 *Id.*
122 *Id.*
123 *Id.* at 335.
124 *Id.* at 333.
125 *Id.* at 332.
126 *Id.* at 338.

in scope, by the House of Lords.[127]

Lord Cairns summarized the court's views:

> [The defendant] . . . might lawfully have used [the land] for any purpose for which it might in the ordinary course of the enjoyment of land be used; and if, in what I may term the natural user [sic] of that land, there had been any accumulation of water, either on the surface or underground, and if, by the operation of the laws of nature, that accumulation of water had passed off into the close occupied by the Plaintiff, the Plaintiff could not have complained . . .[128]

He continued by stating that a "non-natural"[129] use brought onto the land

> . . .water either above or below ground in quantities and in a manner not the result of any work or operation on or under the land,–and if in consequence of their doing so, or in consequence of any imperfection in the mode of their doing so, the water came to escape and to pass off into the [land] of the Plaintiff, then it appears to me that that which the Defendants were doing they were doing at their own peril; and, if in the course of their doing it, the evil arose to which I have referred, the evil, namely, of the escape of the water and its passing away to the [land] of the Plaintiff and injuring the Plaintiff, then for the consequence of that, in my opinion, the Defendants would be liable.[130]

In this statement, Lord Cairns emphasized the "non-natural" use of the water.[131] He then quotes Blackburn's Court of Exchequer Chamber opinion to highlight another aspect of the ruling:

> We think that the true rule of law is, that the person who, for his own purposes, brings on his land and collects and keeps there anything likely to do mischief if it escapes, must keep it in at his peril; and if he does not do so, is *prima facie* answerable for all the damage which is the natural

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[127] *Id.* at 338–39.
[128] *Id.* at 338.
[129] *Id.*
[130] *Id.* at 339.
[131] *Id.* at 338.

consequence of its escape."[132]

It is in this quote from Blackburn that we can find what was later termed the "abnormal danger" of the thing brought onto the land.[133] In Blackburn's opinion, there is also reference to a defense to the tort of strict liability that is still available today: an "Act of God."[134]

2. Act of God

The only defense available in the case of strict liability, in the absence of an intentional act of a third party, is the "Act of God."[135] An Act of God is an event not foreseeable by a reasonable person in the place of the defendant, or, in the words of a court, "all . . . unavoidable or inevitable accidents."[136]

This is explained in one case as follows: "Generally, strict liability is confined to those consequences which lie within the extraordinary risk created. The requirement of foreseeability of the consequences places a limitation on the liability. When harm results from the intervention of an unforeseeable force of nature[,] liability does not fall on the defendant."[137] In the context of dam safety, the Act of God is usually an unprecedented rainfall–a rain so intense or so extended in time that it would be inconceivable to an engineer practicing in accordance with the required standard of care that it would happen during the life of the structure.[138] A rain event like that may well raise the level of the reservoir at an unpredictably fast rate, so that reservoir level management becomes impossible, and overtopping or failure of the dam ensues.[139]

The Act of God defense is not always successful, but there are examples of its acceptance by courts.[140] In *Caldbick v. Marysville Water & Power Co.*, the court found that there was a genuine issue of fact regarding the cause of failure—whether negligence by the power company or an unprecedented rainfall—to take the case to the jury, thus recognizing the validity of Act of God defense put forth by the company.[141]

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[132] *Id.* at 339–40.
[133] *Id.*
[134] *Id.*
[135] *Id.*
[136] Walpole v. Bridges, 5 Blackf. 222, 223 (Ind. 1839).
[137] Lee v. Mobil Oil Corp., 452 P.2d 857, 860 (Kan. 1969).
[138] *E.g.*, Curtis v. Dewey, 475 P.2d 808, 810 (Idaho 1970).
[139] *See id.* In this regard, a possible wrinkle in the "Act of God" defense is climate change. For dams built in the future, engineers might have to be more conservative in estimates of credible rain events.
[140] *See* Binder, *supra* note 19, at 31.
[141] Caldbick v. Marysville Water & Power Co., 195 P. 1027, 1028 (Wash. 1921).

The Act of God may not prevail as a defense if negligence was present.[142] For example, in *Frederick v. Hale*, the court upheld jury instructions stating that, if the harm resulted from a combination of negligence by the defendant and an unprecedented flood, then the plaintiff would still prevail so long as the negligence of the defendant was the proximate cause of the harm.[143] This type of ruling can be confusing because it mixes two theories, using negligence to defeat a defense traditionally used against strict liability.

3. Application

American courts started stretching the narrow holding of *Rylands* from the start.[144] The very first case adopting *Rylands* was *Ball v. Nye*.[145] In it, dirty water stored by a city resident flowed into the well of a neighboring property.[146] Massachusetts and then Minnesota courts went on to apply it to a variety of other situations.[147]

Whereas Massachusetts and Minnesota embraced *Rylands*, many states initially did not.[148] Then, at the start of the 20th century, that changed.[149] Scholars differ on the reason why a greater number of states adopted *Rylands* at the turn of the century.[150] The traditional view has been that greater urbanization and industrialization removed the main reasons to avoid application of strict liability, such as incentivizing industry, commerce, and progress.[151] According to this theory, one would not impose strict liability on those responsible for growing the nation's economy and bringing much needed economic progress.[152] Shugerman, on the other hand, argues that the floodgates of strict liability opened with the Johnstown flood disaster, in which the South Fork Dam failed, leading to the flooding of the town of Johnstown.[153]

Numerous failures happened in the last quarter of the 19th century in, *inter alia*, Arizona, Tennessee, Oregon, North Carolina, Texas, Virginia, and

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142 Rylands v. Fletcher, L.R. 3 H.L. 330, 340 (1868).
143 Frederick v. Hale, 112 P. 70, 75 (Mont. 1910).
144 Shugerman, *supra* note 16, at 335–36.
145 Ball v. Nye, 99 Mass. 582 (1868).
146 *Id.* at 582
147 WILLIAM L. PROSSER, SELECTED TOPICS ON THE LAW OF TORTS: FIVE LECTURES DELIVERED AT THE UNIVERSITY OF MICHIGAN, FEBRUARY 2, 3, 4, 5, AND 6, 1953 149 (1953).
148 *See* Shugerman, *supra* note 16, at 341.
149 W. PAGE KEETON ET AL., PROSSER AND KEETON ON THE LAW OF TORTS 548 (5th ed. 1984) (citing a passage from Prosser's 1971 edition).
150 *Id.* at 549.
151 *See* Shugerman, *supra* note 16, at 373.
152 *Id.*
153 *Id.* at 347, 360.

West Virginia, culminating with the failures of the South Fork Dam in Pennsylvania, and of St. Francis Dam in California in March 1928.[154] Until the South Fork Dam failure, the failure of the Mill River Dam on May 16, 1874, had been the worst in the United States.[155] The breach of the 43-foot-high Mill River Dam, located upstream of Williamsburg, Massachusetts, killed 138 people, including 43 children.[156]

Failures of tailings dams and dams used for pressure jetting in mining were common in California in the second half of the 19th century and beginning of the 20th.[157] One such failure was that of the large, 331-ft-long, 100-ft-high English Dam in Sierra County. The court in that case characterized hydraulic mining as an "alarming and ever-growing menace."[158]

The failure of the South Fork Dam, located nine miles upstream of the town of Johnstown, occurred on May 31, 1889.[159] Over 2,200 people–amounting to more than 20% of the population of Johnstown–lost their lives in the flood caused by the failure.[160] The human loss and significant economic losses resulting from the failure of the South Fork Dam were horrific, but something made the story even more abhorrent to people at the time. The owner of that dam was a club owned by the richest individuals at the time, including Andrew Carnegie.[161] The dam had in fact been purchased and rebuilt by the club to form a lake for recreational purposes.[162] The dam had been rebuilt without the assistance of an engineer and had been poorly maintained afterwards.[163] As the press flooded the town after the failure and the story got out, the public was enraged.[164] To make things worse, the rich members of the club that owned the dam were never found liable, were rather dismissive of the whole incident, and did nothing more than provide very modest donations to the town.[165] According to Shugerman, the sentiment at the time, even if not reflecting reality, was that negligence theory was to blame.[166] The thought was that judges were not letting cases go to the jury in negligence actions, and that strict liability would set that right.[167]

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[154] Ass'n State Dam Safety Offs. (ASDSO), *Dam Failures and Incidents*, ASDSO, https://www.damsafety.org/dam-failures#Learning%20from%20the%20Past (last visited Sep. 21, 2022).
[155] *Id.*
[156] *Id.*
[157] *See* Shugerman, *supra* note 16, at 356.
[158] Woodruff v. N. Bloomfield Gravel Mining Co., 18 F. 753, 797 (C.C.D. Cal. 1884).
[159] Ass'n State Dam Safety Offs., *supra* note 154.
[160] *Id.*
[161] *See* Shugerman, *supra* note 16, at 358.
[162] *Id.*
[163] *Id.* at 359.
[164] *Id.* at 360.
[165] *Id.* at 361.
[166] *Id.*
[167] *Id.*

Two major consequences of these dam failures were the momentum for strict liability imposition by courts and the first wave of state dam safety legislation, enacted primarily in western states.[168] The California Supreme Court adopted *Rylands* in 1886.[169] It was preceded by Michigan[170] by two years and Nevada[171] by one year, and was later followed by Colorado.[172] Many more states eventually did adopt *Rylands*, but it was never unanimously adopted.[173] In the 1930s, when work started on the Restatement of Torts, only roughly half of American jurisdictions had adopted some version of *Rylands*.[174]

4. The First Restatement

The Restatement addressed strict liability in Sections 519 and 520,[175] reproduced below with certain key terms emphasized.

> § 519. MISCARRIAGE OF ULTRAHAZARDOUS ACTIVITIES CAREFULLY CARRIED ON. Except as stated in §§ 521-4, one who carries on an ultrahazardous activity is liable to another whose person, land or chattels the actor should recognize as *likely to be harmed* by the *unpreventable* miscarriage of the activity for harm resulting thereto from that which makes the activity ultrahazardous, although *the utmost care is exercised* to prevent the harm.
>
> § 520. DEFINITION OF ULTRAHAZARDOUS ACTIVITY. An activity is ultrahazardous if it (a) necessarily involves a risk of serious harm to the person, land or chattels of others which *cannot be eliminated by the exercise of the utmost care*, and (b) is not a matter of *common usage*.

There are a few key concepts in Sections 519 and 520 that are worth discussing. First, strict liability in the Restatement (First) of Torts required

168 *See, e.g.*, Cal. Dep't Water Res., *History of California Dam Safety*, CAL. DEPT. OF WATER RES., https://water.ca.gov/Programs/All-Programs/Division-of-Safety-of-Dams/History (last visited Sep. 22, 2022).

169 Colton v. Onderdonk, 10 P. 395 (Cal. 1886).

170 Boyd v. Conklin, 20 N.W. 595 (Mich. 1884).

171 Boynton v. Longley, 6 P. 437 (Nev. 1885).

172 Sylvester v. Jerome, 34 P. 760 (Colo. 1893).

173 *See* Shugerman, *supra* note 16, at 335.

174 PROSSER, *supra* note 147, at 152.

175 RESTATEMENT OF TORTS §§ 519–20 (AM. L. INST. 1938).

that the activity be "ultrahazardous."[176] To be ultrahazardous, an activity must have an inherent risk of serious harm.[177] Additionally, the risk cannot be eliminated even with the "utmost care."[178] These requirements fly in the face of proper understanding of risk. The real world is probabilistic, not deterministic. Outside of the realm of certain branches of mathematics, there is always a probability of a given event occurring, even if very small. Thus, the use of the verb "eliminate" is a fundamental problem with this definition. Further, according to the definition, an ultrahazardous activity is not one of "common usage,"[179] a term that is also open to interpretation. For example, does this require everyone to directly engage in the activity or is it sufficient for the activity to be part of the life of most people, even if they do not directly engage in it?

Section 519 requires an element of foreseeability if one is to be held liable for a harm.[180] If the harm to the plaintiffs is a foreseeable consequence of the activity, then the defendant is liable for it, regardless of how much care the defendant put into its prevention.[181]

The Restatement went beyond *Rylands* in at least two important ways.[182] First, it did not require "nonnatural" use of the land.[183] It does not even mention the word "land." Instead, it uses a notion of "common usage"[184] that does not equate to the *Rylands* holding. Second, the *Rylands* case, at least in its fact pattern, is restricted to the impact of the activity on neighboring lands.[185] No such constraint exists in Sections 519 and 520.[186] The concepts of strict enterprise liability and loss spreading appear to have influenced the drafters, and this may have been the reason for the broadening of the scope of application of strict liability in the Restatement.[187] The idea of strict enterprise liability is basically that one should not suffer harm caused by an activity in which another engaged for profit, whereas that of loss spreading is that one should not be harmed by an activity for the benefit of the many.[188] Both ideas are meritorious, but too much emphasis may have been placed on "restating" the law to accommodate them.

On the other hand, the Restatement required an activity to be

176 RESTATEMENT OF TORTS § 519 (AM. L. INST. 1938).
177 RESTATEMENT OF TORTS § 520 (AM. L. INST. 1938).
178 *Id.*
179 *Id.*
180 RESTATEMENT OF TORTS § 519 (AM. L. INST. 1938).
181 *Id.*
182 Boston, *supra* note 2, at 605.
183 *Id.*
184 *Id.*
185 *Id.*
186 *Id.*
187 *Id.* at 608.
188 *Id.*

ultrahazardous to apply strict liability.[189] This is not what *Rylands* required.[190] The *Rylands* holding was quite focused. Building a reservoir is not ultrahazardous, but building it where one should not, where it is *nonnatural* to do so, is.[191] This is yet another difference between the *Rylands* holding and strict liability as stated in the Restatement.

5. Restatement (Second) of Torts

The First Restatement's formulation of strict liability was somewhat controversial, particularly in its divergence from the *Rylands* holding.[192] Consequently, the formulation was considerably revised in the Second Restatement.[193] It is noteworthy that the Restatement (Third) of Torts maintains the formulation of the Second Restatement, despite the residual deficiencies in it.[194]

The revised Sections 519 and 520 of the Restatement,[195] with emphasis on certain terms, read as follows:

> § 519 General Principle. (1) One who carries on an *abnormally dangerous activity* is subject to liability for harm to the person, land or chattels of another resulting from the activity, although he has exercised the *utmost care* to prevent the harm. (2) This strict liability is limited to the kind of harm, the possibility of which makes the activity abnormally dangerous.
>
> § 520 Abnormally Dangerous Activities. In determining whether an activity is abnormally dangerous, the following factors are to be considered: (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)

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189 RESTATEMENT OF TORTS § 519 (AM. L. INST. 1938).

190 Rylands v. Fletcher, L.R. 3 H.L. 300 (1868).

191 *Rylands*, L.R. 3 H.L. 300 (holding that one should not bring something upon his land that would be dangerous if it escapes, which directly applies to building a reservoir on land if, as a result of the bursting of the reservoir, the escape of the water caused damage to neighbors or to neighboring land or property).

192 *See generally* Boston, *supra* note 2, at 601–27.

193 RESTATEMENT (SECOND) OF TORTS §§ 519–20 (AM. L. INST. 1977).

194 *Id.*

195 *Id.*

> *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.

The wording of Sections 519 and 520 still leaves something to be desired. Some of the terms used left room for interpretation, which has not always been consistent from the courts. Section 519(2) retained foreseeability of the risk from the first Restatement in its definition of risks falling within the scope of liability.[196]

The fundamental concept justifying application of the strict liability doctrine according to the Second Restatement is that of an "abnormally dangerous activity."[197] Such an activity, Section 519 explains, leaves even a party who exerted the "utmost care" exposed to liability.[198] Utmost care conveys the idea of doing as much as one can do, short of abandoning the activity, to prevent the undesired outcome. In the words of one court, "utmost care" is "the highest degree of care and skill which may be known to be useable [sic] in the circumstances."[199] However–and this is the central point of strict liability–meeting this maximum level of care would not protect the party from liability.[200] Section 520 explains why not: because an acceptable risk level would not result from the exertion of that maximum amount of care.[201] In other words, holding the defendant to a standard of care does not make sense, because no amount of care would make the risk acceptable to society. This idea is at the core of the rationale for the use of strict liability.

The court in *Indiana Harbor Belt Railroad Co.* explains this point by referring to a case resulting from the unintentional landing of a hot-air balloon in a vegetable garden in New York City where a crowd had gathered.[202] The crowd trampled the vegetables in the garden, and the owner of the garden successfully sued the balloonist.[203] The *Indiana Harbor* court notes: "Yet the balloonist had not been careless. In the then state of ballooning it was impossible to make a pinpoint landing . . . such accidents could not be prevented by the exercise of due care; the technology of care in ballooning was insufficiently developed."[204] The court then analyzed the incentive provided by the use of the strict liability doctrine that is not provided by the negligence doctrine: an incentive to cease the activity

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196 RESTATEMENT (SECOND) OF TORTS § 519 (AM. L. INST. 1977).
197 *Id.*
198 *Id.*
199 Clark's Adm'r v. Ky. Util. Co., 158 S.W.2d 134, 137 (Ky. 1942).
200 RESTATEMENT (SECOND) OF TORTS § 519 (AM. L. INST. 1977).
201 RESTATEMENT (SECOND) OF TORTS § 520 (AM. L. INST. 1977).
202 Ind. Harbor Belt R.R. Co. v. Am. Cyanamid Co., 916 F.2d 1174, 1176-77 (7th Cir. 1990) (citing Guille v. Swan, 19 Johns. 381 (N.Y. 1822)).
203 *Id.* at 1177.
204 *Id.*

altogether or move it to another, more natural location for it.[205]

Moving the activity to another location is not usually possible in the case of dams, because dams need to be sited where the specific purpose for their construction is to be achieved, such as supplying water to a given community or retaining the mining tailings from a mining operation; additionally, engineering requirements may also limit relocation of a dam. However, abandonment or relocation of the abnormally dangerous activity is not the only way in which the strict liability doctrine can incentivize a better outcome. In engineering activities, it is possible to go beyond the "standard of care," which is the level of care that is "*customarily* exercised by similarly competent or experienced engineers in performing professional engineering services under similar circumstances."[206] The key word in this particular definition of the standard of care is "customarily." An engineer "customarily" applies the knowledge corresponding to the "state of practice" in his community, which is usually the knowledge that is available and is adopted by other engineers in the same community, as discussed previously. One can decide to operate instead at the "state of the art," which is the knowledge that is available more broadly, as from recent research in the field that has not yet found its way into practice. As a court in a case involving manufacturing defined it, "[t]he term 'state of the art' is defined as the *best* technology reasonably feasible at the time the product was designed [and] manufactured[.]"[207] Even the state of the art is not necessarily a ceiling to the standard of care, because a corporate owner of an expensive structure may very well fund research to clarify open questions even as the structure is being designed and constructed, thereby expanding state-of-the-art knowledge. Although this heightened level of care does not legally protect the defendant from liability, because it never brings the risk down to a level accepted by society, it will still lower the probability of failure and all its consequences, which is a desirable policy goal. It is also a worthwhile goal for the dam owner to pursue because it reduces the chances of a disaster at a still manageable cost.

Therefore, even if relocation is not possible, strict liability theory provides an incentive to perform the activity—design or maintain a dam, for example—at a heightened standard of care. Such an incentive would not be present if negligence theory were applied, because, in that case, meeting a minimum standard of care would be sufficient for a defendant to evade

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[205] *Id.*

[206] John A. Dal Pino & Kirk Haverland, *Do You Know the Standard of Care?*, STRUCTURE MAGAZINE (Dec. 2016), https://www.structuremag.org/wp-content/uploads/2016/11/D-BusPract-Dalpino-Dec16-1.pdf (emphasis added).

[207] Bourke v. Ford Motor Co., No. 2:03-CV-136, 2007 WL 704127, at *1 (N.D. Ind. Mar. 5, 2007) (emphasis added).

liability.[208] Strict liability in this case would implicitly, but not explicitly, provide an incentive for practice at a heightened level of care.

Section 520 then tells us that there are six factors to consider in determining whether an activity is abnormally dangerous.[209] The first factor —factor (a)—is a "high degree of risk" associated with the activity.[210] Courts have interpreted this to mean that there is a high probability of the contemplated harm occurring if the activity is undertaken.[211] The second factor—factor (b)—is that there is a likelihood that "great harm" will result from the activity if it is undertaken and miscarried.[212] These two factors, together, constitute what we usually define as "risk."[213] Risk is a combination—in fact, the product–of the probability of an undesirable event happening and the damages resulting from that event.[214] Therefore, these two factors should be taken together. An analysis of court decisions show that courts tend to use judicial notice of community knowledge to analyze factors (a) and (b), instead of detailed analyses of evidence.[215]

The third factor—factor (c)—is the inability to eliminate the risk with the exercise of reasonable care.[216] This factor cannot be read literally. This wording was retained from the Restatement (First) of Torts, according to which a negligence test cannot be used if no amount of care would have been sufficient to "eliminate the risk" from the activity.[217] The same misapplication of the concept of risk present in the First Restatement remains: risk can never be eliminated, so risk "elimination" would have to be construed as reduction of the overall risk to a tolerable level.[218] This is indeed how courts have construed the provision.[219]

The fourth factor—factor (d)—is that the abnormally dangerous activity is not of "common usage," a concept also retained from the first Restatement,[220] but now presented as a factor instead of a required element.[221] As before, it is unclear whether this term requires everyone to directly engage in the activity or whether it is meant in the sense that the activity touches on and connects with people's daily lives. An analysis of court decisions does

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[208] RESTATEMENT (SECOND) OF TORTS § 285 cmt. a(3) (AM. L. INST. 1965).
[209] RESTATEMENT (SECOND) OF TORTS § 520 (AM. L. INST. 1977).
[210] RESTATEMENT (SECOND) OF TORTS § 520(a) (AM. L. INST. 1977).
[211] Boston, *supra* note 2, at 655.
[212] RESTATEMENT (SECOND) OF TORTS) § 520(b) (AM. L. INST. 1977).
[213] *See* discussion *infra* Section III(A)(1).
[214] *Id.*
[215] Boston, *supra* note 2, at 659.
[216] RESTATEMENT (SECOND) OF TORTS) § 520(c) (AM. L. INST. 1977).
[217] RESTATEMENT OF TORTS § 520(a) (AM. L. INST. 1938).
[218] *See generally* Boston, *supra* note 2, at 640.
[219] *Id.* at 600.
[220] RESTATEMENT OF TORTS § 519 (AM. L. INST. 1938).
[221] RESTATEMENT (SECOND) OF TORTS § 520(d) (AM. L. INST. 1977).

not find this factor to be determinative.[222]

The fifth factor**,** factor (e), restores to the doctrine of strict liability the part of the *Rylands* holding that was left out of the First Restatement: the nonnatural fit of the activity to the location or land where it takes place.[223] The last factor, factor (f), however, requires consideration of the utility of the activity to the community.[224] This last factor was not part of the *Rylands* decision.[225] Reservoir building would certainly be considered a useful activity, but there was no mention of that one way or another in that decision.[226] It is difficult for a court to find that an activity that has a high risk of harm that "cannot be eliminated" even with the "utmost care" is not abnormally dangerous because it is useful to the community. The reason for that is simple: the vast majority of activities engaged in for commercial purpose or as a direct service to the community are inherently useful.[227] A possible key two words in this factor are "to the community" in which the activity takes place. Which community? A last point regarding this last factor is that this sort of cost versus benefit analysis is found more commonly in negligence determination.[228]

6. Application of the Strict Liability Test of the Restatement (Second) of Torts

Having discussed the weaknesses of Sections 519 and 520, this article now turns to how they have been applied by courts generally. Many courts have found factor 520(c) to be determinative.[229] A few illustrations should suffice to stress the importance of this point. Crop dusting–the aerial application of pesticides and other products on crops–is one activity found by courts to be abnormally dangerous.[230] The nature of the activity is such that, once the offending product is released into the air, it will go where the winds take it, and no amount of care can control that.[231] In contrast,

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[222] Boston, *supra* note 2, at 659.
[223] RESTATEMENT (SECOND) OF TORTS § 520(e) (AM. L. INST. 1977).
[224] RESTATEMENT (SECOND) OF TORTS § 520(f) (AM. L. INST. 1977).
[225] Rylands v. Fletcher, L.R. 3 H.L. 330 (1868).
[226] *Id.*
[227] It is this author's observation that no one will build a dam for no economic purpose, and if there is an economic purpose, it will be of value to someone.
[228] U.S. v. Carroll Towing Co., 159 F.2d 169, 173 (2d Cir. 1947) (setting out the well-known "Hand Formula," in which the cost to do something that will reduce the risk of harm is compared with the benefit resulting from risk reduction).
[229] Boston, *supra* note 2, at 622.
[230] Langan v. Valicopters, Inc., 567 P.2d 218 (Wash. 1977) (en banc).
[231] *Id.*

transportation of a highly toxic chemical in railroad tank cars,[232] construction of a hydraulic landfill,[233] storage of contaminants in underground storage tanks (USTs),[234] the handling of sulfuric acid,[235] and the use of chlorine gas in water treatment or manufacturing of bleach[236] were all found not to be abnormally dangerous activities primarily because reasonable care could bring the probability of harm down to acceptable levels.

Factor (c) in Section 520 has often been treated by courts as a barrier to the application of strict liability.[237] If courts conclude that reasonable care can lower the risk from the high level required by factors (a) and (b) of Section 520 to acceptable levels, they tend not to apply strict liability, no matter what their reading of the other factors is.[238]What an acceptable probability of harm is does not appear to have been discussed by courts.[239] Supposedly, courts will resort to judicial notice of a community's general expectations to make the judgment of what probability of the harm occurring is acceptably small.

Factor (e) of Section 520 can have an impact on the determination of applicability of strict liability. An example is again blasting.[240] Courts have found blasting to be appropriate to the location in rural areas or in areas isolated from any potential recipients of damage.[241] However, the drafting of Section 520 is far from perfect here. It is not so much a matter of where the activity is performed, but of whether, where performed, it represents a risk of serious harm. That is captured by factors (a) and (b), suggesting that incorporation of location in the definition of the activity would probably be sufficient, eliminating the need for factor (e).

Sometimes courts bring into the analysis factors that are not part of the Restatement formulation. As discussed in greater detail later, the existence of safety laws targeting an activity or regulation of an activity has tended to be interpreted by courts as allowing the inference that compliance with these laws or regulations will bring the risk of harm down to an acceptable level, thus precluding application of strict liability.[242] Another component to consider is the progress in science and engineering that has happened since many of these opinions have been written. Blasting is a good example of an engineering application to which strict liability has traditionally been

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232 Ind. Harbor Belt R.R. Co. v. Am. Cyanamid Co., 916 F.2d 1174 (7th Cir. 1990).
233 Doundoulakis v. Town of Hempstead, 368 N.E.2d 24 (N.Y. 1977).
234 Grube v. Daun, 570 N.W.2d 851, 857 (Wis. 1997).
235 Edwards v. Post Transp. Co., 228 Cal. App. 3d 980 (Cal. Dist. Ct. App. 1991).
236 Erbrich Prods. Co. v. Wills, 509 N.E.2d 850 (Ind. Ct. App. 1987).
237 Boston, *supra* note 2, at 601.
238 *Id.*
239 *See generally supra* notes 232–36.
240 Boston, *supra* note 2, at 668.
241 *Id.* at 661.
242 *Id.* at 214.

applied.[243] Stark argues that engineers' understanding of blasting allows them to control risk by exerting the appropriate level of care, and that negligence theory should apply to it.[244]

Emphasizing another consideration that is not explicitly part of Sections 519 and 520, in *Siegler v. Kuhlman*, the court favored strict liability because of the impossibility of proving negligence.[245] In that case, a tanker was transporting 5,000 gallons of gasoline over a crowded highway, an activity that the court determined to be abnormally dangerous.[246] The tanker exploded, destroying all evidence and, in the court's view, any opportunity to prove negligence.[247] This view does not fit neatly into factor (c), which refers to the ineffectiveness of higher levels of care in reducing risk to tolerable levels, nor to any evidentiary aspects of establishing negligence. Other courts have rejected the *Siegler* court's view, instead requiring a degree of care commensurate with the danger involved in the activity[248] and offering *res ipsa loquitur* as a viable path in such situations.[249]

The *res ipsa loquitur* doctrine stems from the seminal *Byrne v. Boadle* case, in which a barrel of flour fell upon the plaintiff's head. The court allowed recovery without direct proof of the barrel's point of origin because it could have come only from Boadle's shop.[250] According to the *res ipsa loquitur* doctrine, for fact patterns like that of *Boadle,* there is a rebuttable presumption of negligence on the part of the defendant.[251] The courts rejecting *Siegler* take the view that negligence can be presumed in such cases, following *res ipsa loquitur,* placing the burden on the defendant to rebut.[252] In applying the *res ipsa loquitur* doctrine when a dam failed, the court in *City Water Power Co. v. City of Fergus Falls* explained why the doctrine was necessary:

> The dam, its construction, and its maintenance were within the exclusive possession and control of the defendant or its agents. Dams constructed and maintained with the care required by law do not in the ordinary course of things break by the pressure of the water held back by them. The very purpose of constructing them is

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[243] RESTATEMENT (SECOND) OF TORTS § 519(2), cmt. e. (AM. L. INST. 1977).
[244] Timothy D. Stark, *Is Construction Blasting Still Abnormally Dangerous?*, 2 J. LEG. AFFAIRS & DISPUTE RESOLUTION ENG'G CONSTR. 208, 208 (2010).
[245] Siegler v. Kuhlman, 502 P.2d 1181 (Wash. 1972) (en banc).
[246] *Id.* at 1185.
[247] *Id.*
[248] Foster v. City of Keyser, 501 S.E.2d 165, 175 (W. Va. 1997).
[249] Mahowald v. Minn. Gas Co., 344 N.W.2d 856, 864 (Minn. 1984).
[250] Byrne v. Boadle, 159 E.R. 299 (Exch. 1863).
[251] RESTATEMENT (SECOND) OF TORTS § 328D (AM. L. INST. 1965)
[252] *See* Boston, *supra* note 2, at 647–49.

> to impound water of the stream . . . It would be, from the very nature of this case, a great hardship, if not an impossibility, for the plaintiff to affirmatively allege and prove the particular negligence in the construction and maintenance of the dam; but, on the other hand, the defendant knows presumably just how it was constructed and maintained.[253]

II. DAMS AND TAILINGS DAMS

This section discusses what dams are, how they are constructed, and how they can fail before reviewing the current state of the law regarding dam failures. This discussion is essential for the later application of the strict liability test set out by Sections 519 and 520 of the Restatement[254] to activities related to dam construction and operation in Section III.

A. Traditional Dams Used to Retain Water

Dams have been used to store water since the beginning of civilization.[255] Water storage is done for public use, for hydropower generation, for irrigation, or for flow control.[256] Dams can be built in many ways.[257] Depending on the source of stability for the dam, dams may be classified generally as gravity dams, arch dams, or buttress dams, with several variants of each possible.[258] Gravity dams, which today are often embankment dams, rely on their own weight for stability: the pressure of the reservoir water on their upstream side is resisted by the dam's self-weight.[259] Embankment dams are built from a combination of clay, silt, sand, gravel, and rock fill.[260] Arch dams are reinforced concrete dams that transfer the loading received from the water to the dam's rock abutments.[261] Buttress dams, also built today of reinforced concrete, have structural elements on the downstream side of the

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253 City Water Power Co. v. City of Fergus Falls, 128 N.W. 817, 818–19 (Minn. 1910).
254 RESTATEMENT (SECOND) OF TORTS §§ 519-20 (AM. L. INST. 1977).
255 A. TREVOR HODGE, HANDBOOK OF ANCIENT WATER TECHNOLOGY 331 (Orjan Wikander ed. 2000).
256 Ass'n State Dam Safety Offs., *Dams 101*, ASDSO, https://damsafety.org/dams101.
257 *Id.*
258 *Id.*
259 *Id.*
260 FELL, *supra* note 61, at 2–6.
261 *Id.* at 6–9.

dam responsible for the reaction necessary to sustain the load applied on the dam by the reservoir.[262]

Embankment dams are the most common type of dam.[263] These dams are built in the same general way as embankments for roadways: by adding layers of compacted soil or broken rock, one on top of the other, until a target height is reached.[264] Pervious and relatively impervious materials may be combined in specific ways to redirect or prevent water flow and to prevent detrimental water pressure buildup within the dam.[265]

B. Tailings Dams

Tailings dams have been used in the mining industry for roughly two centuries.[266] Mining is notorious for its low yield, with the rate of waste in mining for gold, as an example, reported as twenty tons of waste for every gold ring produced.[267] This waste—referred to as tailings, slimes, tails, refuse, process residue, leach residue, or slickens—usually washes down the mines, coming to rest behind the dam.[268] The waste is, in essence, a slurry: solids or chemicals suspended or dissolved in large volumes of water.[269] Tailings dams therefore hold in their reservoir not just water, but water with the mine tailings suspended and soluble chemicals dissolved in it.[270]

Tailings dams are essentially embankment dams.[271] They are built by the same process of adding layers of compacted soil on top of each other until a desired height is achieved.[272] Thus, from a purely functional point of view, tailings dams are no different from embankment dams.[273] However, in a significant contrast with traditional embankment dams, tailings dams incorporate the tailings themselves.[274] This adds a variability in the material mechanical properties that is not present in traditional embankment dams. Another important distinction between tailings dams and traditional dams is

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262 *Id.*
263 Ass'n State Dam Safety Offs., *supra* note 256.
264 FELL, *supra* note 61, at 2–6.
265 *See generally* FELL, *supra* note 61.
266 Moira Warburton et al., *The Looming Risk of Tailings Dams*, REUTERS GRAPHICS (Jan. 3, 2020), https://graphics.reuters.com/MINING-TAILINGS1/0100B4S72K1/index.html.
267 Earthworks, *Environmental Impacts of Gold Mining*, EARTHWORKS, https://earthworks.org/issues/environmental-impacts-of-gold-mining/ (last visited Oct. 29, 2022).
268 FELL, *supra* note 61, at 1075.
269 *Id.*
270 Earthworks, *Tailings*, EARTHWORKS, https://earthworks.org/issues/tailings/ (last visited Oct. 29, 2022).
271 FELL, *supra* note 61, at 1075.
272 *Id.*
273 *Id.*
274 *Id.*

that they do not have a predefined height.[275] The dam is built up as the mining operations continue and more tailings accumulate behind it.[276]

There are three different ways of increasing the height of the dam: the downstream, the upstream, and the centerline methods.[277] In the downstream method, the dam is expanded in the direction away from the tailings pond (here, the "reservoir").[278] In the centerline method, the dam is expanded vertically up, with no change in the location of its axis.[279] In the riskiest of the three methods, the upstream method, the dam is expanded in the direction of the reservoir; that is, new dam sections are built on top of the retained tailings in the reservoir.[280] This is possible because tailings reservoirs, as coal ash ponds, can develop some stiffness, although this stiffness and its distribution across the reservoir can be unreliable over time.[281]

A final important difference between tailings dams and traditional dams is that decommissioning of a tailings dam is a much longer process.[282] Because they hold very harmful materials, they must still be maintained safe after mining operations have ceased, because there is no other place to which to take the tailings.[283] In traditional dams, in contrast, anything, in theory, could be done, including emptying the reservoir and blowing up the dam.[284]

C. Design Considerations

Regardless of the type of dam involved, the stability design problem is fundamentally one of statics: is there enough resistance provided by self-weight, rock abutments, or the ground upon which the dam rests to withstand the pressures exerted on the dam by the reservoir water or sludge?[285] Another

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275 U.S. ENV'T PROT. AGENCY, DESIGN AND EVALUATION OF TAILINGS DAMS 6 (1994), https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=2000EF89.TXT.

276 *Id.*

277 FELL, *supra* note 61, at 1075.

278 *Id.* at 1102–04.

279 *Id.* at 1104–06.

280 *Id.* at 1101–02.

281 MUHAMAD AUCHAR ZARDARI, STABILITY OF TAILINGS DAMS: FOCUS ON NUMERICAL MODELLING 1–2 (2011), https://www.diva-portal.org/smash/get/diva2:991436/FULLTEXT01.pdf.

282 Okane Consultants, *Reclassification and Decommissioning of Tailings Storage Facilities*, OKANE (July 14, 2021), https://www.okc-sk.com/reclassification-and-decommissioning-of-tailings-storage-facilities/; F.A. BAKER & D.S. BERTHELOT, LONG-TERM MANAGEMENT OF TAILINGS AND TAILINGS DAMS AT DECOMMISSIONED MINING PROPERTIES, https://open.library.ubc.ca/media/download/pdf/59367/1.0042343/1.

283 BAKER & BERTHELOT, *supra* note 282.

284 *See generally* U.S. SOC'Y ON DAMS, GUIDELINES FOR DAM DECOMMISSION PROJECTS (2015), https://www.ussdams.org/wp-content/uploads/2016/05/15Decommissioning.pdf.

285 *See generally* U.S. ARMY CORPS ENG'RS, EARTH AND ROCK-FILL DAMS–GENERAL DESIGN AND CONSTRUCTION CONSIDERATIONS (1994), https://apps.dtic.mil/sti/pdfs/ADA402893.pdf.

important consideration is whether the dam and its foundation will be sufficiently impervious to water.[286] A third important consideration regards the height of the dam and its ability to handle a peak water precipitation event.[287] The design of spillways must be such that enough water can be released from the reservoir during severe flood conditions to prevent overtopping of the dam.[288] Overtopping, in embankment dams, is fatal to dam stability because the water flowing over the dam will tend to erode the top and downstream face of the dam.[289] However, if the flow in the river downstream of the dam becomes excessive, that will also lead to potentially catastrophic conditions.[290] All of these considerations must inform the design of these structures.

Although there are many other details in dam design that are crucial to the safe operation of the dam, the focus of this article is on catastrophic dam failures. These failures are usually of one of two types: (1) loss of stability of the dam under the action of the reservoir water or (2) a rapid increase in downstream flow such that it substantially exceeds what the natural flow of the dammed river would have been without the dam, even if the dam itself remains structurally sound.[291]

D. Failures

A dam or tailings dam may fail in more than one way.[292] The most important failure mechanisms are foundation failures (in which the foundation soil fails to sustain the weight of the dam without excessive settlement), overtopping (in which reservoir water flows over the top of the dam), piping (in which water flows through an embankment dam, carrying the soil of which the dam is made with it and leading to gradual disintegration and, towards the end, sudden failure of the dam), and slope failures (in which a part of the dam slides away from the rest of the dam.[293] Overtopping, if it leads to a massive flood, is a failure of the dam in the context of this article, even if the dam does not fail structurally.[294] However, embankment dams are

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[286] *Id.*
[287] *Id.*
[288] *See* Fed. Emergency Mgmt. Agency, *supra* note 64, at 5, 20.
[289] *Id.* at 19.
[290] *Id.*
[291] For this second mode of failure, see Binder, *supra* note 19, at 20.
[292] *See* Su-Chin Chen et al., *Modeling of Natural Dam Failure Modes and Downstream Riverbed Morphological Changes with Different Dam Materials in a Flume Test*, 188 ENG'G GEOLOGY 148 (2015).
[293] *Id.* at 149.
[294] U.S. DEP'T INT. BUREAU RECLAMATION & U.S. ARMY CORPS ENG'RS, BEST PRACTICES IN DAM AND LEVEE SAFETY RISK ANALYSIS § D-3, https://damfailures.org/wp-content/uploads/2019/11/Best-Practices-D-

vulnerable to overtopping and usually do fail if it occurs, because of erosion of the downstream face of the dam.[295]

Dam failures occur via several mechanisms. Overtopping due to inadequate spillway design, debris blockage of spillways, or settlement of the dam crest account for approximately 34% of all U.S. dam failures.[296] Approximately 30% of all dam failures are due to foundation movement and the resulting cracking of the dam.[297] Approximately 20% of U.S. dam failures have been caused by piping (internal erosion caused by seepage).[298] In the *Rylands* case, the dam failed to hold water in the reservoir.[299] A structure designed to retain water that does not do so obviously fails.[300] This type of failure usually means that the reservoir can never get filled, with water escaping continuously.[301] These failures, the atypical *Rylands* case aside, are usually not catastrophic because leaks in the reservoir take place continuously and gradually.[302]

The failures of concern in this article are those that lead to sudden release of large volumes of water or tailings sludge, usually caused by structural failure of the dam.[303] This sudden release of large volumes of water or sludge can cause catastrophic damage and loss of life downstream from the dam.[304] Examples of these types of failure include the Teton Dam in the United States[305] and the Córrego de Feijão, Brumadinho tailings dam in Brazil.[306] The Vajont dam, a dam in Italy that survives still, illustrates an overtopping failure in which the dam never failed structurally.[307] The failure in that case was of the designers to foresee that the reservoir would include unstable rock

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[295] FELL, *supra* note 61, at 1143.

[296] Ass'n State Dam Safety Offs., *supra* note 154.

[297] *Id.*

[298] *Id.*

[299] Rylands v. Fletcher, L.R. 3 H.L. 330 (1868).

[300] Energy Educ., *Dam failures*, UNIV. OF CALGARY, https://energyeducation.ca/encyclopedia/Dam_failures (last visited Oct. 29, 2022).

[301] *See* Dep't. of Primary Indus. & Reg'l Dev., *Treating Leaky Farm Dams in Western Australia*, GOV'T W. AUSTL., https://www.agric.wa.gov.au/water-management/treating-leaky-farm-dams-western-australia (last visited Oct. 29, 2022).

[302] *Id.*

[303] Binder, *supra* note 19, at 2.

[304] FED. EMERGENCY MGMT. AGENCY, CONDUITS THROUGH EMBANKMENT DAMS: BEST PRACTICES FOR DESIGN, CONSTRUCTION, PROBLEM IDENTIFICATION AND EVALUATION, INSPECTION, MAINTENANCE, RENOVATION, AND REPAIR iv (2005), https://www.swc.nd.gov/pdfs/conduits_embankment_dams.pdf.

[305] *Case Study: Teton Dam (Idaho, 1976)*, ASS'N STATE DAM SAFETY OFFS., https://damfailures.org/case-study/teton-dam-idaho-1976/ (last visited Oct. 29, 2022).

[306] Luiz Henrique Silva Rotta et al., *The 2019 Brumadinho Tailings Dam Collapse: Possible Cause and Impacts of the Worst Human and Environmental Disaster in Brazil*, 90 INT'L J. APPLIED EARTH OBSERVATION & GEOINFO. 1 (2020).

[307] Lee Mauney, *Case Study: Vajont Dam (Italy, 1963)*, ASS'N STATE DAM SAFETY OFFS., https://damfailures.org/case-study/vajont-dam-italy-1963/ (last visited Oct. 29, 2022).

slopes, the sliding failure of which would make the dam unsafe.[308] Indeed, on first filling of the reservoir, a large slide occurred that led to a significant wave, overtopping of the dam, and a disastrous flood.[309] These, and a few other examples of notable dam failures, are given in Table 1.

Table 1. Recent examples of significant dam failures.

Dam	Date	Type of Dam	Cause	Resulting Damage
Vajont Dam, Italy[310]	Oct. 9, 1963	Arch dam	No failure of the dam, but landslide within reservoir caused major flood downstream	2,056 lives Unknown damages
Buffalo Creek Valley, WV[311]	Feb. 26, 1972	Coal-waste impoundment	Possibly internal erosion or piping seepage	125 lives Approx. $50 million in damages
Canyon Lake Dam, Rapid City, SD[312]	June 9, 1972	Embankment	Overtopping	238 lives Approx. $160 million in damages
Teton Dam, ID[313]	June 5, 1976	Embankment	Piping	11 lives Approx. $400 million in damages
Laurel Run Dam, PA[314]	July 19–20, 1977	Embankment	Overtopping	40 lives Approx. $5.3 million in damages

308 *Id.*
309 *Id.*
310 *Id.*
311 Nathaniel Gee, *Case Study: Buffalo Creek Dam (West Virginia, 1972)*, ASS'N STATE DAM SAFETY OFFS., https://damfailures.org/case-study/buffalo-creek-dam-west-virginia-1972/ (last visited Oct. 29, 2022).
312 *Case Study: Canyon Lake Dam (South Dakota, 1972)*, ASS'N STATE DAM SAFETY OFFS., https://damfailures.org/case-study/canyon-lake-dam-south-dakota-1972/ (last visited Oct. 29, 2022).
313 *Supra* note 305.
314 *Case Study: Laurel Run Dam (Pennsylvania, 1977)*, ASS'N STATE DAM SAFETY OFFS., https://damfailures.org/case-study/laurel-run-dam-pennsylvania-1977/ (last visited Oct. 29, 2022).

Kelly Barnes Dam, Toccoa Falls, GA[315]	Nov. 6, 1977	Embankment	Unclear	39 lives Approx. $2.5 million in damages
Córrego de Feijão mine dam No. 1, Brumadinho, Brazil[316]	Jan. 25, 2019	Tailings dam (upstream type)	Still under investigation	At least 270 lives Approx. $7 billion in damages

E. Current State of the Law Regarding Dam Failures

The current state of the law regarding which theory—negligence or strict liability—to apply to dam failures is fluid. In some states, under some circumstances, strict liability applies.[317] For example, in *Clark-Aiken Co. v. Cromwell-Wright Co.*, the plaintiff brought an action in tort alleging negligence or strict liability to recover for damage caused by water released by a dam on the defendant's property.[318] The trial court rejected the count of strict liability, but the Supreme Court of Massachusetts reversed, stating that strict liability is the law of Massachusetts.[319] The opinion endorsed the Restatement (Second) of Torts articulation of what constitutes an abnormally dangerous activity, highlighting a comment in a draft of the Restatement regarding location as a factor that distinguished cases in which "large quantities of water are stored 'in [a] dangerous location in a city'" from those in which "water is collected in a rural area, with no particularly valuable property near."[320] Thus, according to the *Clark-Aiken* court, strict liability would be imposed in the failure of a reservoir located in the city, but not in the failure of one in a rural area. Although it did not explicitly state so, the fact that the decision refers to the Restatement (Second) of Torts in the

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315 Nathaniel Gee, *Case Study: Kelly Barnes Dam (Georgia, 1977)*, ASS'N STATE DAM SAFETY OFFS., https://damfailures.org/case-study/kelly-barnes-dam-georgia-1977/ (last visited Oct. 29, 2022).

316 Rotta et al., *supra* note 306; Manuela Andreoni & Letícia Casado, *Vale Mining Company to Pay $7 Billion in Compensation for Brazil Dam Collapse,* N.Y. TIMES (Feb. 4, 2021), https://www.nytimes.com/2021/02/04/world/americas/vale-brazil-dam-collapse-7-billion-compensation.html#:~:text=The%20dam%20burst%20destroyed%20almost,water%20to%20five%20different%20states.

317 *See generally* Shugerman, *supra* note 16.

318 Clark-Aiken Co. v. Cromwell-Wright Co., 323 N.E.2d 876, 877 (Mass. 1975).

319 *Id.* at 877–78.

320 *Id.* at 887.

context of a case about a dam clearly suggests that courts in the state consider the activity to be abnormally dangerous, at least in cases resembling *Clark-Aiken*.

In *Cities Service Co. v. State of Florida*, the breach of a mine dam holding a phosphate mining residue settling pond led to release of one billion gallons of phosphate slime, which traveled a long distance, causing significant damage even to properties distant from the dam.[321] The court performed a Section 520 analysis, concluding that the mining of phosphate was an abnormally dangerous activity.[322] The court held that "[i]t is too much to ask an innocent neighbor to bear the burden thrust upon him as a consequence of an abnormal use of the land next door."[323] Weighing heavily on the court's decision was the nature of the material being impounded:

> This is not clear water which is being impounded. Here, Cities Service introduced water into its mining operation which when combined with phosphatic wastes produced a phosphatic slime which had a high potential for damage to the environment. If a break occurred, it was to be expected that extensive damage would be visited upon property many miles away . . . [T]he Cities Service slime reservoir constituted a non-natural use of the land such as to invoke the doctrine of strict liability.[324]

This holding is certainly applicable to tailings dams and to any reservoir holding harmful substances, but it is unclear whether it would apply to dams holding water.

In *Tennessee Electric Power Co. v Robinson*, the court stated that one who interfered with the natural current of the stream was absolutely liable, without any question of negligence, for damages caused to one who is entitled to have the river flowing in its natural state.[325] This holding directly conflicts with the holding in *Barnum v. Handschiegel*, in which the Nebraska court considered dams for energy generation, holding that the owner of a dam erected across a natural stream for the purpose of raising water for irrigation, power, or other useful purposes was liable only for negligent construction or maintenance if it fails.[326]

Courts in New Mexico do not favor the use of strict liability for dams. The Supreme Court of New Mexico affirmed reversal by the appellate court

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321 Cities Service Co. v. State of Fla., 312 So.2d 799, 800 (Fla. App. 1975).
322 *Id.* at 803.
323 *Id.* at 801.
324 *Id.* at 803.
325 Tenn. Elec. Power Co. v. Robinson, 8 Tenn. App. 396, 398 (1928).
326 Barnum v. Handschiegel, 173 N.W. 593, 594 (Neb. 1919).

of a decision imposing strict liability on the owner of a dam.[327] Texas also rejected strict liability involving the outflow of salt water from ponds storing runoff from oil wells when levees and dams failed.[328] The Texas Supreme Court reasoned that there was no alternative technology that could be used and that it did not want to hinder the oil industry.[329]

In *Bowling v. Town of Oxford*, the court held that liability required negligence in the construction or maintenance of the dam.[330] In *Kunz v. Utah Power & Light Co.*, the court added operation of the dam to construction and maintenance as activities for which liability could be found only based on negligence.[331] A holding restricting causes of action in the case of dams to negligence is also found in *Moulton v. Groveland Paper Co.*[332]

Statutes may play a role in whether negligence or strict liability theory applies, even if few states have well-developed dam safety statutes.[333] Whether a Colorado statute expressly imposed strict liability on dam owners was questioned in a dam breach case, *Beaver Water & Irrig. Co. v. Emerson*.[334] The statute provided that, "the owners of the reservoirs shall be liable for all damages arising from leakage or overflow of the waters therefrom or by floods caused by the breaking of the embankments of such reservoirs."[335] The *Beaver* court interpreted the statute as imposing strict liability on the defendant, even though the defendant was not found negligent, and even though failure of a dam above that of the defendant, owned by third parties, had probably caused the flood that, in turn, led the defendant's dam to fail.[336] In the court's view, if the statute did not make him liable, then the statute was pointless.[337] The court argued that everybody is liable for his own negligence at common law, and that the only thing that the statute could do that would go beyond that was to establish liability regardless of negligence, i.e., to make the actor strictly liable.[338]

In contrast, a New Hampshire statute made it unlawful to have a "dam in disrepair."[339] The New Hampshire Supreme Court did not interpret this statute as imposing strict liability in *Moulton v. Groveton Papers, Co.*: "We are of the opinion and hold that RSA 482.42 provides a standard of conduct

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327 Gutierrez v. Rio Rancho Estates, Inc., 605 P.2d 1154 (N.M. 1980).
328 Turner v. Big Lake Oil Co., 96 S.W.2d 221, 221–22 (Tex. 1936).
329 *Id.* at 226.
330 Bowling v. Town of Oxford, 148 S.E.2d 624, 628 (N.C. 1966).
331 Kunz v. Utah Power & Light Co., 792 P.2d 926, 929 (Idaho 1990).
332 Moulton v. Groveton Papers Co., 289 A.2d 68, 72 (N.H. 1972).
333 *See* Denis Binder, *Dam Safety: The Critical Imperative*, 14 LAND & WATER L. REV. 341 (1979).
334 Beaver Water & Irrigation. Co. v Emerson, 75 Colo. 513, 514 (1924) (interpreting C.L. § 1684).
335 *Id.*
336 *Id.*
337 *Id.*
338 *Id.*
339 *Moulton*, 289 A.2d at 70 (discussing RSA 482).

on the part of dam owners intended to protect against damage from the flooding of the land of others by their dams."[340] One way to understand this interpretation is that dam safety statutes that prescribe procedures that dam owners or operators must follow provide defendants with the defense that they followed those procedures strictly and are therefore not negligent. The rationale is that the existence of such statutes allows the inference that risk can be controlled by following certain procedures and by taking certain precautions, and therefore strict liability does not apply. This is the view taken by the *Moulton* court in holding that an action for damages based on a violation of the statutory duty imposed on the defendants to repair, operate, maintain, and control their dam so that it did not become a dam in disrepair could be maintained and that such action did not seek recovery on the basis of absolute or strict liability.[341] According to the court, a violation of a statutory standard of conduct causing the harm is legal fault in the same way a violation of a common-law standard of due care is.[342]

Given the relatively few cases involving significant dam failures, particularly in recent years, there is not complete clarity on what the law is in all 50 states. An examination of the theoretical requirements for application of strict liability laid out by the Restatement can therefore be useful in guiding future court decisions.

III. NEGLIGENCE OR STRICT LIABILITY? APPLICATION OF THE RESTATEMENT (SECOND) OF TORTS TO DAMS, LEVEES, AND TAILINGS DAMS

This section applies the Second Restatement test of Sections 519[343] and 520[344] to the engineering, construction, and operation of dams. The test involves first applying the six different factors of Section 520 to these activities and determining if they are "abnormally dangerous."[345] If they are, then Section 519 determines that strict liability, not negligence, applies.[346] The analysis distinguishes water dams from tailings dams, but much of what applies to water dams applies to levees, structures which are functionally similar. This section ends with a conclusion regarding which doctrine is most appropriate for each of these two types of dams.

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340 *Id.* at 70–71.
341 *Id.* at 72.
342 *Id.* at 71.
343 RESTATEMENT (SECOND) OF TORTS § 519 (AM. L. INST 1977).
344 RESTATEMENT (SECOND) OF TORTS § 520 (AM. L. INST 1977).
345 RESTATEMENT (SECOND) OF TORTS § 519 (AM. L. INST 1977).
346 *Id.*

A. Risk of Failure of a Dam

1. Risk

Risk, as it is understood in the disciplines to which its quantification is essential, such as decision analysis, is the probability of an undesired event multiplied by the monetary consequences of that event.[347] This measure of risk (or its flipside: gain or utility associated with some probability) can be assigned to the various alternatives available to a decision maker, allowing an objective selection of one over the others.[348] The way this is done is to assign probabilities and financial or utility values to each possible outcome of each possible alternative.[349] Then, the expected value of each alternative is calculated as the sum of the products of the probabilities of the outcomes by their respective financial or utility outcomes.[350] In most practical situations, a rational decision maker will choose the path leading to the highest expected value of utility. If the outcomes are expressed in terms of a profit or return, with losses expressed as negative numbers, then the goal is to maximize profits or minimize losses.

The same analysis is implicit in engineering design. Any structure can be made safer by spending more in materials and time; that is balanced against spending less, but having a higher probability of a costly outcome. For any dam, there is a probability of successful and safe performance over the useful life of the dam and a probability that it will fail, and these can be tied to design decisions.[351] If the dam fails, there may be damage to real estate and chattels downstream and even possibly loss of life.[352] Although juries might, understandably, be upset by this balancing that is inherent to many decisions in life and business, assigning monetary values to a life lost has been part of tort law for over a century.[353] Thus, the loss from a dam failure can be quantified by adding property damage to losses due to injury, wrongful death, infliction of emotional distress, and other forms of legally recognized damages.

Risk in this sense is captured by Restatement (Second) § 520 factor (a),

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[347] *See* Abraham Wald, *Contributions to the Theory of Statistical Estimation and Testing Hypotheses*, 10 ANN. MATH. STAT. 299 (1936).

[348] *See generally* Ralph L. Keeney, *Decision Analysis: An Overview*, 30 OPERATIONS RESEARCH 803 (1982).

[349] *Id.* at 817.

[350] *Id.*

[351] *See generally* SALGADO, *supra* note 63.

[352] *See supra* Table 1.

[353] RESTATEMENT (SECOND) OF TORTS § 925 cmt. a (AM. L. INST. 1979).

which refers to the probability of a failure resulting in damages to third parties, and factor (b), which refers to the magnitude or "value" of the resulting damages.[354] Thus, what is important in the context of this article is whether the probability of the failure of a dam can be calculated or estimated and therefore determined to be high or low and whether monetary damages resulting from a failure can be reasonably estimated.

The argument in favor of imposing strict liability in a dam failure case is, to a large extent, based on the existence of a risk deemed high because of the combined effect of the probability of dam failure and the magnitude of the resulting harm. In this sense, it may not make sense to treat dams uniformly. A very small dam, creating a very small reservoir, may only cause minor damage if it fails.[355] So, regardless of the probability of failure, factor (b) would not favor application of strict liability in this case. The real question in connection with factor (b) is related to large dams, whose failure could lead to many deaths and large monetary losses that society might not deem tolerable.[356] This divergence creates a conceptual impediment to application of strict liability to the broadly defined activity of dam building. Factor (b) would require most of the time that the dam be of some minimum size before strict liability could be applied. Using a definition for "large dams," which are dams greater than 15 meters (approximately 49 ft) in height, according to the National Performance of Dams Program, might provide a useful demarcation after which strict liability would apply.[357]

The probability of the failure of a dam over its service life can be estimated in one of two ways.[358] The first way is by dividing the number of observed failures by the number of dams constructed. This method requires consideration of failure databases and provides estimates of the probability of failure for a whole class of dams. The second way is by considering, for a given project, the variability of factors affecting loads and resistances, performing Monte Carlo simulations of the performance of the structure for a very large number of scenarios, each differing from the other by a small variation in one of the pertinent variables, and again dividing realizations for which failures were observed by the total number of simulations.[359]

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[354] RESTATEMENT (SECOND) OF TORTS § 520(a), (b) (AM. L. INST. 1977).

[355] N. Leroy Poff & David D. Hart, *How Dams Vary and Why It Matters for the Emerging Science of Dam Removal*, 52 BIOSCIENCE 659, 662 (2002).

[356] *Id.*

[357] *See* Nat'l Performance of Dams Program, *supra* note 31.

[358] *See* Rodrigo Salgado & Dongwook Kim, *Reliability Analysis of Load and Resistance Factor Design of Slopes*, 140 J. GEOTECH. GEOENVIRON. ENG. 57 (2013).

[359] *See* discussion *infra* Section III(B).

2. Traditional Dam Applications: Water Storage for Flood Control, Electric Power Generation, or Agricultural Use

The incident database maintained by the Association of State Dam Safety Officials documents 238 incidents going back to 1984.[360] Of these, 38 are characterized as failures.[361] This database tracks incidents in dams both small and large.[362] These failures have led to zero fatalities, evidencing the fact that there were not serious failures of large dams after 1984.[363] Material damages have also been small.[364]

The estimated total number of dams, large and small, built in the United States is over 2.5 million.[365] A very rough estimate of an overall probability of failure for dams in the past 40 years is then 38 divided by 2.5 million, i.e., a probability of the order of 1 in 100,000. This underestimates the probability of failure, because some existing dams failed before 1984 and the vast majority of the dams still in service have not completed their service life. On the other hand, the number is likely too high for larger dams: the standard of care is higher for such structures, and more sophisticated engineering goes into designing and building large dams. This is reflected in the fact that the database does not contain a single large dam that has failed in the United States in the last 50 years.[366] To stress the point that this value of the probability of failure of dams is low, it is of the same order as the probability that a given person will die of a lightning strike.[367]

Another dam database is maintained by the National Performance of Dams Program of Stanford University.[368] The estimate of the probability of failure is higher based on calculations done with this database.[369] Using an approximation based on the failure rates of dams built after 1980 and the failure rate of dams during the period of record, the statistics suggest that approximately five dams out of 1,000 will fail during their design life.[370]

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360 Ass'n State Dam Safety Offs., *Dam Incident Database Search*, ASDSO, https://www.damsafety.org/Incidents (last visited Oct. 29, 2022).

361 *Id.*

362 *Id.*

363 *Id.*

364 *Id.*

365 NAT'L RESEARCH COUNCIL, RESTORATION OF AQUATIC ECOSYSTEMS 26 (1992).

366 *See supra* note 360.

367 Ins. Info. Inst., *Facts + Statistics: Mortality Risk* (2020), https://www.iii.org/fact-statistic/facts-statistics-mortality-risk.

368 *See* Nat'l Performance of Dams Program, *supra* note 31.

369 Email from M.W. McCann, Jr., Adjunct Prof. Civ. and Env't Eng'g, STAN., to Rodrigo Salgado, Prof. Civ. Eng'g, Purdue Univ. (2021) (on file with author).

370 The yearly failure rates for dams built after 1980 and all dams for the period of record (since 1848) are 8.8 × E-05 and 3.92 × E-04, numbers that are not markedly different. *Id.* If we approximate these as simply 1.0 × E-04 and multiply that by five decades to approximate an average design life for a dam, we obtain 0.005.

However, failures in the Stanford database include inconsequential failures.[371] These failures are those of small dams whose spillway is designed for floods with return periods as low as 50 years because their failure would cause little to no damage.[372] Additionally, only 4% of the failures recorded in the Stanford database have resulted in fatalities.[373] Considering the percentage of failures leading to fatalities and the failure rate of dams over the course of their service life, we arrive at a probability of a serious failure occurring—2 in 100,000—that is of the order of our previous estimate of 1 in 100,000. Thus, the overall conclusion of this analysis is that the probability of failure of water dams is very low, of the order of one in 100,000 during their design life.

The failure of larger dams would very likely lead to considerable harm.[374] These dams, even if probabilities of failure are small, could still be considered abnormally dangerous. The examples in Table 1 show that the number of fatalities and the property damage resulting from the failure of large dams can be very significant. In general, however, one must conclude that given the low fatality rate, low probability of failure, and modest material damage resulting from the relatively few dam failures observed in the past few decades, factors (a) and (b) of Section 520 of the Restatement[375] do not favor application of strict liability to dams whose purpose is the storage of water for agriculture, flood control, hydropower generation, or other such uses. Construction and operation of a large dam, given the magnitude of the potential harm, could be considered abnormally dangerous activities based on factor (b) alone, but courts would need to wrestle with what constitutes a large dam from the point of view of an owner at the planning and design stages of the dam. It is possible to estimate potential damages and even a probability of failure for dams, as we have done in an approximate manner here. But how many lives lost and how much in property damage would define the threshold for abnormal or intolerable danger? Given that these questions must be answered not retrospectively but prospectively by individuals when deciding to engage in the activity, any lack of uniformity and predictability in the application of the law would be problematic.

The analysis considering only factors (a) and (b) of § 520[376] is therefore

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371 Nat'l Performance of Dams Program, *supra* note 31.

372 Email from M.W. McCann, Jr., Adjunct Prof. Civ. and Env't Eng'g, STAN., to Rodrigo Salgado, Prof. Civ. Eng'g, Perdue Univ. (2021) (on file with author).

373 *Id.* The probability of a fatality-causing failure is then $0.04 \times 0.005 = 20 \times$ E-05, which is comparable to the estimate made based on the number of failures documented by the Association of State Dam Safety Officials National divided by the total number of dams built in the United States as estimated by the National Research Council.

374 *See supra* Table 1.

375 RESTATEMENT (SECOND) OF TORTS § 520(a), (b) (AM. L. INST. 1977).

376 *Id.*

inconclusive for dams holding water, with a bias against a finding of abnormal danger. It is possible, however, that operation of *large dams* near populated areas would be considered by courts to be abnormally dangerous, for the loss of lives that would result would weigh heavily on the factor (b) determination of the magnitude of the risk.

3. Tailings Dams

Based on data from the International Commission on Large Dams (ICOLD) and the World Information Service on Energy (WISE), Bowker and Chambers determined that what they called serious and very serious failures–failures that caused consequential compromise of environmental security beyond the mine site–accounted for 31% of the 214 tailings dam failures and accidents in the 1940–2010 period, and 63% of the 52 total incidents in the 1990–2010 period.[377]

At least three of the world's roughly 3,500 tailings dams fail every year, corresponding to a failure rate of around 0.1%.[378] Considering that the design life of a tailings dam–including the period after which it has been decommissioned–is now proposed to be approximately 1,000 years, the probability of failure of a tailings dam during its design life is many times the annual failure rate.[379] This would be considered a high probability of failure.

Tailings dams can be massive structures, but even the failure of smaller dams can be disastrous. It did not take a massive tailings dam failure to contaminate the Blackfoot River in western Montana,[380] made famous by Norman Maclean's novel "A River Runs Through It"[381] and the film based on it.[382] Like many rivers in the west, however, the Blackfoot has suffered from decades of mining at its headwaters.[383] As to large failures, Bowker and Chambers also searched for reliable data on the total cost to compensate those harmed by these failures and arrived at a dollar amount between $500 and

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377 LINDSAY NEWLAND BOWKER & DAVID M. CHAMBERS, THE RISK, PUBLIC LIABILITY, & ECONOMICS OF TAILINGS STORAGE FACILITY FAILURES 1–2 (2015), https://www.resolutionmineeis.us/sites/default/files/references/bowker-chambers-2015.pdf.

378 Zongjie Lyu et al., *A Comprehensive Review on Reasons for Tailings Dam Failures Based on Case History*, 2019 ADVANCES IN CIV. ENG'G 1, 2 (2019).

379 NEELTJE SLINGERLAND ET AL., GEOMORPHIC ANALYSIS FOR TAILINGS DAM DESIGN IN CONSIDERATION OF A 1000-YEAR CLOSURE DESIGN LIFE 2 (2018).

380 Bonnie Gestring, *Forty-Seven Years and Counting: The Lasting Damage of Tailings Dam Failures*, EARTHWORKS (July 6, 2021), https://earthworks.org/blog/forty-seven-years-and-counting-the-lasting-damage-of-tailings-dam-failures/.

381 NORMAN MACLEAN, A RIVER RUNS THROUGH IT AND OTHER STORIES (Univ. of Chicago Press 1976).

382 A RIVER RUNS THROUGH IT (Columbia Pictures 1992).

383 Gestring, *supra* note 380.

$600 million per serious or very serious failure.[384] Even this estimate may be low. The data that they used did not include damages from the recent failure of the Córrego do Feijão dam, in Brumadinho, Brazil, which is estimated to exceed $7 billion, an amount that does not include environmental remediation.[385]

Bowkers and Chambers argued that the economics of the mining industry, with the decreasing yield of mineral sources and decreasing real price of metals, has led to much larger volumes of mining and to attempts to curtail costs, which in turn magnify the potential harm resulting from future mine failures.[386] They argue that many miners do not have balance sheets strong enough to cope with the cost of serious failures.[387]

Considering both the magnitude of the potential harm from tailings dam failures and their much more frequent occurrence when compared with water dams, not to mention the often-unaccounted-for environmental costs, both factors (a) and (b) of Section 520 of the Restatement (Second) of Torts[388] favor imposition of strict liability to the activity of building and operating a tailings dam.

B. Possibility of Risk Control by Adherence to a Standard of Care

1. Traditional Dam Applications: Water Storage for Flood Control, Electric Power Generation, or Agricultural Use

Factor (c) of Section 520 would apply strict liability if due care would not reduce the risk of engaging in the activity to acceptable levels.[389] As discussed earlier, courts have not quantified this in any way.[390] This article has discussed earlier how probabilities of failure can be estimated at the design stage. They can be adjusted down by adopting considerably more conservative approaches, such as doing much more material characterization and site investigation work to reduce uncertainties in the evaluation of design

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384 BOWKER & CHAMBERS, *supra* note 377, at 2.

385 Marta Nogueira & Tatiana Bautzer, *Brazil's Vale Agrees to $7 Billion Brumadinho Disaster Settlement*, REUTERS (Feb. 4, 2021), https://www.reuters.com/article/us-vale-sa-disaster-agreement/brazils-vale-agrees-to-7-billion-brumadinho-disaster-settlement-idUSKBN2A41V5.

386 BOWKER & CHAMBERS, *supra* note 377, at 3.

387 *Id.*

388 RESTATEMENT (SECOND) OF TORTS §520(a), (b) (AM. L. INST. 1977).

389 RESTATEMENT (SECOND) OF TORTS §520(c) (AM. L. INST. 1977).

390 *See supra* Section I(C)(6).

properties of soil and rock in the ground where the dam will be constructed.[391] They can also be reduced by conservative selection of values of material engineering properties, loading, and flood levels at design time.[392] The use of more advanced methods of analysis and engaging highly specialized professionals and scholars can also reduce probabilities of failure.[393] In legal terms, what the owner of a dam is doing through any of those actions is adjusting the level of care. The degree of care put into engineering work is a function of the consequences of the failure of a structure, and a major structure whose failure will cause significant harm is designed, constructed, and maintained with a higher level of care.[394]

Engineering has developed significantly since the first dam failures in the middle of the 19th century became the object of litigation.[395] This means, certainly in connection with water dams, that design and construction can be adjusted in ways to make a dam safer. Monitoring of the structure can also be made more rigorous depending on the required level of safety by measuring more variables at more locations.[396] These measurements can be done, with modern technology, continuously.[397] Today, traditional dams for the storage of water are unlikely to fail in the absence of negligence because of improved methods of analysis, improved methods of site characterization, and our better understanding of the response of the various materials involved in dam construction. In other words, it is possible to increase the level of care so as to reduce the probability of failure to an acceptable level, swaying factor (c) of Section 520 of the Restatement against application of strict liability.[398]

In fact, even in the failure of older dams, negligence can virtually always be shown to have been present. In *Rylands*—the seminal case for the imposition of strict liability on those engaging in abnormally dangerous activities—the plaintiff today could have sued the defendant, the engineer, and the contractor involved and prevailed.[399] As the court itself admitted, the engineer and contractor were generally aware of the existence of mining works in the neighboring property, which should have led to a more detailed investigation of what that required in the engineering of the intended

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[391] *See supra* Section III(A)(1).
[392] *Id.*
[393] *Id.*
[394] *See generally* Binder, *supra* note 19.
[395] *See generally* GOODMAN, *supra* note 36; *see generally* Salgado, *supra* note 36.
[396] Dam Assessment, *Monitoring Dams*, HGI HYDRO GEOPHYSICS, https://damassessment.com/dam-monitoring/ (last visited Sep. 26, 2022).
[397] *Id.*
[398] RESTATEMENT (SECOND) OF TORTS § 520(c) (AM. L. INST. 1977).
[399] Rylands v. Fletcher, L.R. 3 H.L. 330 (1868). At the time, that was not possible because the plaintiff was not in privity with the engineer and contractor, and this was required for liability to be imposed on either the contractor or engineer.

structure.[400] In the failure of South Fork Dam, as discussed previously, there was no engineer involved in the rebuilding of the dam that preceded the failure.[401] Referring back to the examples in Table 1, the Buffalo Creek Dam failure resulted from a virtual absence of the involvement of engineers.[402] The specific words of the commission that investigated the failure of "Dam No. 3" was that the failure resulted from "the age-old practice in the coal fields of disposing of waste material and was constructed without utilizing technology developed for earthen dams and without using or consulting with professional persons qualified to design and build such a structure."[403] Another example in which plaintiff's attorneys would likely succeed in proving negligence, at least in today's environment, is the failure of the Vajont Dam.[404] As discussed earlier, a lack of understanding of the valley geology prevented consideration of the hazard that ultimately doomed the use of the dam and that killed thousands of people: rockslides in the reservoir.[405]

2. Tailings Dams

There is a difference when the discussion turns to tailings dams. Tailings dams are frequently constructed under more precarious conditions, often incorporating the tailings into the dam.[406] Material properties can be expected to vary more widely than in a traditional embankment dam, and quality control during construction may not be at the same level.[407] Still, it is possible to make tailings dams safer by being conservative in design and construction. The difficulty lies in whether the legal and economic environment provide a disincentive for miners to invest sufficiently in the safety of tailings dams.[408] The magnitude of potential harm from the failure of tailings dams is quite substantial and likely much greater than water dams of comparative size because of the toxic nature of the material stored in their reservoirs.[409] If the damages resulting from a potential failure are taken into account, it may very

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400 *Id.*
401 Shugerman, *supra* note 16, at 359.
402 *The Buffalo Creek Flood and Disaster: Official Report from the Governor's Ad Hoc Commission of Inquiry*, WEST VIRGINIA DEPARTMENT OF ARTS, CULTURE & HIST. (1973), http://129.71.204.160/history/disasters/buffcreekgovreport.html.
403 *Id.*
404 *See generally* Mauney, *supra* note 307.
405 *Id.*
406 FELL, *supra* note 61, at 1075.
407 *Id.*
408 *See generally* BOWKER & CHAMBERS, *supra* note 377.
409 *See generally* Warren Cornwall, *A Dam Big Problem*, SCIENCE (2020), https://www.science.org/content/article/catastrophic-failures-raise-alarm-about-dams-containing-muddy-mine-wastes.

well make a nonnegligible percentage of mining projects unprofitable. In a negligence framework, so long as a miner feels comfortable that it can prove adherence to a minimum standard of care, it may not pursue additional measures that could have a beneficial effect, reducing the probability of failure.

Courts that favor application of negligence theory, presumably because they believe that the right level of care will prevent dam failures, do account for the difficulties that plaintiffs may face proving negligence, the reason given in *Siegler* for application of strict liability.[410] The issue of the impossibility of proving negligence in the case of a tailings dam failure is undoubtedly present, as these dams are completely or nearly completely destroyed when they fail.[411] Forensic work is difficult and often speculative.

However, courts have more often than not resisted application of strict liability for the reason given in *Siegler*.[412] For example, in *Barnard v. Fergus Falls*, when considering the failure of a hydroelectric dam, the court opined that the rule of *res ipsa loquitur* applied to such a situation, but that the rule of absolute liability did not.[413] It stated that the burden was on the dam operator to prove that the failure of the dam was not a result of negligent construction.[414] The court in *Fergus Falls*, and other courts in similar situations, have avoided the application of strict liability by arguing that the negligence doctrine framework is perfectly suited to handle claims in which proving negligence could be challenging for a plaintiff.[415] Likewise, in *Winans v. Northern States Power Co.*, the court held that the doctrine of *res ipsa loquitur* was applicable when the dam gates gave way, further holding that the gates of the dam are a structural part of it and that the jury could view their failure as equivalent to a portion of the dam itself giving way.[416] These examples show that courts that do not adopt strict liability are not blind to the potentially difficult position of plaintiffs in proving negligence by the defendant. The alternative doctrine to which courts usually resort in such cases is either *res ipsa loquitur* or negligence per se, if there is a statute on point.[417]

In conclusion, with modern engineering knowledge, it is possible to reduce the likelihood of the failure of tailings dams, but uncertainties about the mechanical behavior of the material of which the dam is made, about the

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[410] Siegler v. Kuhlman, 502 P.2d 1181 (Wash. 1972) (en banc).

[411] *See generally* Rotta et. al., *supra* note 306. This was well-illustrated by the failure of the Brumadinho Córrego do Feijão tailings dam, whose failure was captured by cameras from multiple directions.

[412] *Siegler*, 502 P.2d at 1185.

[413] Barnard v. City of Fergus Falls, 132 N.W. 998 (Minn. 1911).

[414] *Id.* at 998.

[415] *Id.*

[416] Winans v. N. States Power Co., 196 N.W. 811, 812–13 (Minn. 1924).

[417] Boston, *supra* note 2, at 648.

way in which the dam is constructed, and other factors in the engineering design and construction processes are much more significant than for a traditional water dam. As a result, probabilities of failure have been and likely would be too high to be acceptable. This factor would therefore favor application of strict liability.

C. Is Dam Ownership or Operation an Activity of "Common Usage"?

Restatement (Second) of Torts § 520(d) refers to whether an activity is of "common usage."[418] Although not everyone is involved in dam construction or operation, nearly everyone who drinks water, eats produce from irrigated land, or uses electricity from hydroelectric power benefits from the results of such activities. In that sense, activities related to traditional water dams are common, familiar, and connected to people and their everyday lives. A similar argument could be made for levees, which enable normal life in areas that would otherwise be subjected to flooding.[419] A much weaker argument could be made for activities related to the construction and operation of tailings dams, which are structures with which most of the public would be unfamiliar and are used to collect environmentally harmful mining byproducts.

This factor, therefore, would not favor application of strict liability theory to dams for storage of water or control of water flow connected with activities such as water supply, energy generation, and irrigation, but would favor its application to tailings dams.

D. Appropriateness of the Site

Restatement (Second) of Torts § 520(e) addresses the "inappropriateness of the activity to the place where it is carried on."[420] Fundamental to the analysis of site appropriateness is the reason this factor was added to Restatement Section 520: the natural versus nonnatural use distinction made in *Rylands*.[421] The question for water dams then becomes whether it is natural to build a dam across a stream. In *Barnum v. Hanschiegel*, the court considered dams for energy generation, holding that the owner of a dam

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418 RESTATEMENT (SECOND) OF TORTS § 520(d) (AM. L. INST. 1977).
419 *Levee*, NATIONAL GEOGRAPHIC, https://education.nationalgeographic.org/resource/levee (last visited Sep. 26, 2022).
420 RESTATEMENT (SECOND) OF TORTS § 520(e) (AM. L. INST. 1977).
421 Rylands v. Fletcher, L.R. 3 H.L. 330 (1868).

erected across a natural stream for the purpose of raising water for irrigation, power, or other useful purposes, is liable only for negligent construction or maintenance if it fails.[422] It distinguished the rule in *Rylands*, stating that this rule was based on the distinction between natural and nonnatural uses of land, and applied only to nonnatural uses.[423] Since streams have always been used as sources of power, the court stated, the placing of dams upon them is a natural use; hence, it has generally been held that the breaking of such a dam produces no liability in the absence of negligence.[424] It would follow from this opinion that any use that has "always" been made of water, such as irrigation or domestic use, would also evade strict liability.

Another factor that has been considered is the distance from the site to locations with heavy residential concentrations. The doctrine of strict liability has been followed in many jurisdictions where water is stored in large quantities in a dangerous location in cities.[425] On the other hand, the doctrine has not been followed in many jurisdictions where water is stored in rural areas.[426]

Tailings dams would likely not benefit from this or similar holdings. For example, in *Nola v. Orlando*, waters escaped from a flume and invaded the property of third parties, causing damage.[427] The court stated:

> As we conceive the present state of the law in California relating to the outlined evidentiary situation, appellants' contention [that the damage was caused by and through the negligence of the defendant] cannot be upheld. The cement flume of defendants constituted an artificial and not a natural watercourse. The escape of water therefrom was not in any degree caused by the added pressure of flood or storm waters, nor was the same occasioned as a consequence of an inevitable accident. It occurred solely by reason of the manner of the construction and maintenance of defendants' said flume, plus their act of pumping water through it. With this certain cause of the injury in view, we regard it as immaterial whether or not these acts be in terms held negligent; it being a sufficient basis upon which to predicate liability in a case such as

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422 Barnum v. Handschiegel, 173 N.W. 593, 594 (Neb. 1919).
423 *Id.*
424 *Id.*
425 RESTATEMENT (SECOND) OF TORTS § 520, cmt. i, j (AM. L. INST. 1977).
426 *Id.*
427 Nola v. Orlando, 6 P.2d 984 (Cal. Dist. Ct. App. 1932).

> this that said acts constitute the sole, efficient, and proximate cause of the injury.[428]

There is not much that is natural about destroying entire hillsides to extract tiny percentages of some mineral from rock. Although society depends on mining for productive endeavors (and also for apparently limitless consumption), it is difficult to argue that mining and the storage of its residue behind tailings dams that will need to be designed for a service life of a thousand years is natural.

This factor therefore disfavors strict liability in connection with traditional, water dams, but favors it in connection with tailings dams.

E. Value to the Community

Restatement (Second) of Torts § 520(e) addresses the value of the activity to the community.[429] Restatement (Second) of Torts § 520, Comment k, gives an example of a site-appropriate, useful activity: a reservoir in an arid region may be regarded as a natural and common use of the land, whose value to the community is such that the activity will not be regarded as abnormally dangerous.[430]

The Restatement counters an early rationale for imposition of strict liability: not to punish a party harmed by the miscarriage of an activity that is useful to the community. An example of this is *Bridgeman-Russell Co. v. Duluth*, a case in which a main leading from a large municipal reservoir broke and damaged the plaintiff's premises.[431] The court stated:

> Congestion of population in large cities is on the increase. This calls for water systems on a vast scale either by the cities themselves or by strong corporations. Water in immense quantities must be accumulated and held where none of it existed before. If a break occurs in the reservoir itself, or in the principal mains, the flood may utterly ruin an individual financially. In such a case, even though negligence be absent, natural justice would seem to demand that the enterprise, or what really is the same thing, the whole community benefited by the enterprise, should stand the loss rather than the individual. It is too

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[428] *Id.*
[429] RESTATEMENT (SECOND) OF TORTS § 520(e) (AM. L. INST. 1977).
[430] RESTATEMENT (SECOND) OF TORTS § 520, cmt. k (AM. L. INST. 1977).
[431] Bridgeman-Russell Co. v. Duluth, 197 N.W. 971 (Minn. 1924).

> heavy a burden upon one. The trend of modern legislation is to relieve the individual from the mischance of business or industry without regard to its being caused by negligence.[432]

In contrast, the court in *Jeffers v. Montana Power Co.*, recognizing the need for water management and supply in arid regions, said:

> To adopt the theory advanced by the plaintiff, we would be obliged to hold that one impounding waters in this state and using the natural channel of a stream for the transportation of such waters is absolutely an insurer against all damages. This would place such an unreasonable burden on legitimate business as to practically discourage the reclamation of the state's arid lands and the development of many of our natural resources.[433]

The court in *City Water Power Co. v. City of Fergus Falls* did not extend the rule of absolute liability to a utility company whose hydroelectric power dam failed.[434] The court held that negligence theory must apply to power dams, because they are of such great and increasing public importance, but offered that the doctrine of *res ipsa loquitur* applies, because dams constructed and maintained with the care required by law do not ordinarily fail under the pressure of the very water which they were constructed to hold back.[435]

Given the usefulness of water supply and energy generation to civil society, this factor disfavors application of strict liability to dams used for water supply or hydroelectric power generation. In contrast, whereas mining is useful to society in general, it is certainly not as useful as water supply or energy generation, and it is questionable that it is especially useful to the community in which the dam is located. In fact, an argument could be made that failures of tailings dams are a source of environmental injustice, affecting underprivileged or native communities that do not benefit from the activity at all. For tailings dams, therefore, this factor favors strict liability application.

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432 *Id.* at 972.
433 Jeffers v. Mont. Power Co., 217 P. 652, 660 (Mont. 1923).
434 City Water Power Co. v. City of Fergus Falls, 128 N.W. 817, 818 (Minn. 1910).
435 *Id.*

F. Should the Rule of Strict Liability be Used for Dams?

The preceding analysis is summarized in Table 2. The failure of dams that store water for traditional uses–water consumption, energy generation, and irrigation–should be analyzed using the rule of negligence because all factors in Restatement Section 520 favor it.[436] Although the magnitude of the consequences of failure for large water dams could be such that strict liability might be applied, in general this is balanced by the other factors, particularly the ability of the engineering professional to bring risks down with an appropriate standard of care.

Table 2. Restatement Section 520 analysis applied to dams and tailings dams.

Restatement Section 520 Factors	Water Dams	Tailings Dams
Factors (a) and (b)	Favor negligence, but could favor strict liability for large dams	Favor strict liability
Factor (c)	Favors negligence	Favors strict liability
Factor (d)	Favors negligence	Favors strict liability
Factor (e)	Favors negligence	Favors strict liability
Factor (f)	Favors negligence	Favors strict liability

An opposite result follows from the analysis applied to tailings dams.[437] Mining and the accumulation of large volumes of tailings behind dams that fail with significant frequency are risky, are not of common usage, are not appropriate to the sites where they are located (even if these sites are rural or remote, given the potential for grave environmental damage), and have a value to the community that does not balance any of the drawbacks. It has been argued that factor (c) would be a barrier to the application of the rule of negligence,[438] but the construction and operation of tailings dams are probably activities for which defendants will not be allowed by courts to escape strict liability.

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436 *See supra* Table 2.
437 *See supra* Table 2.
438 Boston, *supra* note 2.

CONCLUSION

Rylands v. Fletcher created a new cause of action for activities that were unnatural and especially dangerous.[439] These were later formulated in the Restatement (Second) of Torts as abnormally dangerous activities.[440] In order to determine whether an activity is abnormally dangerous, courts review six factors from the Restatement's § 520:

(1) Is the probability of harm too high?
(2) Is the magnitude of the potential harm too large?
(3) Can a heightened level of care reduce the risk (either the probability of the harm, its magnitude, or both) to a level that society would accept?
(4) Is the activity of common usage?
(5) Is the activity appropriate to the site?
(6) Is the activity valuable to the community?[441]

There are nuances to the application of this test. Factors (1) through (3) appear to have been most important in court decisions.[442] A harm that is too horrible to contemplate, even if very unlikely to happen, would be a risk that society would prefer to be borne entirely by the party taking it. Even if the harm is not so large, if chances that it would happen are high, the same conclusion applies. Finally, if the risk cannot be avoided–that is, brought down to a tolerable level–by increasing the level of care, then that would be an activity too risky for society to permit a guiltless third party to suffer the consequences of its failed undertaking. The other three factors have helped shape opinions, but typically have not been decisive; however, in the case of water dams, the usefulness to the community is important, and court opinions have highlighted that.[443]

With respect to water dams, the analysis in this article suggests that the size of the dam and its use might have to be considered in a strict liability analysis, but only factor (b) would point to strict liability in that case. In general, for dams used for water storage for domestic consumption, power generation, or irrigation, with the exception of large dams, all factors point to the activity not being abnormally dangerous in the Restatement sense.

Tailings dams store mining residue, material that is toxic to the environment and to people.[444] The activity, while useful, is not necessarily or

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[439] Rylands v. Fletcher, L.R. 3 H.L. 330 (1868).
[440] RESTATEMENT (SECOND) OF TORTS § 519 (AM. L. INST. 1977).
[441] RESTATEMENT (SECOND) OF TORTS § 520 (AM. L. INST. 1977).
[442] *See supra* Section I(C)(5).
[443] *See supra* Section III(E).
[444] Earthworks, *supra* note 270.

especially useful to the community in which the dams are located. Their annual failure rate is high, and the harm resulting from a breach is significant.[445] Additionally, in contrast to water dams, whose failure rate has come down in the last decades, the failure rate of tailings dams has not noticeably decreased.[446] Consequently, the analysis in this article favors application of strict liability to these structures. Strict liability application should in fact provide an incentive for owners to operate at a heightened level of care, because *it is possible* to reduce the probability of failure of these dams, and accordingly to reduce the likelihood that owners will face liability. It is just not possible at present to reduce it to a level that would be tolerable to society in the context of a Restatement analysis.

Engineers have traditionally not been subjected to strict liability when hired to provide professional services whose product is simply guidance to a defendant, a design, or construction specifications.[447] There does not seem to be case law that would suggest otherwise if these services were provided in support of an abnormally dangerous activity. This is the correct result: engineers, unless acting negligently or unethically, provide work that lowers the risk of harm, and indeed may even suggest that the risky activity should not be undertaken.

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445 *Id.*
446 *Id.*
447 Stuart v. Crestview Mut. Water Co., 34 Cal. App. 3d 802, 811 (1973).