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Dam Safety: The Critical Imperative

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The spectacular nature of the Teton Dam break emphasizes the basic problem of Dam Safety in this country. Nevertheless, it took several dam breaks and near-misses before the Federal Dam Safety Inspection Act was passed in 1972. It took another series of dam breaks and close-calls for meaningful implementation of the Act to result. Accordingly, this article sets forth a number of critical measures which are essential to a viable dam safety program. Using this model, the author evaluates the Federal Dam Inspection Act, the proposed model codes, and the existing state regulatory procedures and makes appropriate recommendations.

DAM SAFETY: THE CRITICAL IMPERATIVE

*Denis Binder**

I. INTRODUCTION

A major reappraisal is being undertaken by the Carter Administration with respect to Western water policy.[1] The appraisal is not yet completed. So far though, the sanctity of large federal projects has been tarnished. The benefit-cost ratio has undergone major attacks.[2] Acreage limitations are highly controversial.[3] The need for new multi-purpose federal dams is questioned.

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1. *See e.g.* Lichtenstein, *West's Water Flight Intensifies as Carter Plans Project Cuts,* N. Y. Times, March 7, 1977 at p. 1, col. 3.
2. *See e.g.* 38 FED. REG. 24778 (1973); U.S. Comm. Gen., Rept to the Cong., *Better Analysis of Uncertainty Needed for Water Resource Projects* (PAD 78-67, June 2, 1978); HOWE, BENEFIT-COST ANALYSIS FOR WATER SYSTEM PLANNING (1971).
3. *See especially,* United States v. Imperial Irr. Dist., 559 F.2d 509 (9th Cir. 1977); United States v. Tulare Lake Canal Co., 535 F.2d 1093 (9th Cir. 1976); United Family Farmers, Inc. v. Kleppe, 552 F.2d 823 (8th Cir. 1977); Note, *The Sherman Act and*

Although professional engineers have been extensively involved in dam safety studies for decades, and have issued invaluable reports and recommendations,[4] including improved construction, safety and inspection criteria, it took a series of dam disasters, most notably Teton Dam, to bring to public attention the critical constraint of dam safety. The spectacular nature of the Teton Dam break, and several other tragedies, emphasize the basic problem of dam safety, which is a major, continuing problem in this country. Since 1930 over 100 major dams have failed; yet 1,600 dams are built every year, subject to licensing provisions ranging from non-existent to very rigorous.[5] It took several dam breaks and close-calls for enactment of a Federal Dam Safety Inspection Act.[6] It took another series of breaks and near-misses for meaningful implementation of the Act to result.[7] Based upon the limited number of inspections completed so far, it is difficult to reach conclusions, but the percentage of dams found to have major safety problems gives cause for deep concern.[8]

Land: The Interstate Commerce Requirement, 3 COL. J. ENV. LAW 306 (1977) and TRELEASE, WATER LAW: RESOURCE USE AND ENVIRONMENTAL PROTECTION 736, n. 7 (1974).

4. *See especially*, U.S. Comm. on Large Dams, (USCOLD); SUPERVISION OF DAMS BY STATE AUTHORITIES (1966); USCOLD, MODEL LAW FOR STATE SUPERVISION OF SAFETY OF DAMS AND RESERVOIRS; USCOLD, LESSONS FROM DAM INCIDENTS, (1975).
5. DAM SAFETY: *Eighteenth Rep't of the House Comm. on Gov't Operations*, 95th Cong., 2nd Sess. 1 (H.R. 95-880, 1978). Another significant, but misleading statistic, is that the United States has 35% of the world's dams, but 58% of the major dam failures. Washington Dep't of Ecology, *Washington's Water Resources' Recommendations to the Legislature, January 30, 1977.* The reason the figure is misleading is that the United States has reported all dam failures, while other nations have only selectively reported all significant incidents to their dams. Comm. on Failure and Accidents to Large Dams of the United States Comm. on Large Dams, *Lessons from Dam Incidents, USA* 77 (1975). A list of major dam failures in the United States between 1930 and 1966 appears in *Teton Dam Disaster*, Hearings Before a Subcom. of the House Gov't Op. Comm., 94th Cong., 2nd Sess. at 59-61 (1976).
6. These include the failure of the Canyon Lake Dam in June, 1972, at Rapid City, South Dakota and the mine refuse embankment at Buffalo Creek, West Virginia in February, 1972. The first killed 230 people and the second 125. In addition, in June 1, 1972, Hurricane Agnes caused extensive rainfall and flooding in the Northeast, and damaged or overtopped a number of dams. There was also the near failure of the Van Norman Dam during the San Fernando Earthquake in California in February, 1971. The result of these four events was Congressional enactment of P.L. 92-367, The National Dam Inspection Act of 1972. Comptroller General of the U.S., Rep't to the Congress, *Slow Progress in Developing and Implementing a National Dam Safety Program 5* (CED-77-94, June 24, 1977).
7. Most notable are the Teton Dam Disaster of June 9, 1976 and the failure of the Kelly Barnes Dam at Toccoa, Georgia, which killed 38 on November 6, 1977. In addition, an earthen dam gave way in Newfound Creek near Canton, North Carolina on February 22, 1976, and killed four. *Dam Safety Implementation, supra* note 6 at 3. Another earthen dam, the Walter Bouldin Dam, gave way on February 10, 1975. There were no fatalities. *See*, Office of Electric Power Regulations Federal Energy Regulatory Commission, *Walter Bouldin Dam Failure and Reconstruction* (1978).
8. 12 of the first 273 dams checked by the Corps of Engineers in the safety program were found to need "immediate remedial action to eliminate unsafe conditions." Two were drained. 2 ENGINEER UPDATE No. 2 at 1 (March 1978). This relatively high problem rate may be deceptive though in that frequently "suspect" dams have been

This article will look at the Teton break, the Federal Dam Inspection Act, proposed model codes, and existing state regulatory procedures, and then make appropriate recommendations.

On the whole the existing regulatory system is generally inadequate in light of the enormous risks involved. A need exists for federal regulation to ensure compliance by the states with minimum safety standards.

In analyzing dam construction and safety, certain underlying factors should be kept in mind. First, there are no problem-free sites, but rather each site possesses different conditions bearing on dam safety.[9] Thus, flexibility in engineering approaches is mandated by the uniqueness of each site.

Second, because of unique conditions at each site, it is impossible to specifically define acceptable design criteria for all dams. Rather, criteria must be site specific, and reliance must be placed upon the personnel and expertise of the agencies, subject to outside review processes.[10]

Third, a basic criteria for the safe design of earthfill dams is that seepage flow occurring through or around the embankment must be controlled so that no internal erosion will occur.[11]

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inspected first.

The need for extensive dam safety investigations is well documented. For example, after the Buffalo Creek coal refuse bank break, coal mine refuse banks and impoundments were investigated at 495 sites in Ohio, West Virginia, Virgina, Kentucky and Pennsylvania. 30 were classified as critically hazardous, and 172 potentially hazardous, all requiring some corrective action. Office of the Chief of Engineers, Department of the Army, *National Program of Inspection of Dams* 3 (1975).

9. Comptroller Gen. of the U.S., *Rep't Actions Needed to Increase the Safety of Dams Built by the Bureau of Reclamation and the Corps of Engineers.* 6 (CED-77-85, June 3, 1977). The major federal dam building organizations are the Bureau of Reclamation, which is part of the Interior Department, and the Army Corps of Engineers. The Bureau operates in the sixteen western states, and is charged with reclaiming land through irrigation. The Corps operates nationwide, and is primarily charged with flood control and navigation improvement. In fact, the large multi-purpose dams built by the two agencies are functionally equivalent in that they supply irrigation water, hydroelectric power, recreational opportunities, flood control and navigation benefits.
10. *Id.* at 7. Relevant factors include safety, economic feasibility, environmental impact, local support and suitability in meeting local water resource needs. *Id.* at 6.
11. *Id.* at 34. For example, every reservoir has bank storage. Frequently, the bank storage works its way laterally well into the reservoir banks and around the dam, and returns to the river downstream. *Teton Dam,* hearing Bef. the Subcomm. on Energy Research and Water Resources of the Sen. Comm. on Int. and Ins. Affairs at 37 (Statement of Commissioner Stamm) (94th Cong., 2nd Sess. 1976).

This author is reminded of an anecdote while on a tour of Grand Coulee and Chief Joseph Dams during the summer of 1976. The Project Manager at Chief

Finally, and most critical of all, is the premise that society will not tolerate a major dam break.[12] A major dam break, like a major nuclear disaster, is a risk that society finds unacceptable. Dam safety is one area where absolute safety is demanded.[13]

The task then is to draw upon the lessons to be learned from the Teton Break and other dam incidents in constructing a viable dam safety program, and the accompanying legal norms.

II. TETON DAM

Teton dam was a central-core, zoned earthfill structure,[14] rising 305 feet above the river bed, and 405 feet above the lowest point in the foundation. It was designed and built by the Bureau of Reclamation. To control seepage, a key trench was dug in the foundation rock above elevation 5,100 feet,[15]

Joseph Dam said, "See that leak up there? That's no leak: that's an optical illusion. The Corps does not build dams that crack." He continued along these lines. "In fact, every dam has leaks and cracks." We design the dam so as to channel the water. When necessary we will drill to determine the source of the leak and take appropriate measures to correct it, if necessary." Both Chief Joseph and Grand Coulee are concrete dams.

12. Although this statement is difficult to quantify, the operating premise of the engineers I know at the Corps is that society will not tolerate a dam break, and design their structures accordingly. They do not make trade-offs involving risks and costs, such as we normally do in negligence analysis. *See* the famous opinion of Learned Hand in United States v. Carroll Towing Co., 159 F.2d 169 (2nd Cir. 1947).
13. Although this statement may appear hyperbolic, a problem occurs in determining acceptable risks for dams. For example, the Corps of Engineers uses the "probable maximum flood for spillover design." This flood could be exceeded. Therefore, total safety is impossible; yet society will not tolerate dam breaks because of the costs in human life, health, property and suffering occasioned thereby. The damages of a dam break can be great. Aside from the costs of the Teton break, other examples are available. In settling claims on the Buffalo Creek break, Pittston Corp. so far has spent $43,880,000, of which $15.1 million was covered by insurance. Wall Street J., January 25, 1978 at p. 14, c. 2. The secondary impact of dam failure can also be great. In effect, a domino effect can result. For example, in order to reduce the reservoir sufficiently to accept the floodwaters from Teton, the downriver American Falls Dam had to discharge large amounts of water, flooding out and damaging downriver canal systems.
14. Various soils and rocks comprised the five different zones of materials in the dam. The core of the dam, accounting for over half its volume, consisted of a mound of fine, windblown silt that was compacted to make it impermeable to water. This core was covered by a blanket of sand, gravel and cobbles. Various other layers of earth materials and rocks formed additional shells, with somewhat differing configurations being used on the upstream and downstream sides.

    The core material was compacted at less than optimum water contact, which made it very brittle and erodable, which were prime factors in the Teton collapse. The material, as compacted, permitted continuous erosion channels to be formed in the core. Independent Panel to Review Cause of Teton Dam Failure, *Report to United States Department of the Interior and State of Idaho on Failure of Teton Dam* 7-14 (1976). Wherever this material would be subjected to the action of flowing water, it would be attacked and washed away rapidly. Seepage could also produce backward erosion due to grain-by-grain removal at points of emergence of flow lines, where such points consisted of voids unprotected by filters. *Id.* at 12-15.
15. The foundation key trench in each abutment was intended to intercept the more open rock joints, and to reach a groutable horizon. These trenches were 70' deep. Crest elevation of the dam was 5332 feet. The dam failed when the water level was at 5301.7 feet, 22.6 feet below the maximum reservoir water level.

and a cutoff trench below that elevation to foundation rock.[16] A grout curtain[17] was extended below both trenches. Total storage capacity of the 17 mile long reservoir was 288,250 acre-feet of water.[18]

As a result of the dam break 11 lives were lost, 25,000 people were left homeless, 300 square miles were totally or partially inundated, and claims approximating $400 million will be paid by the Bureau of Reclamation.

A. The Lessons to Be Learned

1. Technical

The Teton Dam was breached at 11:57 a.m. on June 9, 1976 as the reservoir was being filled for the first time. Only 5 hours elapsed from the time of the first observed seepage in the immediate vicinity of the dam until it breached.[19] Extensive post-mortems have disclosed the physical causes of the breach.[20] Essentially, the dam and its foundations were not structurally sound in light of the difficult geological conditions. Adequate preliminary investigations indicated the relevant geology and characteristics needed to develop a

16. The trenches and grout curtains were designed to control seepage. The trenches were filled with highly impervious and strong material, but which was highly erodable. Bureau of Reclamation criteria for earth dams provide, whenever economically feasible, that seepage through a pervious foundation such as Teton, be cut off by extending a trench to bedrock or other impervious materials, and then filling it with impervious material. Needed Actions, *supra* note 8, at 29.

17. Grout is a mixture of bentonite, water and calcium chloride, which, when forced under high pressure into drill holes or natural openings in rock, is supposed to form a watertight seal. The grout curtain consisted of three lines of grout holes on Teton. U.S. Dep't of the Int., Teton Dam Failure Review Group, *Failure of Teton Dam: A Report of Findings* 32 (1977). The Bureau of Reclamation normally grouts a foundation along a single line of holes, centered 10 to 20 feet apart to create a grout curtain. Needed Actions, *supra* note 9, at 32. The three lines of grout holes at Teton effectively constituted only a single grout curtain since the outer two rows were only intended as semi-pervious grout barriers against which the center row of grout holes could reasonably be fully and successfully grouted.

18. The rocks in the canyon walls and bed were highly fractured, providing numerous passageways for water to travel, thereby necessitating the use of design technologies, such as grouting, to prevent erosion. For a description of the Teton design, *see* Boffey, *Teton Dam Verdict, A Foul-Up by the Engineers*, 195 SCIENCE 270, (1977).

19. Failure of Teton Dam, *supra* note 17, at 42.

20. *See* Independent Study, *supra* note 14; *Teton Dam, supra* note 11, *Teton Dam Failure*, Print of the Subcom. on Energy Research and Development of the Sen. Comm. on Energy and Natural Resources, 95th Cong. 1st. Sess. (1977); *Teton Dam Claims*, Hearings Bef. the Subcom. on Ad. Law & Gov't Rel. of the House Comm. on the Jud., 94th Cong. 2nd Sess. (1976).

In addition, a separate internal investigation was undertaken to review the Bureau's procedures and practices on dam safety. Large, Jr., Bureau of Reclamation Review Team, *Report of the Bureau of Reclamation's Dam Safety Review* (1977). *See also* Needed Actions, *supra* note 9, *Dam Safety, supra* note 5, Dam Safety Implementation, *supra* note 6, and Comm. on the Safety of Dams, Assembly of Engineering, National Research Council, *Safety of Dams: A Review of the Programs of the U.S. Bureau of Reclamation for the Safety of Existing Dams* (1977).

satisfactory design. Thus, sound engineering practices should have built a structurally safe dam.[21]

Instead, inadequate measures were taken to prevent internal erosion,[22] referred to as "piping". The primary cause of the leakage was probably either hydraulic fracturing in the key trench fill,[23] or imperfect grouting, or a combination of these.[24] The core material used was extremely susceptible to erosion. A study concluded that the dam failed as a result of inadequate protection of the impervious core material from internal erosion.[25]

One key engineering difference in approaches between the Bureau and the Corps of Engineers is that the Corps stresses the importance of providing multiple defenses in dams to prevent erosion or seepage. Grout curtains are used only in conjunction with other measures to control seepage, such as filters and sealing of all cracks.[26] Corps dams, if anything, are over-engineered. Indeed, the Corps had just completed the Ririe Dam 30 miles from the Teton Dam on roughly similar terrain, but used different methods to safeguard against seepage. Post-Teton studies have indicated no Teton-type problems at Ririe.[27] The Teton investigations emphasized that reliance on a grout curtain as the solution to

21. Failure of Teton Dam, *supra* note 16, at 103. Defensive measures, such as rock surface sealing and adequate filters, should have been used. A filter on the downstream side of the key trench would have stopped fine material from the infilling from flowing out with the seepage water. A granular fill upstream of the key trench would have tended to fill cracks that might have occurred across the key trench. Water would have moved this material into cracks that formed there precluding the opening of passageways through the core material. Teton Dam Failure, *supra* note 18, at 17.
22. The foundation and adjoining rock had extensive cracks and fissures. One opening was explored by a Bureau employee for about 100' both downstream and upstream of the dam's axis. The cavity on the downstream side was about four feet wide. Further exploration was blocked by a large rock, but a room or passage could be seen beyond. Needed Action, *supra* note 8, at 26. The extensive grouting program on Teton Dam was supposed to seal the foundation, but failed to do so. The eroded soil particles exits through channels in and along the interface of the dam with the highly pervious abutment rock, and openings existed through inadequately sealed rock joints, which may have developed through cracks in the core zone in the key trench. Once started, piping progressed rapidly through the main body of the dam. Independent Study, *supra* note 17, at 111.
23. Hydraulic fracturing is a phenomenon, the dynamics of which are not yet fully understood. Essentially, it is a condition leading to the creation and preparation of a thin physical separation in a soil whenever the hydraulic pressure exerted on a surface of the soil exceeds the sum of the total normal stress on that surface and the tensile strength of the soil. It is suspected of occurring in the cores of several embackment dams due to reservoir water pressures. For a detailed analysis of the hydraulic fracturing theory, *see* Leed, Appendix D: found at Independent Study, *supra* note 17, at D-1 to D-39.
24. *Id.* at 12-18.
25. Failure of Teton Dam, *supra* note 17, at iii.
26. Needed Action, *supra* note 9, at 24, 33.

seepage problems is misplaced since it should never be considered capable of eliminating seepage through the foundation.[28]

In the Teton post-mortems, a need was recognized for much greater use of instrumentation in the dams,[29] and the need for timely interpretation of the data by a single responsible group.[30] The Bureau had decreased the use of instrumentation over the past decade because it felt that it could predict, as a result of past expertise, the structural behavior of many earth-fill dams as they are subject to reservoir water pressures.[31]

On Teton there was not good instrumentation in the foundations and none in the dam itself. Review of well readings were made only periodically, and forwarded to the regional office at least once a month.[32] The result was that the bureau staff was not fully informed of the changing conditions in the embankment and its abutments.

One key factor in a crisis is the capability of rapid lowering of a reservoir through outlet facilities. It was disclosed during the Teton investigations that not only were Teton's outlets inoperable, and that there are, as yet, no widely accepted rules for sizing these outlets, but also that many im-

27. *Id.* at 76. For example, Ririe was constructed with multiple layer protective filter zones against the abutment and impervious core to prevent internal erosion of material through or around the dam. Teton Dam Disaster, *supra* note 5, at 508. In addition, the Corps policy, unlike the Bureau, is to either fill or cover all the cracks in the rock surface with concrete or grout to render impossible the movement of core material into cracks in the foundation rock. At Ririe, a three-foot foundation blanket was placed between the silt core and the foundation rock. All large cracks were backfilled with concrete, and all small cracks were filled by broomgrouting. *Id.*

28. Failure of Teton Dam, *supra* note 17, at 88. The basic function of a grout curtain is to reduce seepage under a dam to tolerable limits. Seepage will exist, and the embankment must be protected against it.

29. Instrumentation in earthfill dams could include piezometers, observation wells and surface monuments and other devices to measure earth movement. Instrumentation in concrete dams usually includes stress meters and strain gauges to measure internal stress, plumblines and collimation systems to monitor deflection of the dam; deformation meters to measure foundation deformation; drainage collection systems to monitor seepage; piezometers to measure uplift pressure, and thermometers to measure concrete and reservoir temperatures. Instrumentation though is no guarantee that dams will not break. For example, the Walter Bouldin Dam broke on February 10, 1975 without warning in spite of extensive instrumentation. Office of Electric Power Regulation, *Walter Bouldin Dam Failure and Reconstruction* 19 (1978).

30. Review Study, *supra* note 20, at 111. Failure of Teton Dam, *supra* note 17, at 107.

31. Needed Actions, *supra* note 9, at 48. The bureau had instrumentation on about half of its dams. To be precise, instruments have been installed in 37 out of 56 concrete dam structures, and 147 out of 300 earthen dams, Safety of Dams, *supra* note 18, at 24.

32. *Id.* at 51. Corps practices, depending on the district, require readings as often as daily during reservoir filling, and immediate transmission of the data to the proper officials. *Id.* at 54.

portant dams have no facilities to permit emptying the reservoir quickly.[33] Here is the seed of future disasters. The sizing of outlet works should be reviewed to control both the rate of filling and to provide for emergency reservoir evacuations.

Special precautions should be taken for filling critical dams in initial filling, first drawing, and refilling stages after extreme drawdown. The Bureau has a rule of thumb on initial fillings of not allowing the reservoir to fill at a rate exceeding one foot per day.[34] On Teton, filling commenced in a time of intensified snowpack runoff. Since the outlet works were not complete, the reservoir had to be filled at a rate higher than one foot per day.[35]

Other dams have been filled faster,[36] and the rapidity of the chain of events on Teton suggests insufficient time in which to have taken advantage of instrumentation warnings. However, a more conservative approach to instrumentation and rate of filling might have averted the disaster.[37]

Another inspection-filling lesson comes from Teton. Daily inspections were made of Teton, but not nightly inspections. Dam breaks do not respect the clock, and are as likely to occur at night as in the day. For example, the Toccoa, Georgia break that killed 38 occurred at 1:30 a.m.[38] Under the circumstances, nighttime inspection schedules should be implemented during the critical filling, drawdown, and refilling times.

2. Political-Institutional Lessons

The post-mortem findings on physical defects are significant for future dam builders. More relevant to this article are the underlying institutional weaknesses discovered in the dam-building cycle.

33. Independent Study, *supra* note 17 at 8-9. Outlets in Corps and Bureau dams could empty most of the water in 90-120 days. California's dams are generally designed with outlets that would empty at least half the reservoir in 14 days. *Id.*
34. *Id.* at 129.
35. At one point the reservoir fill rate was up to 4 feet a day. It seems obvious that the outlet works should be operational prior to initial reservoir filling. *Id.* at 129.
36. Independent Study, *supra* note 17, at 10-14.
37. *Id.* at 10-15. Needed Actions, *supra* note 9, at 47.
38. It occurred on a Sunday, November 6, 1977. Federal Investigative Board, *Rep't of Failure of Kelly Barnes Dam,* Toccoa, Georgia 1 (1977). The Alabama Power Company Walter Bouldin Hydroelectric Dam on the Coosa River in Elmore County, Alabama, failed without warning at 1:30 a.m. on February 10, 1975. It had been in operation 8 years at the time. 9 FPC No. 37 (August 20, 1976).

Teton dam was not a mechanical or technical failure, nor was it an act of God. It was an institutional failure which ultimately is human failure. Basically, the Bureau of Reclamation, the builder of Teton, had developed a hubris, which cannot be allowed to recur in an area as critical as dam safety.[39] An internal Bureau of Reclamation study states that "past experiences at other dam sites may have given the USBR designers an unwarranted sense of confidence".[40] Excessive faith was placed on engineering expertise, which is not fully justified in light of the fact that many areas are still not fully understood, such as hydraulic fracturing.[41]

One of the most significant institutional lessons is that no identifiable person is responsible for the disaster. In the bureaucratic maze of the Bureau of Reclamation, it seems that since everyone was responsible, no one was responsible.[42] Teton investigations reveal no records, documents or reports that show logical resolution of each of the identified design problems, why a particular design alternative was considered satisfactory and selected in preference to others, or why an identified design problem was subsequently judged important or not important, and omitted from, or excluded from further consideration. The result is that it is now difficult to determine the personnel involved in a particular design issue.[43]

In addition, continuity of personnel from the planning process through construction is essential so that critical personnel have adequate familiarity with a project. The past

39. Needed Actions, *supra* note 9, at 12.
40. Failure of Teton Dam, *supra* note 17, at D-18.
41. Teton Dam Failure, *supra* note 20 at 26-27.
42. Needed Actions, *supra* note 9 at 46. An interesting outcome of the Teton break illustrates the lack of responsibility present in the Bureau. When Cecil Andrus became Secretary of the Interior, he announced that he would fire all Bureau officials responsible for the Teton Break. Denver Post, May 10, 1977 at 23, col. 3. Harold G. Arthur, Director of Design and Construction for the Bureau, disclaimed responsibility since the design was engineered by his predecessor, Bernard P. Bellport, who retired in 1972. Arthur, though, was Bellport's deputy, and prior to that he was Bellport's "chief design engineer". Bellport denies all responsibility because he was an administrator, not a design engineer. All the the design engineers had retired by the time of the Teton Break, with the exception of Arthur. Denver Post, May 23, 1977 at 13, cols. 1-2.
43. Failure of Teton Dam, *supra* note 17, at 87. Failure of communications were also disclosed in the investigations. For example, the principal Bureau designer of Teton Dam stated he had intended all open cracks in the foundation rock under the highly erodable core be sealed. This intent was not fully carried out because of unclear instruction drawings, and specifications and misinterpretations by project staff. Needed Actions, *supra* note 9, at 42.

had seen rapid turnover in individual jobs, with the assumption that the work of one's predecessors was correct.[44]

An internal study of the Bureau's dam safety procedures recommended identification of one agency as the responsible agency for safety within the Bureau.[45] Design and construction functions should be integrally linked in the agency. Requisite administrative support should be provided the professional staff. Individual responsibility has to be pinpointed within the agency on all levels;[46] signatures are to reflect technical responsibility.[47] Interestingly enough, one reviewing group, comprised of non-lawyers, indicated that negligence analysis could be a method for determining responsibility.[48] The gist of these recommendations was to eliminate the existing paper-shuffling and passing-on tendencies of the agency.

Strong internal review procedures were advocated.[49] Reviewers should be independent.[50] External review should occur for all dams which could pose a continuous, potential hazard if failure occurred, as well as of procedures, technologies and special problems requiring innovative solutions. Unlike the Corps of Engineers, The Tennessee Valley Authority and the State of California, the Bureau made little use of outside consultants, and when it did, it was generally

44. In 1970 16 dam designers produced three dam specifications per year. By 1977 this same number were producing 6 dam specifications per year. The study revealed severe understaffing problems. *Id.* at 64-4. Between 1967 and 1977 funding increased 130% to $326,010,000 while personnel decreased 22% to 8, 458 from 10,850. *Id.* at 70. In the interim, many additional responsibilities, such as NEPA and the Freedom of Information Act have been imposed on the agency. *Id.* at 63.
There is reason to believe that, because of heavy workloads, supervisors might find it difficult to spend as much time on reviews as they would otherwise. Teton Dam Failure, *supra* note 20, at 38.
45. Review Study, *supra* note 20 at 11. No single organizational unit in the Bureau was responsible for dam safety; Safety of Dams, *supra* note 18, at 21. A related organizational problem is that the engineer-in-charge of construction at any given project had two masters. He takes technical direction from the Director of Design and Construction, and administrative direction from the Regional Director. The result is a lack of clear understanding of responsibility. Review Study, *supra* note 20, at 30.
46. *Id.* at 11, 46. Because of an organizational reshuffle, a void developed in Bureau responsibility, *Id.* at 35-36.
47. *Id.* at 12, 47. For example, the individual signing the drawing may have had little or no technical competence in that area. Or the approval signature may be by the head of an organizational entity who has had minimal involvement in the details of the design. *Id.* at 47. Commissioner Stamm of the Bureau of Reclamation testified to the existence in the Bureau of a proclivity for people to initial without reading. Teton Dam Failure, *supra* note 18, at 28.
48. Review Study, *supra* note 20, at 47. If only Torts were so simple!
49. For example, both the accuracy of the technical work and the validity of the basic assumptions used in performing the work need to be checked before it leaves the responsible designs unit. *Id.* at 54. Internal review is recommended at each transition in the dam plan-design-construct-operate process. *Id.* at 58.
50. *Id.*

limited to input on a specific problem. It is now recommended that an independent review board be convened for each major dam project to review both design and construction at frequent intervals.[51]

A major institutional problem had been reluctance of the Bureau to discuss problems—not only externally, but also internally. For example, the Bureau had a near failure at Fontenelle Dam in Wyoming in 1965. A paper on it was presented in Turkey in 1967. Copies were circulated in February 1977, after the collapse of Teton. Many Bureau engineers in the dam design-construction-operation process were unaware of the details until after the Teton Dam failure.[52] Due to the great similarities between the two dams, the Teton Break may have been prevented. The lessons that should have been learned from Fontenelle were institutionally forgotten.

On a political-institutional level, one report made specific recommendations to safeguard against the momentum to continue a project once it has been approved. These proposals consist of the establishment of an office of Dam Safety,[53] the expertise and supervision of the dam teams, and internal review procedures.[54] Ultimately though, any solution to this problem depends upon the quality of the leadership and the political realities of Washington. President Carter's attempts to cut back on certain pork barrel, water-development projects in the West illustrate the complexities of this problem.

It should be noted that the Bureau has abandoned or modified several projects because of foundation safety problems.[55] Neither the Bureau nor the Corps, though, could iden-

51. Failure of Teton Dam, *supra* note 17, at 107. Safety of Dams, *supra* note 20, at 19. Needed Actions, *supra* note 9, at 24, 54. External review is especially critical. Many of the remaining dam sites are considered more difficult to build on than past sites. *Id.* at 6.
52. Review Study, *supra* note 20, at 88. One major recommendation of the Fontennelle paper was that a slow, controlled filling of reservoirs was needed where unfavorable foundation conditions are known to exist. Needed Actions, *supra* note 9, at 61.
53. It was felt that an internal review process could avoid the "momentum to build" tendency. Review Study, *supra* note 20, at 53.
54. Dam Safety Review, *supra* note 20, at 133.
55. These include reducing the storage capacity of American Falls Dam and Reservoir in Idaho by half, abandonment of the Virgin City Dam in Utah, Cannonball Dam in North Dakota and Bixby Dam in South Dakota before construction commenced. Teton Dam Disaster, *supra* note 6, at 274-275.

tify any dam project terminated once actual construction had commenced.[56]

In hindsight, so many of the recommendations and lessons learned from Teton smack of common sense and ordinary reasonableness. Yet the fact remains that a disaster was needed to recognize them.

The Bureau seems to be learning its lessons.[57] Nor should the Bureau necessarily be singled out for human errors.[58] Teton gave us both an "X-ray analysis" of one particular dam failure and the opportunity to review in detail the overall area of dam safety. Failure of other dams have not necessarily received such microscopic analysis.[59]

On a much broader level, a difficult dilemma arises. Acceptance of the prime principle that dams should not break could slow technology development. Unlike the premises of the air and water pollution statutes, dam safety cannot be a

56. *Id.* at 276, 456, 506. A Corps spokesman, in explaining why they could not identify any dams where construction stopped and the project was abandoned, stated: "I think the reason why we could not find any is that there is a general principle of modern engineering that almost any site can be used for construction if the owner can stand the price." *Id.* at 506. In other words, the Corps will request additional money from Congress to correct any foundation problems discovered during construction.

57. For example, in addition to the internal studies undertaken, the Bureau has hired outside consultants for an independent review of its designs for all storage dams, and has asked for bids from consulting firms to study its technical procedures used in planning, designing, and constructing dams to see if they follow reasonable safety standards within the limits of existing technology. Needed Actions, *supra* note 9, at 24.

One year after the Teton Break, the Bureau halted filling of the Nambe Falls Dam in New Mexico, because of grave concern over safety. Observations of six springs indicate that seepage from the reservoir is finding its way through or around the right abutment grout curtain at the dam. After Teton the Bureau hired a private consultant to make an emergency investigation of its seven newest dams. Denver Post, June 6, 1977 at 1, col. 1. As a result of these studies, the Bureau suspended the pool filling of three of these dams pending further study and remedial work. Safety of Dams, *supra* note 20, at 65.

58. For example, a Federal Power Commission investigation into the failure of the Alabama Power Company Walter Bouldin Dam on February 10, 1975, identified four major weaknesses, which contributed to the failure: (1) construction of the dam did not comply with design specifications; (2) company inspection procedures were inadequate to detect critical deficiencies in construction; (3) FPC staff review procedures were insufficient to identify marginal design criteria before construction began and (4) FPC staff methods for review of dam construction procedures and maintenance was not sufficiently exacting to uncover construction deficiencies. Walter Bouldin Dam, *supra* note 6, at 22-23.

After studying ad nauseum the record of the Storm King Mountain (Scenic Hudson) litigation some of us are concerned with the ability of the FPC (now Federal Energy Regulatory Commission) to give full weight to safety issues. *See especially* the discussion of the New York City aquaduct issue in Scenic Hudson Preservation Conference v. F.P.C., 453 F.2d 465 (2nd Cir. 1971) (Dissent).

59. Compared with the extensive studies on the Teton Break, we have a 20 page report on the Kelly Barnes Dam disaster, which killed 39 at Toccoa, Georgia. *See* Federal Investigative Board, *Rep't of Failure of Kelly Barnes Dam, Toccoa, Georgia* (1977).

technology-forcing situation.[60] "Engineering, particularly in the case of dams, is not an experimental science".[61] The risk of loss is too great. Thus, there is strong incentive to conservatively design well within the state-of-the-art since novel approaches could cause disaster.[62] For example, the key trench design on Teton was unique; it departed significantly from past Bureau practices in that it was deeper than usual, but also narrower for cost reasons.[63]

Yet we should not freeze technology. Quite the contrary. We should be encouraging innovation. Considering the engineering bias in dam construction to "go by the book", the Corps approach is probably the best practical solution to the problem. Innovative solutions to problems are not proscribed, but are subject to review by a panel of outside consultants.[64] Government should also fund independent research in dam construction and safety, and broaden the existing technology sharing activities with other countries, who have substantial experience in dam construction. To a major extent, technology sharing is being done through the International Committee on Large Dams and the State Department technological exchange programs. These activities should be intensified, and the information received expeditiously disseminated.

III. CRITICAL PROVISIONS NECESSARY FOR VIABLE DAM SAFETY AND INSPECTION REGULATION

In developing the parameters of proposed dam safety legislation, we will draw heavily upon the lessons learned from Teton, other studies, general observations, common sense, state statutes, and from several concepts this author developed in an article on strip-mining.[65] Although the sub-

60. *See* Bleicher, *Economic and Technical Feasibility in Clean Air Act Enforcement Against Stationary Source*, 88 HARV. L. REV. 316 (1975), Kramer, *Economics, Technology, and the Clean Air Act Amendments of 1970: The First Six Years*, 6 ECOLOGY L. Q. 161 (1976), Note, *Technology Forcing Under the Clean Air Act: The Electric Utility Dilemma*, 38 U. PITT L. REV. 565 (1977).
61. Teton Dam Failures, *supra* note 18, at 31. Thus it can be said "earth fill dam design criteria must be reasonably conservative". Walter Bouldin Dam, *supra* note 6, at 25.
62. It should be noted that every embankment "can be said to have its own personality requiring individual design consideration and construction treatment". Treatment of these individualities produces most of the continuing advances in dam design and construction technology. Independent Study, *supra* note 14, at vii-viii.
63. *Id.* at 25.
64. *Id.* at 31.
65. *See* Binder, *Strip Mining, The West and the Nation*, 12 LAND & WATER L. REV. 1, 22-25 (1977).

jects of strip-mining and dam safety may initially appear unrelated, the underlying issue in both instances, as in most socio-ecological concerns, is resource allocation. In both instances the goal is to maximize the general welfare while minimizing the adverse consequences. The regulatory measures essential to advance these goals are very similar. Consequently, many socio-ecological concerns may be resolved in an interdisciplinary, technology-transfer approach.

The program should include all dams that could pose a potential hazard to human life or property. Any meaningful dam safety program should include a permit system administered by a competent state agency. Because of the magnitude of the risks involved with major dams, a bifurcated permit system should be adopted similar to that used in licensing nuclear power plants. An initial permit is needed to begin construction.[66] Then a separate permit, or operating license, is required before operation (or filling) may commence.[67] Separate studies, investigations and hearings must be held before the second license shall issue. The permit system should cover not only the initial construction of a project but also any changes or alterations which might affect the integrity and safety of the structure. Similarly, provisions should be established to govern the removal of existing structures.[68] Permits should also be required for significant changes or modifications to a facility, either during or after construction.

The permit application must include not only the schematic of the dam and its immediate physical surroundings, but more importantly, detailed baseline studies of the dam site and drainage basin, detailing geologic, topographic, hydrologic and seismic characteristics. These studies must include establishment of specified ecological and geophysical baselines, such as ground water characteristics,[69] surface water flow patterns, meteriological characteristics, flow patterns and history, test borings and plans to minimize

66. 42 U.S.C. § 2235 (1970).
67. 42 U.S.C. §§ 2131, 2133 (1975).
68. For a broader discussion of the problem of old dams and their removal, *see* Waite, *Nineteenth Century Dams and Twentieth Century Problems: Commentary on a Statutory Solution*, 28 ME. L. REV. 619 (1977).
69. Dam design should include a complete analysis of ground water behavior. Review Study, *supra* note 20, at 40.

seepage flow through a dam. Emphasis should be placed on structural integrity, including construction methods, core materials, grouting, filters and channels. On a macro level, dam safety should include a complete analysis of groundwater behavior. Independent experts and boards of outside consultants should be employed in the dam design, dam review and safety investigation processes. At a minimum they should be employed when novel design approaches or major safety issues arise, and to assess the proposed measures undertaken to ensure structural integrity.

Plans should provide for adequate instrumentation and monitoring. Provisions should be included for preconstruction site inspections, inspections during construction, inspections before issuance of the operating license, and periodic inspections once operation commences. These inspections should occur at intervals of no more than five years. It may be that subsequent experience will tell us that inspections and state approval must occur before each distinct phase of construction ensues. This type of inspection approval provision is becoming common in lesser construction projects and home repairs. Inspection criteria must be provided so that inspectors, owners and operators are aware of critical safety constraints. Inspectors must be fully trained and inspection records should be detailed, comprehensive and consistent in form. Slides, springs, foundation problems and similar occurrences should be thoroughly investigated to ascertain if structural problems exist in a dam.[70] Rights of access must be provided the inspectors. A critical constraint is the need for the owner to maintain detailed, up-to-date records of the dam, its history and safety factors.[71]

To ensure that these responsibilities imposed upon an agency can be fulfilled, adequate staff and funds must be provided the agency.[72] Inspection and safety criteria should

70. Walter Bouldin Dam, *supra* note 6, at 26-8.
71. A major handicap in ascertaining the cause of the Kelly Barnes Dam break at Toccoa, Georgia, was the age of the dam, the lack of design, construction and maintenance records. Federal Investigative Board, *Rep't of Failure of Kelly Barnes Dam, Toccoa, Georgia* 2 (1977).
72. Adequate funding and staffing is one of the requirements for federal approval of a state strip mine program. At present, 54,195 dams are under state supervision, but only $4,371,379 is the determinable approximate annual budget of the state authorities directly related to dam and reservoir supervision. Many states have inadequate staff to enforce their dam safety statutes. Dam Safety Program, *supra*

be regularly upgraded in light of changing technology. In addition to funding through general funds of the state, the expense could also be offset through permit applicant fees, and charging the dam owner for the reasonable costs of the safety inspections. This provision could occur by requiring the owner of a dam to be re-licensed at periodic intervals, such as five years.[73] The permit application fee would cover the reasonable costs of inspection. A major factor in any effective inspection program will be the cost. For example, the Corps estimated that the estimated annual program for the 79,000 dams identified in the inventory will be $73,500,000.[74] Two-thirds of the states have stated they would like to have federal monies to carry out a meaningful program of dam safety.

Periodic inspections are essential,[75] but are meaningless without the power to compel corrective actions by the owner. The statutes should provide for a full range of remedial powers in the administrating agency, including detailed emergency powers, which should include, if necessary in light of the surrounding circumstances, agency assumption of control over the dam, lowering of the water level, and power to breach the dam.

Although many of the desired powers of the agency may already be conferred in broad administrative procedure acts,[76] or the general authority of an agency, or otherwise be implicit in the broad discretion granted administrative agencies today, still it is advisable to expressly grant these

note 8, at 4-5. *See also,* Dam Safety, *supra,* note 4 at 16-17. Tennessee's program went from $60,000 in funding in 1973 to 0 in 1977. *Id.* at 19. The history of dam safety legislation in North Carolina is illustrative of state efforts to regulate dam safety in this country. In 1967 a dam safety act was passed. In 1974 the first money was appropriated to enforce it. Between 1974 and 1976 300 dams were inspected. In February 1976, Bear Wallow Dam burst. Then a crash inspection effort was implemented. 22 inspectors were hired, and 3,082 dams identified. The costs of repairs or removals, borne by the owner, equalled $2 million. *Id.* at 18-19.

73. *See e.g.* TENN. CODE ANN. § 70-2514.

74. Dam Safety Program, *supra* note 8, at 14. This figure averages out to $1,500 per dam per year. The estimated cost of inspection for significant and high hazard potential dams is expected to range between $5,000 and $10,000 per dam, depending on the dam's size and complexity.

75. As a result of the Buffalo Creek Disaster 687 coal waste structures were inspected, and 230 were determined to be critically or potentially dangerous. The Corps of Engineers has discovered that periodic inspections not only avert possible structural failure, but also allow construction of less costly remedial measures than if its structure deteriorated further. This type of inspection program can be analogized to the benefits of a preventative maintenance program.

76. *See e.g.* UNIFORM LAW COMMISSIONERS' REVISED MODEL STATE ADMINISTRATIVE PROCEDURE ACT § 2 (1970).

powers in dam safety legislation because of the "strict construction" nature of the agencies involved, such as the Army Corps of Engineers, which as part of a military body, is conditioned to act within the limited powers expressly conferred by Congress. The courts should interpret the agency's powers, especially those relating directly to dam safety, broadly to carry out the broad public policy in these cases. Similarly, provisions should be included which would allow the agency to impose tighter restrictions than the national minimum standards.[77] This directive recognizes the primary responsibility of the state and affords flexibility in light of local conditions.

Although the legal system should not encourage frivolous complaints by outsiders, one lesson of Teton, and other dam breaks, is not to rely entirely upon the owner or agency. The history of administrative/environmental litigation over the past fifteen years, indicates the need for meaningful citizen's input.[78] Provisions which prevent or financially handicap citizen's involvement may well discourage the one complaint which is timely and well-founded. In an area as critical as dam safety, society cannot afford that risk. One common provision which could well discourage citizen's input on a dam safety issue requires the citizen's complainant to advance the costs of a safety investigation initiated pursuant to his complaint. If his complaint is well-founded upon investigation, then his money is refunded.[79]

An analagous situation under common law requires posting of a bond by the plaintiff if a preliminary injunction issued. The purpose was to compensate the defendant for any losses incurred if, upon full trial, it developed the preliminary injunction was improvidentially granted.[80] The federal courts have relaxed this doctrine in environmental cases brought by public interest groups.[81] The goal is to en-

77. *See e.g.* 30 U.S.C. § 1255 of the Federal Surface Mining and Reclamation Act.
78. The growth in citizen-initiated private environmental litigation has created a virtual revolution in Administrative Law such that distinguished jurists are now publicly articulating and reappraising their roles. *See e.g.* Oakes, *The Judicial Role in Environmental Law,* 52 N.Y.U.L. REV. 498 (1977), Oakes, *Environmental Litigation: Current Developments and Suggestions for the Future,* 15 CONN. L. REV. 531 (1973), Wright, *The Courts and the Rulemaking Process: The Limits of Judicial Review,* 59 CORNELL L. REV. 375 (1974).
79. *See* notes 142-145, *infra,* and accompanying text.
80. *See e.g.* FED. R. CIV. P. 65(c).
81. *See e.g.* West Virginia Highlands Conservancy v. Island Creek Coal Co. 441 F.2d 232 (4th Cir. 1971), Natural Resources Defense Council, Inc. v. Grant, 473 F.2d 280 (4th Cir. 1972).

courage these suits where the public interest is being vindicated by public interest groups, frequently opposed by the public agency which is statutorily charged with protecting the public interest.

On a broader level, the whole area of environmental litigation has caused individual judges and courts to reassess their role.[82] Traditional concepts, such as ripeness and[83] the burden of proof,[84] have received sweeping reappraisals amounting, at times, to a revolution in administrative law. It would be particularly unfortunate if, in an area as critical to public health and welfare as dam safety, citizen involvement should be discouraged.[85] Again the lessons of Teton should be heeded.

It should also be noted that since the lead time on a large dam project is great anyway,[86] the additional regulatory lag occasioned by meaningful citizens' involvement, which may already be required by other statutes, should not be viewed as critical. Public participation should therefore occur during the permit application stage and subsequently, when safety issues arise. To the extent that this participation could delay a project, it should be noted that such delays are already occasioned through use of the National Environmental Policy Act (NEPA).

Procedures should be provided for appealing an agency decision, both in the permit issuance proceedings, and in the reinspection process, but appellate processes should not be allowed to interfere in emergency situations where prompt action is required.

Other safety provisions should include minimum dam and reservoir operation standards and criteria, including

82. *See* note 78, *supra.*
83. *See e.g.* Citizens to Preserve Overton Park v. Volpe, 401 U.S. 402 (1971).
84. *See especially,* Ethyl Corp. v. Environmental Protection Agency, 541 F.2d 1 (D.C. Cir.) (en banc), *cert. denied* 426 U.S. 941 (1976) and United States v. Reserve Mining Co., 514 F.2d 492 (8th Cir. 1975).
85. Although NEPA theoretically serves to promote citizen participation, the NEPA process applies prior to the federal action. It has no effect on existing dams for which we want public input, such as thorough reports of safety defects.
86. For example, the Clarence Cannon Dam and Reservoir in Missouri was authorized by Congress in 1962, initially scheduled for completion in 1973, but is now scheduled for completion in 1981, eight years late. Thirteen other major Corps of Engineers dam projects remain uncompleted 11 years after the detailed construction estimate was completed. There is a schedule slippage of 9 years for the Harry S. Truman Dam and Reservoir Project. Comptroller General of the United States, *Report to the Congress, Clarence Cannon Dam and Reservoir - Cost, Schedule, and Safety Problems* 8-9 (PSAD-77-131. July 18, 1977).

river discharge controls, and minimum construction design standards, always considering though that each dam's design must be site specific. Plans, criteria and safety measures should be periodically reviewed to upgrade them in light of changing technology and knowledge. Safe standards of 40 years ago may be grossly inadequate today.[87] Records and logs should be maintained and readily available for all dams. Teton taught us the need for adequate stream warning systems and emergency evacuation plans.[88]

Dam safety incidents around the country should be studied, and the results promptly circulated to all concerned agencies, engineers and others. A central clearing house of information should be established. At present, only the voluntary, professional organization, the United States Committee on Large Dams, serves a clearing house role.

Special provisions should govern old unused dams.[89] Hazards can be especially acute with the older dams, built 50-100 years ago. A few states provide that abandoned dams will become the property of the state, and then dealt with appropriately.[90] One method of maintaining an up-to-date record of dams and their owners would be to require annual registration similar to municipal licensing requirements, at the minimum fee. Failure to register for a prescribed period of years would create a rebuttable presumption of abandonment.

A major problem will be the financing of repairs and maintenance. Even for the federal government, funds are limited. For example, the Bureau of Reclamation lists 44 dams that will not pass maximum probable floods. Some of these are in serious shape, but needed funds for repairs and up-grading have not been sought. Indeed, the Bureau's last

87. Compare Davison v. Snohomish County, 149 Wash. 109, 270 P.422 (1928); Bartlett v. Northern Pac. R. Co., 74 Wash. 2d 881, 447 P.2d 735 (1968).

88. Needed Actions, *supra* note 9, at 68. *See also,* Walter Bouldin Dam, *supra* note 7, at 47.

89. It has been shown that older dams have experienced failure and accident rates more frequently and on a larger scale than modern, well-engineered dams constructed since 1940. Many of the older dams were not designed, or supervised during construction, by engineers. With the development of modern soil dynamics, dam design, particularly with earth embankments, was drastically revised, and most dams built by the federal and state governments, major utilities, larger cities, were well engineered and supervised during construction, Dam Incidents, *supra* note 4, at 31, 87.

90. FLA. STAT. ANN. § 58: 373,426; MINN. STAT. ANN. § 110.37. Of course, the financial and legal burdens imposed on the states by these provisions can be great.

budget requested $5.6 million for repairs, and $723 million for new construction.[91]

On a local level, the problems can be even greater for those without access to large capital or public resources. For example, Massachusetts has many old mill dams, which no longer serve their original purpose. The present owners, through mesne conveyances, do not have the financial capabilities, technical knowhow, or incentive to make the necessary repairs or demolitions.[92]

One way to increase the chances of a dam being maintained past its uncertain economic life is to require in an appropriate case, where reasonable doubts exist, the creation and maintenance of a trust fund, the income of which would go towards maintenance of the dam.[93] Creation of the trust fund would be a condition to issuance of a permit. Another method would be a means, such as forfeiture through nonuse, eminent domain, or gift, for the state to acquire an old dam and then take the necessary remedial actions. The costs could be paid by a special fund raised through taxes on operating dams.

Power must be invested in the agency to bar new dams in areas where safety or environmental values should preclude development, such as in the Wild and Scenic Rivers system.[94]

There must exist a willingness in the agency to revoke or modify existing permits, deny new permits or deny operating permits after completion or construction.[95] In environmental law we witness the hesitancy of courts and agencies to revoke or deny permits if large amounts of capi-

91. Dam Safety, *supra* note 5, at 24. The Corps requested $1.5 billion for new construction and but $27.5 million for rehabilitation. *Id.* Examples of deficiences in existing Bureau dams are discussed in *Id.* at 22-24.
92. *See* Dam Safety Program, *supra* note 8, at XXXVIII.
93. *See e.g.* Daly v. Natural Resources Board, 60 Wis. 2d 208, 208 N.W.2d 839 (1973).
94. 16 U.S.C. §§ 1271. Under 16 U.S.C. § 1278, neither the Federal Power Commission nor any other federal agency may license a dam on a river included in the system. For a general discussion of the Act, *see* Tarlock & Tippy, *The Wild and Scenic Rivers Act of 1968*, 55 CORNELL L. REV. 707 (1970). A few states have similar provisions. *See e.g.*, ME. REV. STAT. ANN. § 12-661. WIS. STAT. ANN. § 30.26 and MICH. COMP. LAWS ANN. § 281.761. One common provision is to protect fish and wildlife. *See e.g.* ARK. STAT. ANN. § 21-1306(1); ILL. ANN. STAT., ch. 19 § 705.
95. California has been willing to take these actions. Teton Dam Disaster, *supra* note 7, at 325. The reason is undoubtedly because of its past experience with dam breaks.

tal have been invested in a project,[96] or if the project's goal corresponds to an essential mission of the agency, such as the production of power.[97] For these reasons, dam safety should not be entrusted to agencies such as the Federal Energy Regulatory Commission nee Federal Power Commission or state public commissions. Instead, preferably an independent agency should be established whose sole responsibility is dam safety. In the alternative the powers should be invested in an agency, such as a water resources commission, whose track record evidences a history of carrying out a multiplicity of responsibilities.

Criteria can be established to promote viable dam safety mechanisms, including both strong internal review procedures, and external review procedures involving independent consultants, other agencies in an interdisciplinary approach, and public input. However, the key to effective agency action will be internal, and depend upon several factors including the level of funding, the competency of the staff and the receptiveness to new ideas. Ultimately though, it will depend upon leadership from above. By encouraging input from outside, such as independent consultants, hopefully a sufficient catalyst will exist to direct the agency's actions.

IV. MODEL CODES

The next step in the dam safety study is to compare existing models with the critical provisions, just set forth.

A. United States Committee on Large Dams

The United States Committee on Large Dams[98] has proposed a Model Dam Safety Law, which has been enacted by a few states.[99] The Act provides for pre-construction applica-

96. Teton Dam is a good example of this reluctance. The dam was 52% complete at the time of the Court of Appeals decision.

97. *See e.g.* the litigation involving the Federal Power Commission and Storm King Mountain. Scenic Hudson Preservation Conference v. Federal Power Commission, 354 F.2d 608 (2nd Cir. 1965), *cert. denied* 384 U.S. 941 (1966).

98. The United States Committee on Large Dams (USCOLD), is a member of the International Commission on Large Dams. It is comprised of professional engineers, geologists and individuals and organizations concerned with the design, construction, operation and maintenance of dams and reservoirs. The proposed model law was circulated in 1970, and is found at Dam Safety Program, Appendix C, *supra* note 7.

99. *See e.g.* ARIZ. REV. STAT. § 45-701 (1973), IDAHO CODE § 42-170; North Carolina Dam Safety Law of 1967, N.C. GEN. STAT. § 143.215.25; South Carolina Dam and Reservoir Safety Act of 1977, S.C. CODE § 49-11-110; Tennessee Safe Dams Act of 1973, TENN. CODE ANN. § 70-2501; West Virginia Dam Control Act of 1973, W. VA. CODE ANN. § 20-50-1.

tions and approval by an agency,[100] (including detailed design analysis),[101] periodic inspections during construction,[102] inspections,[103] and review and issuance of a certificate after construction but before water can be stored.[104] The act therefore establishes a bifurcated licensing procedure whereby separate permits are needed for construction and operation. Completed dams are to be investigated and inspected at least once every five years.[105] The agency is empowered to issue corrective measures,[106] including emergency actions.[107] The act covers all dams, except federal dams,[108] and the common exception for dams less than twenty-five inches in height, or with an impounding capacity of less than 50 acre feet.[109]

Several provisions are designed to protect the state's interest, including a non-waiver of sovereign immunity if a dam breaks.[110] The owner or operator of the dam will remain legally liable, but the measure of liability is left undefined.[111] Thus, resort would be by default to the state common law to ascertain the standard of care imposed upon the owner or operator.[112] The owner remains liable even when the agency takes over control in an emergency, but by inference,[113] liability in this situation may be limited to negligence.[114]

Other measures protecting the state interest include preemption of inconsistent local measures.[115] In addition, the

100. MODEL CODE at § 1160.
101. MODEL CODE at § 1102(f).
102. MODEL CODE at § 1166.
103. MODEL CODE at §§ 1081.2, 1166, 1176.
104. MODEL CODE at § 1152. In seeking this operating license, the applicant must include a record of all geological boreholes, grout holes and grouting, a record of permanent location points, benchmarks and instrumentation, test records of concrete, or other material used in construction, and a record of seepage flows and embedded instrument readings. MODEL CODE at § 1150.
105. MODEL CODE at § 1176.
106. MODEL CODE at § 1178. In determining when an emergency exists, the agency can consider, interalia, seepage, overtopping, settlement, erosion, cracking, earth movement, earthquakes and failure of facilities, such as bulkheads, flashboards, gates and conduits. *Id.* at § 1080.
107. These include taking control of the dam, lowering the water level, emptying the reservoir, and other measures as necessary. MODEL CODE at § 1179.
108. MODEL CODE at § 1005(g).
109. MODEL CODE at § 1002.
110. *Id.* at § 1028.
111. *Id.* at §§ 1028-1029.
112. The question of civil liability of a dam owner for a dam break is so complicated that it will be the subject of a subsequent article.
113. MODEL CODE at § 1179.
114. The section states: "The agency's take over will not operate to relieve the owner of a dam or reservoir of liability for any *negligent acts* of the owner or his agents. *Id.* (emphasis added)
115. MODEL CODE at § 1026.

state agency can issue appropriate rules and regulations,[116] investigate a site,[117] and take necessary legal actions.[118]

The permit application must contain detailed baseline studies, such as the area of the drainage basins, rainfall,[119] stream-flow,[120] flood-flow records,[121] and maps.[122] In addition, in its discretion, the agency may require topographic, geographic and seismic studies.[123] It can require exploratory cuts, drills, wells and other pre-permit studies.[124] Physical tests can be made both on-site and in a laboratory.[125] All these studies and plans are in addition to the standard requirements of detailing the dimensions and storage capacity of the dam, and plans for permanent instrumentation. The agency on-site inspection before filling shall include a review of the records, such as geological boreholes, grout holes and grouting, concrete tests, seepage flows and instrumental readings.[126] The agency shall require the dam owner to maintain up-to-date records of the dam.[126a]

Construction of the dam is to occur under the supervision of a responsible engineer.[127] Any repairs, other than routine maintenance, require an application and issuance of a permit.[128] In issuing a construction permit, the agency is empowered to impose terms, conditions and limitations necessary to safeguard life and property.[129] The agency has similar powers in issuing the operating license.[130]

Pursuant to its inspection powers, the agency can act upon a written complaint by an individual of an unsafe condition. However, in acting pursuant to such a complaint, the agency may require the complainant to deposit funds sufficient to cover the costs of inspection. If unsafe conditions

116. MODEL CODE at § 1078.
117. Its inspection powers include a right of entry. *Id.* at § 1076.
118. *Id.* at § 1083.
119. *Id.* at § 1102(e).
120. *Id.* at § 1102(f).
121. *Id.* at § 1102(h).
122. *Id.*
123. *Id.* at § 1103.
124. *Id.*
125. *Id.* at § 1103(b).
126. *Id.* at § 1150.
126a. *Id.* at § 1175.
127. *Id.* at § 1150.
128. *Id.* at § 1027.
129. Routine maintenance and operation do not include actions affecting the safety of the structure. *Id.* at § 1077.
130. *Id.* at § 1153.

are found to exist, the agency shall order corrective measures taken, and return the inspection monies to the complainant.[131] If the complaint is found to be without merit, the state retains the costs of the inspection.[132]

The agency can appoint an outside review board to investigate when issues of safety arise.[133] The costs of the board will be borne by the dam owner.[134] If an owner objects to corrective orders or changes, he may request appointment of an independent consulting board.[135]

Periodic dam investigations can be made by the state's own engineers, or by others hired by the state. The periodic investigations are at the state's expense, but tests or additional work can be ordered at the owner's expense.[136]

The agency is responsible for determining when an emergency exists.[137] In an emergency, the agency can order the owner to perform the requisite repairs, or if necessary, breach the dam. If the owner fails to do so, the agency can do so at the owner's expense.[138] In addition, the agency may revoke or suspend any certificate when it determines a dam or reservoir constitutes a danger to life or property.[139] Remedial powers include state assumption of control of the dam, lowering of the water level, emptying of the reservoir, protective work, and any other steps necessary under the circumstances.[140]

B. Corps of Engineers Proposed Legislation

The Army Corps of Engineers has submitted to Congress a bill[141] under which federal agencies would relinquish jurisdiction over non-federal dams to states with programs which substantially comply.[142]

131. *Id.* at § 1153.
132. *Id.* at §§ 1162-1165.
133. *Id.* at § 1051.
134. *Id.* at § 1052.
135. *Id.* at § 1167.
136. *Id.* at § 1176.
137. *Id.* at § 1177.
138. *Id.* at §§ 1178. 1180.
139. *Id.* at § 1154.
141. The proposed bill is included as an insert at Dam Safety Program, *supra* note 8.
142. *Id.* at § 2(b). The federal agencies affected thereby would be the Corps of Engineers and Federal Regulatory Commission.

In exercising their jurisdiction the federal agencies shall review the plans and specifications,[143] perform inspections during construction,[144] require records to be maintained[145] and issue a certificate of approval at completion.[146] The Act covers dams meeting the height and impounding capacities provided for in the 1972 Federal Dam Inspection Act.[147]

The Secretary of the Army, acting through the Corps of Engineers, shall have 120 days to issue final recommended guidelines for safety inspections and investigations of dams.[148] Other federal agencies should follow the Corps guidelines.[149] A right of entry to both premises and records is provided.[150]

Federal agencies shall periodically inspect the dams over which they have jurisdiction, at least once every five years. In doing so, they should evaluate the hydrologic capabilities, structural stability, and operational adequacy in assessing the safety of the dam.[151]

Inspection expenses, remedial measures and other expenses reviewed by the federal agency with respect to non-federal dams shall be reimbursed by the dam's owner to the government.[152]

Finally, the Act would terminate the requirement of a federal dam inspection program carried out by the Corps of Engineers, but would retain the Corps dam inventory system.[153] The Act would not relieve a dam owner or operator of legal duties, obligations or liabilities. Nor would it create any liability in the United States caused by action or failure to act.[154]

C. Critique of the Proposed Acts

The United States Committee on Large Dams Model

143. *Id.* at § 3(e)(1).
144. *Id.* at § 3(e)(2).
145. *Id.* at § 3(e)(3).
146. *Id.* at § 3(e)(4).
147. *Id.* at § 2.
148. *Id.* at § 4.
149. *Id.*
150. *Id.*
151. *Id.* at § 3(b)(1).
152. *Id.* at § 3(c).
153. *Id.* at § 8.
154. *Id.* at § 9.

Code and the Corps of Engineers proposals should be viewed as complementary parts of a total package, the gist of which is that the Corps is giving back to the states, through the model code primary line, responsibility over dam safety. Several deficiencies exist with respect to the package, starting with the exceptions.

The size constraints used in defining "dam", exclude an unknown number of structures, which pose a serious risk potential to human life or property. For example, the Toccoa, Georgia dam break involved a dam which barely met the statutory definition of "dam".[155] Similarly, the exceptions for federally operated or licensed dams should be premised upon periodic, competent inspections by the appropriate agency. In fact, the inspection practices of the various agencies fluctuate widely. The Teton Dam, for example, was a federal dam subject to the Act's exceptions. The agency involved, the Bureau of Reclamation, had a near-tragedy 15 years earlier, and now reports that several of its dams could break, but is not taking significant remedial measures,[156] thereby illustrating the need for mandatory remedial measures.

The express powers granted in the Corps proposals are very limited, and will require judicial decisions to flesh out their dimensions. The Corps proposal makes no provision for public input, either by expert consultants or by concerned citizens. The Model Code, through the inspection fee deposit provision, severely restricts meaningful citizen's complaints on the safety of any existing dam. It does not contain major instrumentation and monitoring provisions. It fails to cover old or abandoned dams. It does not provide for operational stream warning systems or emergency evacuation plans. It does not provide for periodic review of standards although it does provide for investigation and reviews of safety advances elsewhere. Nor are there provisions prohibiting dams in specified areas. Indeed, it provides little in the way of legislative mandates that the states must meet.

155. The Bear Wallow Dam Break in North Carolina, which killed four, involved a structure which did not meet the statutory definition of "dam".
156. *See* note 91 *supra* and accompany text.

The model code does however contain the bifurcated permit system, detailed baseline studies, rights of inspection and remedial-emergency powers essential to a viable dam safety program. It also provides for the use of outside consultants. On the other hand, the Corps proposal creates a minor regulatory gap whereby regulations are to be issued by one agency, the Corps of Engineers, but which do not have to be followed by other agencies. The proposed act fails to establish minimum national uniform standards which must be followed in issuing rules and regulations, fails to establish minimal inspection criteria, or enforcement procedures, as is common with other federal acts providing for a cooperative federal-state approval.[157] An explanatory statement accompanying the proposed act recognizes the wide discretion granted the agencies in issuing rules and regulations.

The effect of abolishing the National Dam Inspection Program is a retrogression in efforts to ensure dam safety nationally. Existing state measures are generally inadequate, and the proposed act does not mandate meaningful state efforts. Thus, we would be left with large gaps on a national level. Adoption of the Model Code by states would go a long way to filling the gap, but serious deficiencies exist with respect to it.

V. EXISTING LEGAL INSTITUTIONS GOVERNING DAM SAFETY

At this stage in the dam safety study, it is relevant to contrast the critical measures essential to viable dam safety programs, and the models, with the existing, but generally deficient, legal norms.

A. Federal Dam Safety Inspections

1. Federal Dam Safety and Inspections Act

As a result of several dam breaks and near misses in the early 1970's,[158] Congress enacted P.L. 92-367, the Federal Dam Inspection and Safety Act of 1972,[159] which authorizes

157. *See e.g.* 42 U.S.C. § 1857C-5(a) (Clean Air Act of 1978); 33 U.S.C. § 1342 (Federal Water Pollutions Control Act Amendments of 1972).
158. *See* notes 4-5, *supra* and accompanying text.
159. 86 STAT. 506.

a federal dam inventory and inspection procedure, as well as safety inspections. The act is relatively short, and contains numerous deficiencies in its provisions.

Under the Act dams are defined as being 25' or more in height, or having an impounding capacity of 50 acre-feet or more.[160] Impounding structures which do not meet either of these two tests are not considered dams.[161]

As soon as possible, the Secretary of the Army, acting through the Corps of Engineers, is directed to carry out a national program of inspecting dams, as defined, excluding dams constructed or authorized by specified federal agencies, dams inspected during the preceding 12 months by a state agency, and dams which the Secretary determines do not pose a threat to human life or property.[162] The inspection program commenced in December 1977.

The results of an inspection are to be given to the Governor of the appropriate state. In situations where hazardous conditions exist, the Governor shall be notified immediately, and if requested by the Governor, provided advice and recommendations on appropriate remedial measures.[163]

The Secretary is to report back to Congress on a national dam inventory, the results of the safety inspections, and recommendations for a comprehensive national dam safety program.[164] The inventory report was completed in 1975. Finally, nothing in the act, or actions or inactions taken pursuant thereon, shall operate to relieve an owner or operator of any legal duties or liabilities, or create liability in the United States.[165]

There are several deficiencies in the federal act, starting with the exceptions. A substantial deficiency is the height

160. *Id.* at § 1. The 25 foot limitation is measured from the natural bed of the stream.
161. Irrespective of this height and storage capacity, a structure is not considered a dam if it either is 6 foot or less in height, or has a storage capacity of 15 acre feet or less. *Id.*
162. The specified federal agencies are the Bureau of Reclamation, Tennessee Valley Authority and the International Boundary and Water Commission. Also exempt are dams licensed pursuant to the Federal Power Act. *Id.* at § 2. In determining whether a dam constitutes a danger to human life or property, factors to be considered are overtopping, seepage, settlement, erosion, sediment, cracking, earth movement, earthquakes, failure of bulkheads, flashboard, gates or conduits, or other conditions. *Id.* at § 4.
163. *Id.* at § 3.
164. *Id.* at § 5.
165. *Id.* at § 6.

and size limitations on dams covered by the Act. A second deficiency is the exception for federal dams. The previous section pointed out the problems with these exceptions.

The Act nowhere mandates remedial action if safety defects are discovered. All it requires is a report by the Secretary to the appropriate Governor. Presumably, the state or owner would then carry out the necessary corrective measures. However, a number of states possess either no appropriate dam safety legislation, or very ineffective measures.[166] In these situations, the state would be forced to utilize the vagrancies of public nuisance law to compel corrective measures by a recalcitrant owner.[167] An even greater problem exists when the owner is unknown, out of the jurisdiction, or financially unable to take remedial action.

Another problem is that of access for the safety investigators. Nowhere does the Act provide the Corps of Engineers the right of access to any dam. Entry might be possible under the terms of a permit issued pursuant to the Rivers and Harbors act for structures in navigable waters,[168] or by the Federal Power Commission for Hydro Electric Dams on Navigable Waters.[169] The operating assumption of Corps officials is that, if necessary, they will depend upon state law and officials for entry.[170]

A related problem is that the act does not require either the production or maintenance of records by dam owners or operators. Records of construction problems and operating histories can be of critical importance in resolving suspected safety questions.

The Act also fails to provide for the cost of maintaining and reproducing these records, which on a small dam, might

166. *See* notes 174-182 *infra*, and accompanying text.

167. A condition which creates a dangerous threat to public life is a public nuisance. *See* RESTATEMENT TORTS § 821B. Equitable relief, and if necessary, abatement are available as remedies. The privilege of abatement includes a right of entry, and the use of reasonable force. *See* PROSSER, TORTS, 605-606.

168. For example, under the current permit form, Condition 1 (f) authorizes the District Engineer to make periodic inspections at any time necessary to assure the activity is being performed in accordance with the terms and conditions of the permit. Under 1 (g), the permittee shall maintain the structure or work in good condition, and in accordance with the attached plans and drawings, Dep't of the Army Permit 2 (Eng. Form 1721, 1 April 1974) (ER 1145-2-203).

169. 16 U.S.C. § 797(e).

170. And that may lead us back to the vagaries of public nuisance law since many states lack a statutory right of entry for dam inspections. *See* note 167, *supra* and accompanying text.

be highly expensive in proportion to the revenues and benefits accruing to the operator through running of the dam. Finally, the Act does not provide for periodic inspections, or reinspections, which would help insure the continuing safety of dams.

2. Implementation of the Statute.

In hindsight, the major defect in the Act is a very common problem with statutes; the provisions were not self-executing.[171] Just as it took a series of dam failures to prod enactment of the measure, so too it took another series to prod implementation of the inspection provisions. Because of opposition from the Office of Management and Budget,[172] the only funds made available to the Corps pursuant to the Act were for the inventory process, which relied upon the states for the basic data.

The Corps undertook a limited inventory under which it tried to identify dams which, if they failed, could harm human life or property. Yet no actual inspections were made, and no attempt was made to assess the risk of failure of any given dam. The Corps identified a total of 49,329 dams, of which 20,000 or roughly 40% posed a significant risk to human life or property. Nine thousand of these were described as "high hazard".[173] However, less than 8% of these dams had ever been inspected by federal or state officials.

The Corps estimated the study was 90% accurate. It did little to verify the information submitted by the state.[174] Instead, it relied upon voluntary participation by the states. It did not provide minimal inspection criteria to the states.

171. *See* note 7, *supra*.
172. OMB at one point instructed the Army that no Federal inspections of non-federal dams were to occur. Dam Safety, *supra*, note 5, at 7. It was the view of the Nixon and Ford administrations that dam safety of non-federal dams was a matter of state, not federal, concern.
173. Thus, 11,000 were in the "significant hazard potential category". Dam Safety Program, *supra* note 8, at 14. High hazard dams involve a potential downstream loss of life of more than a few, and "excessive-extensive" community, industrial or agricultural potential economic loss. Significant hazard dams involve a potential downstream loss of life of a few and appreciable potential downstream economic loss. Low hazard dams involve no potential downstream economic loss. Low hazard dams involve no potential downstream loss of life and minimal potential downstream economic life. The Corps did not try to quantify these definitions, thereby allowing each state to interpret them differently. Dam Safety Implementation, *supra* note 6, at 7. One major problem with the inventory is that it excluded many dams because of the size limitations, but which pose a threat to human life or property. *Id.* at 6.
174. *Id.* at 5.

Nor, because of a lack of actual inspections, could it identify problem areas calling for increased federal standards.[175]

The Corps has recently implemented an actual inspection program, which will be limited to the 9,000 "high hazard" dams. Although it is too early to form conclusions, it is significant that of the first 273 dams inspected by the Corps, 12 were found to need "immediate remedial action to eliminate unsafe conditions". Two were in such critical shape that they were drawn down.[176] A major problem on a number of dams inspected so far is a lack of drainage facilities. Another problem that has developed is that on occasion, the inspector cannot determine who the owner is, much less what steps should be taken if there is no owner.[177]

One caveat on these inspections is that the safety reports generally do not provide that the dams are "safe", but report on deficiencies. If no deficiencies are found, then the report will provide, in a manner similar to the auditor's statement in an annual report, something like "no deficiency is found based on established criteria".[178] The Corps is not trying to be, and cannot be, an insurer of safety in its inspections.

B. State Dam Safety and Inspection Program

1. General

The purpose of this section is to detail the existing state regulatory systems. Individual state provisions will be highlighted where they differ from the general state provisions. Many significant requirements though are not imposed by statute, but through regulations, internal policies or discretion. These practices will be mentioned where appropriate. The fact that many essential provisions are uncodified illustrates a grave weakness in the statutory scheme.

The record of state dam safety legislation is sporadic from state to state. The overall effect is one of severe deficiencies on a national level. Eleven states or territories have no laws regarding any aspect of dam safety. Six states have

175. *Id.* at 13-14.
176. *See* note 8, *supra.*
177. These statements are based upon discussions with Corps personnel in the Seattle District of the Corps.
178. *Id.*

CRITICAL PROVISIONS NECESSARY FOR VIABLE DAM SAFETY

	PERMIT SYSTEM	BIFURCATED	UNITARY	MODIFICATIONS, AMENDMENTS, CHANGES	REMOVAL	POWER TO IMPOSE TERMS AND CONDITIONS	ANY DAM POSING A THREAT TO HUMAN LIFE OR PROPERTY	DETAILED BASELINE STUDIES	OUTSIDE CONSULTANTS	INSTRUMENTATION AND MONITORING
Model Code	X	X		X		X		X	X	
Alabama	X		X	X						
Alaska										
Arizona	X	X		X	X	X		X	X	X
Arkansas	X		X					Y		
California	X	Y	X	X	X			Y	X	Y
Colorado	X	X				X		Y	X	X
Connecticut	X	X		X	X		X		X	
Delaware	X		X	X				Y		
Florida	X		X	X			X	Y		
Georgia										
Hawaii										
Idaho	X	X		X	X	X		X		
Illinois	X		X				X			
Indiana	X		X					Y		
Iowa	X		X	X	X	X		Y		
Kansas	X		X	X		X		Y		
Kentucky		Y						Y		
Louisiana										
Maine	X		X							
Maryland	X		X	X		X		Y		X
Massachusetts	X		X	X			X	Y		
Michigan	X		X	X				Y	X	
Minnesota	X		X	X	X	X				
Mississippi	X							Y		

Missouri	X									
Montana									X	
Nebraska	X							Y		X
Nevada	X							Y		
New Hampshire	X			X			X	Y	X	
New Jersey	X	Y		X	X	X		Y		
New Mexico	X	X				X		Y	X	
New York	X			X				Y		
North Carolina	X	X		X	X	X		X	X	
North Dakota	X									
Ohio	X					X		Y		X
Oklahoma								Y		X
Oregon	X			X		X		X	X	X
Pennsylvania	X			X		X		Y		X
Rhode Island	X			X			X	Y	X	
South Carolina	X				X		X			
South Dakota	X	X								
Tennessee	X	Y		X	X	X		Y		X
Texas	X	Y		X				Y		X
Utah	X			X			X	Y		X
Vermont	X	Y		X			X	Y	X	
Virginia	X			X		X	X	X	X	
Washington	X			X				Y		
West Virginia	X			X	X	X		X	X	X
Wisconsin	X	Y		X	X			X		X
Wyoming	X			X			X		X	

X = Mandated by Statute
Y = Otherwise Required by State

CRITICAL PROVISIONS NECESSARY FOR VIABLE DAM SAFETY

	INSPECTIONS	PRE-CONSTRUCTION	POST-CONSTRUCTION	PERIODIC	REMEDIAL POWERS	EMERGENCY POWERS	OUTLET FACILITIES	RULE MAKING POWERS	BROAD CITIZEN INVOLVEMENT	PUBLIC HEARINGS
Model Code	X		X	X	X	X				

Alabama										
Alaska										
Arizona	X		X			X	X	X	X	
Arkansas	X		X					X		X
California	X		X		X	X	Y	X		
Colorado	X		X	X		X			X	
Connecticut	X		X	X	X			X		
Deleware										
Florida	X		X		X			X		
Georgia										
Hawaii										
Idaho	X		X	X	X	X	Y	X	X	
Illinois							Y			
Indiana	X		X	X	X	X		X	X	
Iowa	X		Y		X			X		X
Kansas							X	X		
Kentucky			Y							
Louisiana										
Maine	X				X				X	
Maryland	X		X		X			X	X	X
Massachusetts	X		X	X	X				X	
Michigan	X		X		X		X	X		
Minnesota	X		X		X	X			X	X
Mississippi										
Missouri										
Montana	X		X			X			X	
Nebraska	X		X				Y	X		X
Nevada	X		X			X	Y			
New Hampshire	X		X	X	X		Y			
New Jersey	X		X		X		Y	X	X	
New Mexico	X		X		X			X		X
New York	X		X		X	X		X		X
North Carolina	X		X	X	X	X		X	X	
North Dakota					X			X		
Ohio	X		X	X	X			X		
Oklahoma			Y							
Oregon	X	X	X		X					X
Pennsylvania	X		X		X	X	Y	X	X	X
Rhode Island	X		X	X	X		Y		X	
South Carolina	X		X		X	X		X	X	
South Dakota	X		X					X		

Tennessee	X		X	X	X			X	X
Texas	X		Y					X	
Utah	X		X		X				
Vermont	X		X		X			X	X
Virginia								X	X
Washington			Y				Y	X	
West Virginia	X		X		X	X		X	X
Wisconsin	X		X	X		X	X		X	X
Wyoming	X		X	X		X	X			X

X = Mandated by Statute
Y = Otherwise Required by State

no dam safety statutes.[179] Twenty states have old mill dam acts, which are generally inadequate in light of today's needs.[180] Four states' programs are basically part of their regular water permit-appropriation system,[181] but in two others, this system specifically includes dam safety provisions.[182] Only a few states have enacted fairly comprehensive statutes.[183] Twenty-four states told the Corps of Engineers that current dam safety regulations do not fully meet present needs.[184] Twenty-nine states present a fairly comprehensive statutory scheme, which may or may not be effective in practice.[185]

The general approach is that of a permit system administered by an administrative agency. The agency is generally the equivalent of a Department of Natural Re-

179. Dam Safety Program, *supra* note 8, at 4. States with no dam safety legislation are Alabama, Alaska, Delaware, Georgia, Hawaii and Missouri. Since the Corps study was conducted, Florida and South Carolina enacted dam safety measures.

180. ALA. CODE tit. 18 § 2-1, ARK. STAT. ANN. § 35-501, DEL. CODE, tit. 7 Ch. 23 § 1901 (non-navigable waters), IOWA CODE ANN. § 469, KAN. STAT. § 829, KY. REV. STAT. § 182.010, ME. REV. STAT. ANN. tit. 38, § 651, MASS. ANN. LAWS Ch. 253, MICH. COMP. LAWS ANN. § 46.22, MINN. STAT. ANN. § 110-14, MO. ANN. STAT. § 482-1, PA. STAT. ANN. tit. 32 § 291, R.I. GEN. LAWS ANN. § 46-18-1, TENN. CODE ANN. § 54-17-1, VA. CODE ANN. § 62.1-116, WIS. STAT. ANN. § 31.31 (non-navigable waters).

181. MISS. CODE ANN. § 51-3-1, OK. STAT. ANN. tit. 60 § 60, TEX. REV. CIV. STAT. ANN. tit. 2 § 6.002, S. DAK. COMP. LAWS ANN. § 46-5-1. This procedure does not necessarily mean that these measures are totally inadequate. For example, the Texas code requires a permit (TEX. REV. CIV. STAT. ANN. tit. 2 § 6.121), the filing of an application with information and maps (*Id.* at §§ 5-123, 124), inspection provisions during construction (*Id.* at § 6.064), and a right of entry onto the land (*Id.* at § 6.065).

182. N. MEX. STAT. ANN. § 75-5-1, OR. REV. STAT. § 537.010.

183. *See e.g.* ARIZ. REV. STAT. § 45-701 (1973), CAL. WATER CODE § 6001, IDAHO CODE § 42-170, North Carolina Dam Safety Law of 1967, N.C. GEN. STAT. § 143.215.25, South Carolina Dam and Reservoir Safety Act of 1977, S. C. CODE § 49-11-110, Tennessee Safe Dams Act of 1973, TENN. CODE ANN. § 70-2501, West Virginia Dam Control Act of 1973, W. VA. CODE ANN. § 20-50-1, and WYO. STAT. § 41-3-30.

184. Dam Safety Program, *supra* note 7, at 24, A-140 to A-143. Alabama, Arkansas, Delaware, Florida, Idaho, Indiana, New Hampshire, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Utah, Vermont, Virginia, and Washington were unsatisfied with their dam safety program.

185. In addition to the statute set forth in note 203, *supra, see* COLO. REV. STAT. §

sources, or water resources board.[186] In states where it is closely tied to the permit-appropriation system, it is administered by the state engineer.[187] Occasionally it is run by a special agency, such as the public utilities commission.[188]

2. Coverage

Only eleven statutes have provisions which cover any dam which may pose a threat to human life or property,[189] but three of these also look to height or capacity limitations.[190] Significantly, most states which define "dam" for regulatory purposes in terms of height or storage capacity impose smaller size exemptions[191] than those of the model codes, which illustrates the deficiencies in these proposed

37-87-100, CONN. GEN. STAT. ANN. § 25-110, FLA. STAT. ANN. § 373.40, IND. STAT. ANN. § 13-2-20-1, IOWA CODE ANN. § 455A.17, 464.1, MD. ANN. CODE ART. 8 § 802(a), MASS. ANN. LAWS Ch. 253, § 44, MICH. COMP. LAWS ANN. § 281.131, MINN. STAT. ANN. § 105.42, MONT. REV. CODE ANN. § 89-701, NEB. REV. STAT. § 46-208, NEV. REV. STAT. § 535.010, N.H. REV. STAT. ANN. § 482.3, N.J. STAT. ANN. § 57.4-1, N. MEX. STAT. ANN. § 75-5-1, N.Y. WATER LAW tit. 5 § 15-0501, (McKinney), N.D. CENT. CODE § 61-02-20, OHIO REV. CODE ANN. § 1521.06, OR. REV. STAT. § 537.130, PA. STAT. ANN. tit. 32 § 682, R.I. GEN. LAWS ANN. § 46-19-1, VER. STAT. ANN. tit. 10 § 1081, WASH. REV. CODE § 90.03-350, and WIS. STAT. ANN. § 31.02.

186. The following states regulate dam safety through a water resources board, or water division of a broader agency or through an equivalent agency: Arkansas, Delaware, Idaho, Indiana, Kansas, Kentucky, Michigan, Minnesota, Nebraska, Nevada, New Hampshire, North Dakota, Ohio, Oklahoma, Oregon, South Dakota, Tennessee, Texas, Utah, Vermont, Washington, and Wisconsin. States acting through a Department of Ecology, Department of Natural Resources, or the equivalent include Connecticut, Iowa, Massachusetts, Montana, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina and West Virginia. Arizona, California, Colorado and New Jersey act through specialized dam safety offices. *See* Dam Safety Program, *supra* note 7, at A-23 to A-26.

187. New Mexico and Wyoming.

188. Maine acts through the Public Service Commission. Dams producing hydroelectric power are regulated in Vermont through the Public Service Board. Illinois regulates dam safety through the Department of Transportation.

189. CONN. GEN. STAT. ANN. § 25-110, FLA. STAT. ANN. §§ 373-403(1), 413, ILL. ANN. STAT. ch. 19 § 70, MASS. ANN. LAWS ch. 153 § 46, N.H. REV. STAT. ANN. § 482: 3, R.I. GEN. LAWS ANN. § 46-19-3, S.C. CODE § 49-11-120(4), § 49-11-200(2) UTAH CODE ANN. § 73-5-5 (in general, a storage capacity of 20 acre feet or more, unless constitutes a hazard to life or property, but the act excludes dams not posing a hazard to life or property), VA. CODE ANN. § 62.1-107 and WYO. STAT. § 41-3-307 (20' in height or 50 acre feet storage capacity are the general requirements for the act's applicability, but the state can enforce the provisions as necessary).

190. N.C. GEN. STAT. § 143-215.25(e) and (f) (15' in height, 10 acre feet of storage capacity), PA. STAT. ANN. tit. 32 § 682, 688 (private streams, drainage area of less than ½ square mile, and which cannot imperil life or property), and WASH. REV. CODE §§ 86-16-020, 86-03-350 (10 acre feet).

191. ARIZ. REV. STAT. § 45-701 (25' or 50 acre feet), ARK. STAT. ANN. § 21-1310(1), (b) (20 acre feet or at or below high water mark), CAL. WATER CODE § 6002 (25' or 50 acre feet), COLO. REV. STAT. § 37-87-105 (10' or 1,000 acre feet, or 20 acre feet of surface area), IDAHO CODE § 43-1711(b) (10' or 50 acre feet), IND. STAT. ANN. § 13-2-20-4 (20', 100 acre feet or drainage area of one-square mile, IOWA CODE ANN. § 455A.25 (5,000) gallons per day), KAN. STAT. ANN. (10' or 15 acre feet), MD. ANN. CODE ART. 4 § 804(b) (small ponds), MASS. ANN. LAWS Ch. 253 § 44 (10', one million gallons, or drainage area of one square mile), MICH. COMP. LAWS ANN. § 281.131 (5' or 5 acres), MINN. STAT. ANN. § 000000 (dams outside public waters), MONT. REV. CODE ANN. § 89-702.1 (1), (2) (25' or 50 acre feet), NEB. REV. STAT. § 46-257(7) (30' or 50 acre feet), NEV. REV. STAT. (10 acre feet), N.J. STAT. ANN. § 58, 4-1 (5' or ½ square mile drainage area), N. MEX. STAT. ANN. § 57-5-30 (10' or 10 acre feet), N.Y. WATER LAW Art. 5 § 15-0503(4) (one square mile drainage area, 10' or 1,000,000 gallons), N.D. CENT. CODE § 61-02-20 (19½ acre feet), OR. REV. STAT. § 540-400 (10' or 3,000,000

physical standards. Several states have exemptions for certain special classes of small dams, such as livestock or ranching dams,[192] but Arizona imposes a special permit-inspection program for livestock dams.[193]

3. Use of Consultants and Information Required in Applications

Only 16 states authorize the employment of outside consultants for various purposes[194] such as review of proposed plans,[195] or for on-site inspections.[196] In addition, 11 states require the plans and designs to be done by a registered professional engineer.[197] Three of these require expertise on his part.[198] Five states require the construction to be under the aegis of a registered professional engineer.[199] These requirements undoubtedly increase the chances of the smaller dams being constructed in accordance with sound engineering practices, but probably have no effect on the larger projects, which will have several engineers involved in the design and construction.

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gallons), OHIO REV. CODE ANN. § 1521.06 (10' or 1,000 acre feet), TENN. CODE ANN. § 70-7502(a) (20' or 30 acre feet), VA. CODE ANN. § 1-104.1 (25' or 100 acre feet), VER. STAT. ANN. tit. 10 § 1082 (500,000 cubic feet of water), W. VA. CODE ANN. § 20-50-3(e) (15' or 10 acre feet). *See also* Dam Safety Program, *supra* note 7, at A-43 to A-50.

192. *See e.g.* N. MEX. STAT. ANN. § 75-5-30 (stock dams), OHIO REV. CODE ANN. § 152-1-06 (conservancy districts), PA. STAT. ANN. tit. 32 § 691 (fish and fishing purposes if not over 3' in height), TEX. REV. CIR. STAT. ANN. tit. 2 § 11.142 (domestic and livestock reservoirs).

193. ARIZ. REV. STAT. § 45-731.

194. ARIZ. REV. STAT. § 45-711, CAL. WATER CODE §§ 6053, 6054, 6056, COLO. REV. STAT. § 37-87-186, CONN. GEN. STAT. ANN. §§ 25-110, 113, MICH. CONG. LAWS ANN. § 281.1326, N.H. REV. STAT. ANN. §§ 482-6, 8, N. MEX. STAT. ANN. § 75-5-8, N.C. GEN. STAT. ANN. § 143-215, 34, OR. REV. STAT. § 540.38, R.I. GEN. LAWS ANN. § 46-19-7, VER. STAT. ANN. tit. 43 §§ 1089, 1095(a), VA. CODE ANN. § 62.1-100, W. VA. CODE ANN. §§ 20-50-4(g), WYO. STAT. § 41-3-310.

195. CAL. WATER CODE §§ 6054, 6056.

196. COLO. REV. STAT. § 37-87-106, CONN. GEN. STAT. ANN. § 25-113, N.H. REV. STAT. ANN. § 482-8, VER. STAT. ANN. tit. 43 § 1095(a), W. VA. CODE ANN. § 20-50-9, WYO. STAT. § 41-3-310.

197. IDAHO CODE § 42-1715, MICH. COMP. LAWS ANN. § 281.132, N. MEX. STAT. ANN. § 75-5-8, N.Y. WATER LAW tit. 5 § 15-0503(5), N.C. GEN. STAT. ANN. § 143-215-29, OHIO REV. CODE ANN. § 1521.06, S.C. CODE § 49-11-220, TENN. CODE ANN. ch. 182 § 70-2506, VA. CODE ANN. § 621-106(4), W. VA. CODE ANN. § 20-50-5, WYO. STAT. § 41-3-309. In addition, Arizona, California, Colorado, Connecticut, Delaware, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Minnesota, Nevada, New Jersey, Oklahoma, Oregon, Pennsylvania, Rhode Island, Texas, Utah, Vermont, and Washington require plans and construction to be supervised by a professional engineer. Dam Safety Program, *supra* note 7, at A-111 to A-113.

198. N. MEX. STAT. ANN. § 75-5-8 (the qualifications of the registered professional engineer must be approved by the state engineer), N.C. GEN. STAT. ANN. § 143-215-29 (legally qualified engineer), and WYO. STAT. § 41-3-303. North Carolina requires for the certificate of a qualified architect or constructor that he's responsible for the design of the dam, and that it's safe and adequate.

199. IDAHO CODE § 42-1715, N. MEX. STAT. ANN. § 75-5-8, N.C. GEN. STAT. ANN. § 143-215.29, WYO. STAT. § 41-3-309.

A major problem arises with respect to the information required with the application for a permit. A general provision requires the submission of plans, specifications, maps and any other information required by the agency.[200] Arizona provides for the submission of information on the drainage area, rainfall and streamflow records, flood flow records and subsoil and foundation conditions.[201] Idaho[202] and Wisconsin[203] have extensive requirements, in the discretion of the agency, for subsoil and foundation conditions and materials, and extensive preconstruction investigations and reports on hydrologic, geologic and foundation conditions. North Carolina requests stream flow and rainfall information.[204] Pennsylvania requires complete maps, plans, profiles and specifications.[205] Virginia requires the "essential facts,"[206] and West Virginia expects the "relevant and necessary" information.[207] Oregon enumerates extensive project descriptions.[208]

The effect of detailing these state statutory requirements, which exceed the normal "maps, plans, specifications and other information as requested" is to show how little is required by statute in the way of detailed baseline studies, and how much we are dependent upon an administrative agency, which may be understaffed, under-budgeted or lacking in expertise, for the type of pre-construction scrutiny and planning that will minimize the risks of a major dam failure.[209]

200. ARK. STAT. ANN. §§ 21-1304, 1305, CAL. WATER CODE § 6077, COLO. REV. STAT. § 37-87-105, CONN. GEN. STAT. ANN. § 25-112, IDAHO CODE § 42-1712, IOWA CODE ANN. § 469.2, KAN. STAT. ANN. §§ 68-1502, 829-302, MD. ANN. CODE ART. 8 § 805, MASS. ANN. LAWS Ch. 253 § 4, MINN. STAT. ANN. § 105.42 (equivalent to NEPA), MISS. CODE ANN. § 281.132, NEV. REV. STAT. § 535.010, N.J. STAT. ANN. § 58:4-2, N. MEX. STAT. ANN. § 75-5-1, N.Y. WATER LAW tit. 5 § 15-0503(5), N. DAK. CENT. CODE § 61-0220, OHIO REV. CODE ANN. § 1521-06, OR. REV. STAT. § 537-130, PA. STAT. ANN. tit. 32 § 683, R.I. GEN. LAWS ANN. § 46-19-3, S. DAK. COMP. LAWS ANN. § 46-511, TENN. CODE ANN. § 70-2506, UTAH CODE ANN. § 73-5-5, VER. STAT. ANN. tit. 10 § 1083, WYO. STAT. § 41-3-308. Nebraska requires detailed engineering plans. NEB. REV. STAT. § 46-257.

201. ARIZ. REV. STAT. § 45-703(b).

202. IDAHO CODE § 47-1712.

203. WIS. STAT. ANN. § 31-12.

204. N.C. GEN. STAT. § 143-215.26.

205. VA. CODE § 62.1-85.

207. W. VA. CODE ANN. § 20-50-5.

208. OR. REV. STAT. § 537.140.

209. In addition to any statutory requirements, the following states require geologic, soils and hydrologic data: Arizona, Arkansas (hydrologic data), California, Colorado, Delaware, Florida, Idaho, Illinois (hydrologic only), Indiana, Iowa, Kansas (on major structures), Kentucky (on Class B and C structures), Maryland, Massachusetts, Michigan (if deemed necessary by the Department of Natural Resources), Mississippi, Nebraska, Nevada (logs of borings or test site), New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin and Wyoming (hydrologic data in special cases). Dam Safety

4. Permit Systems

Furthermore, although 41 states require permits or licenses prior to construction of a private dam, only 38 require a review of plans and specifications prior to construction,[210] and only 24 cover repairs, alterations, modifications or reconstruction[211] and but 10 expressly require a permit or review process to remove a dam.[212] The language of several new statutes, such as "substantially alter" or "materially alter" could be construed to cover removal.[213] One other state, Iowa, has an opinion of the state attorney general

Program, *supra* note 7, at A-134 to A-136.

Only Arizona, California (uncodified), Colorado, Maryland, Nebraska, Ohio, Oklahoma, Oregon, Pennsylvania, Tennessee, Texas, Utah, West Virginia, and Wisconsin require special instrumentation in the structures. Arizona, California, Colorado, Ohio, Pennsylvania and Texas specifically mention piezometers. *Id.* at A-137 to A-139.

210. ALA. CODE tit. 18 § 2-2 (probate court if on non-navigable stream), ALA. CODE tit. 33 § 7-30 (secretary of state if navigable stream), ARIZ. REV. STATS. §§ 45-702(A), 45-703(A), ARK. STAT. ANN. §§ 21-1304, 1306, CAL. WATER CODE § 6006, COLO. REV. STAT. §§ 37-87-105, 117 (note Colorado requires the approval of plans and specifications, but has no permit or licensing requirement), CONN. GEN. ANN. § 25-112, DEL. CODE tit. 23 § 1904 (superior court if on non-navigable stream), FL. STAT. ANN. § 373.413, IDAHO CODE § 42-1712, ILL. ANN. STAT. ch. 19 § 70, IND. CODE ANN. § 13-2-1-3(2), IOWA CODE ANN. §§ 455A.19-25(2), 469.1, KAN. STAT. ANN. § 68-1502, ME. REV. STAT. ANN. tit. 35 § 11, MD. ANN. CODE ART. 8 §§ 802, 803, MASS. ANN. LAWS ch. 253 § 44, MICH. COMP. LAWS ANN. § 281-133, MINN. STAT. ANN. § 105.42, MISS. CODE ANN. §§ 51-3-31, 39, MO. ANN. STAT. § 236.030 (circuit court for non-navigable streams), NEB. REV. STAT. § 46-257, NEV. REV. STAT. § 535.010, N.H. REV. STAT. ANN. § 482.4, N.J. STAT. ANN. § 58:4-1, N. MEX. STAT. ANN. § 75-5-1, N.Y. WATER LAW tit. § 15-0503(b), N.C. GEN. STAT. §§ 143.215.26, .27, N.D. CENT. CODE § 61-02-20, OHIO REV. CODE ANN. § 1521.06, OR. REV. STAT. § 537.130, PA. STAT. ANN. tit. 32 § 682, R.I. GEN. LAWS ANN. § 46-19-3, S.C. CODE § 49-11-200, S.D. COMP. LAWS ANN. § 46-5-11, TENN. CODE ANN. § 70-2505, TEX. REV. CIV. STAT. ANN. tit. 2, § 11.121, UTAH CODE ANN. § 73-5-5, VER. STAT. ANN. tit. 10 § 1082, VA. CODE § 62.1-85, WASH. REV. CODE § 90.03.350, W. VA. CODE § 20-50-5, WIS. STAT. ANN. § 31.05, WYO. STAT. § 41-3-302.

211. ALA. CODE tit. 18 § 2-17 (probate court), ARIZ. REV. STATS. § 45-702, CAL. WATER CODE § 6006, CONN. GEN. STAT. ANN. § 25-112, DEL. CODE tit. 22 § 1909 (non-navigable stream), FLA. STAT. ANN. § 373.413, IDAHO CODE § 42-1712, IOWA CODE ANN. § 455A.18, KAN. STAT. ANN. § 68-1502, MD. ANN. CODE Art. 8 § 803, MASS. ANN. LAWS ch. 253 § 44, MICH. COMP. LAWS ANN. § 281.132(4), MINN. STAT. ANN. § 105.42, N.H. REV. STAT. ANN. § 482.3, N.J. STAT. ANN. § 58:4-1, N.C. GEN. STAT. § 143.215.27, N.Y. WATER LAW tit. 5, § 15-0503(b), OR. REV. § 537.130, PA. STAT. ANN. tit. 32 § 682, R.I. GEN. LAWS ANN. § 46-19-3, S.C. CODE § 49-11-210, TENN. CODE ANN. §§ 70-2502(e), 2505, TEX. REV. CIR. STAT. ANN. tit. 2 § 11.144, UTAH CODE ANN. § 73-5-5, VER. STAT. ANN. tit. 10, §§ 1082, 1083, VA. CODE §§ 62.18-83, 116, WASH. REV. CODE § 90.03.350, WIS. STAT. ANN. §§ 31.04, 31.13, WEST VA. CODE § 20-5-5, WYO. STAT. § 4-3-301, Florida requires an operation and maintenance permit. FLA. STAT. ANN. § 373.416. Illinois and Indiana require the owner to keep existing dams maintained and repaired. ILL. ANN. STAT. ch. 19 § 70, IND. CODE ANN. § 13-2-20-2.

Arkansas, Colorado, Illinois, Indiana, Kentucky, Nebraska, New Mexico, North Dakota, Ohio and Oklahoma did not require permits. Dam Safety Program, *supra* note 7, at A-71 to A-75.

212. ARIZ. REV. STAT. § 45-706, CAL. WATER CODE § 6077, CONN. GEN. STAT. ANN. § 25-112, IDAHO CODE § 42-1715 (Idaho requires an inspection during removal), IOWA CODE ANN. § 109-15, MINN. STAT. ANN. § 105-42, N.J. STAT. ANN. § 58:4-9 (if in existence 20 years or more, and permanent improvements by owner of the land), N.C. GEN. STAT. § 143-215-26, S.C. CODE § 49-11-200, TENN. CODE ANN. § 70-2505, W. VA. CODE ANN. § 20-50-5, WIS. STAT. ANN. § 31-185.

213. *See e.g.* MD. ANN. CODE art. 8, § 803 (repair, alter or any change), MASS, ANN. LAWS ch. 253 § 441, NEV. REV. STAT. § 535.010 (reconstruct or alter in any way), and R.I. GEN. LAWS ANN. § 46-19-3 (substantially alter).

which construes its statute as requiring a permit to remove a dam.[214]

Only seven states employ a bifurcated permit system whereby separate authorization is necessary for the construction and operation stages. Arizona and Idaho require the filing of plans and drawings upon completion of construction.[215] These plans should include a record of all grout holes and grouting, permanent location points and bench marks, record of tests of concrete or other materials used in constructing the dam, and other items bearing on safety and permanence of location.[216]

Nineteen states expressly authorize the agency to impose terms and conditions in a permit or to modify a plan.[217] One may assume, though, that in the remainder of states where the agency possesses the power to deny a permit, it effectively possesses the power to impose terms or conditions since it could deny the application until it contained the desired conditions. An interesting variation on the standard power to impose terms and conditions in a permit is that Tennessee can impose different conditions, or types of conditions in approving a dam or reservoir based upon different hazard categories.[218]

In issuing a certificate of approval, which is not good for over five years in Tennessee,[219] the Tennessee statute is quite explicit, and could serve as a model for other states. The Commissioner of Conservation is to consider relevant circumstances, including size and type of dam, topography, geology, soil conditions, hydrology, climate, use of the reser-

214. Opinion, Iowa Att. Gen., April 10, 1972.
215. ARIZ. REV. STAT. §§ 45-709, 709(c), COLO. REV. STAT. § 37.87.119, CONN. GEN. STAT. ANN. §§ 25-113, 114, IDAHO CODE §§ 42-1715, 45-709(c), N. MEX. STAT. ANN. §§ 75-5-8, 9, 11, N.C. GEN. STAT. § 143-215-30, S. DAK. COMP. LAWS. ANN. § 46-5-27. California, Kentucky, New Jersey, Tennessee, Texas, Vermont, and Wisconsin also claim to possess the equivalent of a bifurcated permit system, but these requirements do explicitly not appear in the statutes. I Dam Safety Program, *supra* note 7, at A-65 to A-67.
216. ARIZ. REV. STAT. § 45-709, IDAHO CODE § 42-1716.
217. ARIZ. REV. STAT. § 45-707(a), CONN. GEN. STAT. ANN. § 25-114, IDAHO CODE §§ 42-1715, 1719, IOWA CODE ANN. § 469.5, KAN. STAT. ANN. ch. 82a § 303, MD. ANN. CODE art. 8 § 807, MINN. STAT. ANN. §§ 105.44(2), 105.45, N.J. STAT. ANN. § 58:402, N. MEX. STAT. ANN. § 75-59, N.C. GEN. STAT. §§ 143-215.28(a), 215.30(c), OHIO REV. CODE ANN. § 1521.06, OR. REV. STAT. § 537.196, PA. STAT. ANN. tit. 32 §§ 684, 685, TENN. CODE ANN. § 70-2513, VA. CODE ANN. §§ 62.1-91 (for public safety), 62.1-90 (modify plans), W. VA. CODE ANN. §§ 20-50-4(c).
218. TENN. CODE ANN. § 70-2513.
219. *Id.* at § 70-2514.

voir and the lands lying in the flood plain downstream and the hazard category of the dam.[220] On-the-site inspections are prescribed,[221] and the certificate cannot be issued unless the Commissioner determines "that the proposed action will be conducted in such a way that the safety of the public is adequately provided for".[222] Conditions can be imposed in the permit.[223] Both Tennessee[224] and West Virginia[225] expressly include existing dams in the statutes.

5. Inspections and Records

The statutory pattern with respect to dam inspections is varied.[226] Twenty-three states provide on-site inspections by state personnel during construction,[227] and thirty-two have authority to perform safety inspections after construction.[228]

220. *Id.*
221. *Id.* at § 70-2511.
222. *Id.* at § 70-2512(1)
223. *Id.* at § 70-2513.
224. *Id.* at § 70-2508.
225. W. VA. CODE ANN. § 20-50-11, existing dams are to be inspected by the state. Minnesota exempts dams constructed prior to July 1, 1937, except significantly, as necessary to protect the health and safety of the state. MINN. STAT. ANN. §§ 105.42(3), 105.53. In New Jersey every dam and reservoir is to furnish a description of the facility and cause to be made surveys, plans and drawings, as may be necessary to give sufficient information for determining its safety. N.J. STAT. ANN. § 58:43.
226. The following states provide for dam inspections: ARIZ. REV. STAT. § 45-712(a), ARK. STAT. ANN. § 21-1306(2), CAL. WATER CODE § 6102, COLO. REV. STAT. §§ 37-87-106, 109, CONN. GEN. STAT. ANN. § 25-111, FLA. STAT. ANN. § 373.423(1), IDAHO CODE § 42-1701, IND. STAT. ANN. §§ 13-2-20-7, IOWA CODE ANN. § 469.11, ME. REV. STAT. ANN. tit. 38 § 811, MD. ANN. CODE art. 8 § 809, MASS. ANN. LAWS ch. 253 § 45, MICH. COMP. LAWS ANN. § 281.132, MINN. STAT. ANN. § 105.52, MONT. REV. CODE ANN. § 89-702(2), NEB. REV. STAT. § 46-208, NEV. REV. STAT. § 535-030, N.H. REV. STAT. ANN. §§ 482.6, 482.8, 482.46, 482.59, N.J. STAT. ANN. § 58:4-4, N. MEX. STAT. ANN. § 75-5-8, N.Y. WATER LAW tit. 5, §§ 15-0507, 15-0511(1), N.C. GEN. STAT. §§ 143-215-32, 215-37, OHIO REV. CODE ANN. § 1521.06, OR. REV. STAT. § 540.350(3), PA. STAT. ANN. tit. 32 § 685, tit. 71 § 510-4, R.I. GEN. LAWS ANN. § 46-19-4, S.C. CODE §§ 49-11-170, 49-11-240, S. DAK. COMP. LAWS ANN. § 46-19-5, TENN. CODE ANN. §§ 70-2505(b), (k), TEX. REV. CIV. CODE ANN. ART. 12.016, 12.017, UTAH CODE ANN. § 73.56, VER. STAT. ANN. tit. 10 § 1095, W. VA. CODE ANN. § 20-50-4(i), WIS. STAT. ANN. §§ 31.02(3), 31.19, WYO. STAT. §§ 41-3-347, 41-3-310.
227. ARIZ. REV. STAT. § 45-708(a), ARK. STAT. ANN. § 45-708, CAL. WATER CODE § 6075, COLO. REV. STAT. § 37-87-105, CONN. GEN. STAT. ANN. § 25-113, FLA. STAT. ANN. § 373.423(1), IDAHO CODE § 42-1715, MASS. ANN. LAWS ch. 595 § 44, MICH. COMP. LAWS ANN. § 281-132, MONT. REV. CODE ANN. § 89-711, NEV. REV. STAT. § 535-010(5), N.H. REV. STAT. ANN. § 482.6, N.J. STAT. ANN. § 58:4-8, N. MEX. STAT. ANN. §§ 75-5-8 (by supervising engineers), 75-5-10 (lyctate), N.D. CENT. CODE § 61-02-20, OHIO REV. CODE ANN. § 1521.06, OR. REV. STAT. §§ 540.3501(3), 540-380, PA. STAT. ANN. tit. 32 § 685, S.C. CODE § 49-11-230(a), TEX. REV. CIV. CODE ANN. tit. 2, § 12.016, tit. 6.064, 6.065, UTAH CODE ANN. § 73-5-5, VER. STAT. ANN. tit. 10 §§ 1095, W. VA. CODE ANN. § 20-50-9.
228. ARIZ. REV. STAT. §§ 45-709, 712, ARK. STAT. ANN. § 21-1306(a)(2), CAL. WATER CODE §§ 6100, 6102, COLO. REV. STAT. § 37.87.119, CONN. GEN. STAT. ANN. § 25-111, FLA. STAT. ANN. § 373.423(3), IDAHO CODE § 42-1717, IND. STAT. ANN. § 13-2-20-4, MD. ANN. CODE art. 8 § 809, MASS. ANN. LAWS ch. 253 § 45, MICH. COMP. LAWS ANN. § 281.132, MINN. STAT. ANN. § 105.52, MONT. REV. CODE ANN. §§ 89-702(2), 89-704, NEB. REV. STAT. § 46-208, NEV. REV. STAT. § 535.030(1)(a), N.H. REV. STAT. ANN. § 4828, N.J. STAT. ANN. §§ 58:4-4, 58:4-8, N. MEX. STAT. ANN. § 75-58, N.Y. WATER LAW tit. 5 § 15-0507, N.C. GEN. STAT. §§ 143.215.30, 143.215.32, OHIO REV. CODE ANN. § 1521.062, OR. REV. STAT. §§ 540.350(3), 540.390, PA. STAT. ANN. tit. 32 § 685,

Some statutes are quite broad, authorizing inspection at any time, before, during or after construction, at dams constructed prior to enactment of the regulatory statute[229] or authorizing a right of access site through private property without any liability for trespassing.[230] Some statutes authorize access at any time whereas others are limited to reasonable times.[231]

Oregon requires a pre-construction inspection of the site, plans and specifications if failure would result in damage to life or property.[232] South Carolina authorizes preliminary investigations, and then, if the dam poses a danger, detailed investigations, which are all studies and analyses necessary to evaluate conclusively the structural safety of a dam or reservoir, including soil analyses, concrete or earth stability analyses, materials testing, foundation exploration, and hydrologic analyses, including basin studies and flood potential.[233] South Carolina's statute is unique in requiring this thoroughness of investigation.

Only twelve states require periodic investigations of all dams,[234] but four of these impose no maximum time span, but instead authorize a flexible "as often as necessary" approach.[235] The others prescribe periods ranging from one year to five. While most inspection statutes expressly or im-

R.I. GEN. LAWS ANN. §§ 46-19-1, 5, S.C. CODE §§ 49-11-170, 240, S. DAK. COMP. LAWS ANN. §§ 46-5-27, 46-19-5, TENN. CODE ANN. § 70-2516, UTAH CODE ANN. § 73-5-6, WIS. STAT. ANN. § 31.19, WYO. STAT. § 41-3-311, VER. STAT. ANN. tit. 10 § 1095, W. VA. CODE ANN. § 20-50-41 j.

Iowa, Kentucky, Oklahoma, Texas and Washington also assert a right to perform safety inspections after construction. Dam Safety Program, *supra* note 7, at A-89 to A-92.

229. *See e.g.* ARK. STAT. ANN. § 21-1306(2), N.H. REV. STAT. ANN. § 482.59, PA. STAT. ANN. tit. 71 § 510.4(2).
230. CAL. WATER CODE § 6081, CONN. GEN. STAT. ANN. § 25-110, IDAHO CODE § 42-1701(5) (reasonable entry), IND. STAT. ANN. § 13-2-20-7, N.C. GEN. STAT. § 143-215-37, OHIO REV. CODE ANN. § 1521.07, R.I. GEN. LAWS ANN. § 46-49-6, S.C. CODE § 49-11-240, TENN. CODE ANN. § 70-2505(r), TEX. REV. CIV. CODE ANN. tit. 2 § 12.017, W. VA. CODE ANN. § 20-50-4(i), WIS. STAT. ANN. § 3102(3).
231. *See e.g.* NEB. REV. STAT. § 46-208.
232. OR. REV. STAT. § 540.350.
233. S.C. CODE § 49-11-120(7).
234. IDAHO CODE § 42-1717 (dams 20' in height every two years, else as often as necessary), IND. STAT. ANN. § 13-2-20-4 (once a year), MASS. ANN. LAWS ch. 253 § 45 (two years), N.C. GEN. STAT. § 143-215.32 (5 years), OHIO REV. CODE ANN. § 1521.06 (5 years), WIS. STAT. ANN. § 31.19 (every two years if produces over 750 horsepower annually), WYO. STAT. § 41-3-311 (at least once every five years).
235. CONN. GEN. STAT. ANN. § 25-771, N.H. REV. STAT. ANN. § 482-8, R.I. GEN. LAWS ANN. § 46-19-1, TENN. CODE ANN. § 78-2516. In addition, Colorado requires an annual determination by the state engineer of the amount of water which can be stored in a reservoir.

plicitly cover existing dams, Tennessee goes one step further and requires all existing dams to apply for a permit.[236]

In Michigan if hazardous conditions exist in a dam, the Department of Natural Resources can require the filing of a report by a registered professional engineer on the condition of the dam, including statements on whether leakage is present, whether signs of disintegration or erosion of material of the dam or abutments or foundations are evident, and a statement on other changes in conditions relating to safety. The department may then order necessary repair or removal of the dam.[237]

A corollary requirement to inspections is that of the maintenance of records by the dam owner or operator such that not only is the history of the dam available to the inspectors, but that any suspected safety problem can be viewed in its total perspective. Only California[238] and Idaho[239] statutorily charge owners with the responsibility of maintaining records and reports on maintenance, operations, staffing and engineering and geologic investigations.

The paucity of mandatory inspections for all dams, not just large dams, illustrates the weaknesses in the existing dam safety program. Most breaks are in existing dams, not dams under construction. Yet, statutory provisions in states which mandate dam safety inspections, rarely cover all dams which might pose a threat to life or property.

6. Citizen Involvement

The statutes are deficient in safeguarding individual rights, perhaps reflecting the pre-environmental movement theory that administrative agencies are the means of maximizing the public welfare and interest, and that citizen action is frequently frivolous. Sixteen states provide for safety investigations based upon citizen's complaints,[240] but many

236. TENN. CODE ANN. § 70-2508. *See also* W. VA. CODE ANN. § 20-50-11 and WIS. STAT. ANN. § 31.07.
237. MICH. COMP. LAWS ANN. § 281.132.
238. CAL. WATER CODE § 6101.
239. IDAHO CODE § 42-1717.
240. ARIZ. REV. STAT. § 45-713, COLO. REV. STAT. § 37-87-109, IDAHO CODE § 42-1709, IND. STAT. ANN. § 13-2-20-4, ME. REV. STAT. ANN. tit. 38 § 811, MD. ANN. CODE art. 8 § 809, MASS. ANN. LAWS ch. 253 § 45, MINN. STAT. ANN. § 105.52, MONT. REV. CODE ANN. § 89-702(2), N.H. REV. STAT. ANN. § 482,43 (selectmen of town or mayor of city), N.J. STAT. ANN. § 48-4-4, N.C. GEN. STAT. § 143-215-32, PA. STAT. ANN. tit. 32 §

of these are limited to citizens owning property.[241] In addition to these 16 states, an additional eight also provide for citizen initiated safety investigations, but either expressly mandate,[242] or in the agency's discretion,[243] require the complainant to advance the costs of the safety inspection. As previously indicated, the effect of these statutes, which emphasize the rights of the dam owner, may be to discourage a complaint or investigation in a case where a timely investigation may have prevented a dam break.

Another limiting factor on citizen involvement is that only 17 states authorize public hearings,[244] and most of these occur in the initial permit authorization process, not in the investigation of a suspected safety issue of an existing dam. Eighteen states expressly authorize judicial appeals of an administrative order,[245] but here too, some states allow appeal only for the state or dam applicant,[246] not the broader "any aggrieved party" test.[247] On the other hand, many state administrative procedure acts may authorize broad citizen participation before agencies and judicial review.[248]

7. Remedial Powers

The ultimate strength of any dam safety program will depend upon its crisis-resolution abilities. If timely in-

685, R.I. GEN. LAWS ANN. § 46-19-4, S.C. CODE § 49-11-170, VER. STAT. ANN. tit. 10 § 1095(1), WIS. STAT. ANN. § 31.19.

241. *See e.g.* NEB. REV. STAT. § 2-1506.08 (3 title holders), N.J. STAT. ANN. § 58-4-4 ("owning or residing"), OR. REV. STAT. § 540.390 ("owning or residing"), R.I. GEN. LAWS ANN. § 49-19-4. In Maine it takes 10 to complain, ME. REV. STAT. ANN. tit. 38 § 811 and Vermont requires 10 taxpayers, VER. STAT. ANN. tit. 10 § 1095.

242. COLO. REV. STAT. § 37-87-111, N. MEX. STAT. ANN. § 75-5-11, UTAH CODE ANN. § 73-5-6.

243. ARIZ. REV. STAT. §§ 45-713, 732, CONN. GEN. STAT. ANN. § 25-111 ($100 deposit), MASS. LAWS ANN. ch. 253 § 45, OR. REV. STAT. § 540.390, WYO. STAT. § 41-3-312.

244. ARK. STAT. ANN. § 21-1306(c), IOWA CODE ANN. §§ 455A.19(2), 469.3, MD. ANN. CODE art. 8 § 806, MINN. STAT. ANN. §§ 105.31(6), 105.44, NEB. REV. STAT. § 46-209, N. MEX. STAT. ANN. § 75-54.1, N.Y. WATER LAW tit. 5, § 15-0503(3)(d), OR. REV. STAT. § 537.170 (for hydroelectric production over 100 horsepower), PA. STAT. ANN. tit. 32 § 685, TENN. CODE ANN. § 70-2523(a), VA. CODE ANN. § 62.1-86, VER. STAT. ANN. tit. 10 §§ 1085, 1091, W. VA. CODE ANN. § 20-50-7, WIS. STAT. ANN. § 31.06, WYO. STAT. § 41-3-308(a)(ii).

245. ARK. STAT. ANN. § 21-1312 ("any person affected"), COLO. REV. STAT. § 37-87-112, CONN. GEN. STAT. ANN. § 25-117, IDAHO CODE § 42-1720, IOWA CODE ANN. §§ 455A-20, 455A-37, MINN. STAT. ANN. § 105.47, MONT. REV. CODE ANN. § 89-702(3), NEB. REV. STAT. § 46-210, N.H. REV. STAT. ANN. § 482-10, N.Y. WATER LAW tit. 5 § 15-05.5, N.C. GEN. STAT. § 153-215-33, OHIO REV. CODE ANN. § 1521.061, OR. REV. STAT. § 537.185, S.C. CODE ANN. § 49-11-260, TENN. CODE ANN. § 60-2524, VER. STAT. ANN. tit. 10 § 1099, WASH. REV. CODE § 86-16-110, WYO. STAT. § 41-3-318.

246. OHIO REV. CODE ANN. § 1521.061, VER. STAT. ANN. tit. 43 § 1099.

247. *See e.g.* ARK. STAT. ANN. § 21-1312.

248. In addition, many statutes provide that a violation of the dam safety laws constitute a public nuisance for which anyone can seek judicial redress. *See e.g.* ARK. STAT. ANN. § 21-1312, CONN. GEN. STAT. ANN. § 19-311, FLA. STAT. ANN. § 373.433,

vestigation and remedial measures prevent a major disaster, then the program is a success. If not, either the statute or its implementation must be examined and improved. Unfortunately, critical gaps exist in the crisis-resolving abilities of the state statutes. Few statutes govern indirectly related public-safety hazards, such as reservoir-discharge control. Stream-flow monitoring, dam instrumentation and emergency warning systems are virtually non-existent. Thirty-one states authorize the agency to order remedial measures by the owner,[249] but only 18 authorize the agency to take emergency action,[250] such as lowering the water level, emptying or breaching the dam if necessary, or any other measures necessary. Of these 17 states, one, Tennessee,[251] requires the governor to issue a state of emergency order, and another, Massachusetts, has no express statutory authority to take emergency action, but relies upon an opinion of the state's attorney general.[252]

The lack of express statutory authority to take emergency action is not necessarily critical since a dam threatening to break would undoubtedly be held to constitute a public nuisance, and states possess sufficient authority to abate public nuisances. However, if prompt action is necessary to avert a disaster, we do not want the officials on the line wasting precious time in ascertaining whether they possess sufficient authority to act. Consequently, express statutory authorization is preferred. Surprisingly, considering the perils apparent with dam breaks, little statutory criteria is provided for determining a hazardous condition. California

IND. STAT. ANN. § 455A.39, IOWA CODE ANN. § 469.15, ME. REV. STAT. ANN. tit. 17 § 2797, WIS. STAT. ANN. § 31.25.

249. CAL. WATER CODE §§ 6081, 6110, CONN. GEN. STAT. ANN. § 25-111, FLA. STAT. ANN. § 373.434, IDAHO CODE § 42-1718, IND. STAT. ANN. § 13-2-20-4, IOWA CODE ANN. § 455A.28(3), ME. REV. STAT. ANN. tit. 38 § 812, MD. ANN. CODE art. 8 § 809, MASS. ANN. LAWS ch. 253 §§ 46, 46, MICH. COMP. LAWS ANN. § 281.132(1), MINN. STAT. ANN. § 105.52, N.H. REV. STAT. ANN. § 489-9, N.J. STAT. ANN. § 58-4-5, N. MEX. STAT. ANN. § 75-5-10, N.Y. WATER LAW tit. 5 § 15-0500(2), N.C. GEN. STAT. § 143.215-32(b), N.D. CENT. CODE § 61-02-20, OHIO REV. CODE ANN. § 1521.052, OR. REV. STAT. §§ 40-360, 370, PA. STAT. ANN. tit. 32 § 685 (applies to all dams wherever constructed), R.I. GEN. LAWS ANN. § 46-19-4, S.C. CODE § 49-11-160, TENN. CODE ANN. §§ 70-2505(e), 2518, UTAH CODE ANN. § 73-5-6, VER. STAT. ANN. tit. 10 § 1095(a), W. VA. CODE ANN. § 20-50-8.

250. ARIZ. REV. STAT. §§ 45-712(b) and (c), CAL. WATER CODE §§ 6110, 6111, COLO. REV. STAT. § 37-87-109, IDAHO CODE § 42-1717, IND. STAT. ANN. § 13-2-2-5, MINN. STAT. ANN. § 105.42, MONT. REV. CODE ANN. § 89-705, NEV. REV. STAT. § 535-030, N.Y. WATER CODE tit. 5 § 15-0607(ii), N.C. GEN. STAT. § 143.215-32(c), PA. STAT. ANN. tit. 32 § 686, tit. 71 § 510.4(2), S.C. CODE § 49-11-190, W. VA. CODE ANN. § 20-50-10, WIS. STAT. ANN. § 31.19, WYO. STAT. § 41-3-307.

251. TENN. CODE ANN. § 70-2520.

252. MASS. OP. ATT. GEN., Sept. 24, 1975.

provides that in determining if a dam or reservoir constitutes or would constitute a danger to life or property, seepage, earth movement or other conditions would be considered.[253] Thirty states also authorize injunctive relief for statutory violations.[254]

8. Miscellaneous Provisions

Another critical safety provision, that of outlet facilities, receives little attention in the statutes. Only seven states provide for outlets,[255] but some of these are not designed for safety purposes, but only for the protection of the water rights of others.[256]

Five states charge their agencies with investigating, studying and collecting data on dam safety, construction and maintenance such that they will be able to better carry out their responsibilities and stay abreast of changing

253. ARIZ. REV. STAT. § 45-717, CAL. WATER CODE §§ 6110, 6150, CONN. GEN. STAT. ANN. § 25-116, IOWA CODE ANN. §§ 455A.33, 469-15, KAN. STAT. ANN. § 82a-305, ME. REV. STAT. ANN. ch. 38 § 812 (if engineer finds it unsafe, and owner doesn't correct), MD. ANN. CODE art. 8 § 813, MASS. ANN. LAWS ch. 253 § 50, MINN. STAT. ANN. § 105.55, MISS. CODE ANN. § 51-3-39, NEB. REV. STAT. § 46-257(4), N.H. REV. STAT. ANN. § 482-12, N.J. STAT. ANN. § 58:4-6, N. MEX. STAT. ANN. § 75-5-11, N.Y. WATER LAW tit. 5, § 74-1103, N.C. GEN. STAT. § 443.215.36(c), OHIO REV. CODE ANN. § 1521.06, OK. STAT. ANN. tit. 82 § 1072(h), OR. REV. STAT. § 540.370, PA. STAT. ANN. tit. 32 § 6881, R.I. GEN. LAWS ANN. § 46-14.5 (upon failure of owner to take necessary remedial action), S.C. CODE § 49-111-260, TENN. CODE ANN. §§ 70-2505(k), 2525, 2527, UTAH CODE ANN. § 73-5-6, VA. CODE ANN. § 62.1-97, 62.1-104.1 (rules and regulations by the State Water Control Board, but basically excluded dams regulated elsewhere), VER. STAT. ANN. tit. 10 § 1094, WASH. REV. CODE § 90.03.350 (equals a public nuisance), WIS. STAT. ANN. § 31.021 (equals a public nuisance).

254. CAL. WATER CODE § 6081. *See also,* IDAHO CODE § 42-1717 for similar factors, including overtopping, settlement and cracking.

255. ARIZ. REV. STAT. § 45-732 (large enough to accommodate the flood flow of the stream), KAN. STAT. ANN. § 68-1502 (can't approve construction of a dam unless it contains folld gates, or openings that can be opened in times of high water, so as to prevent the overflow of lands in the vicinity of the dam), MICH. COMP. LAWS ANN. § 281.132(3) (the director of the Department of Natural Resources may require an underspill device that will discharge water from the lake bottom), WIS. STAT. ANN. § 31.02(4)(d) (the agency may order spillways or floodgates capable of permitting the passage of freshlets and floods during all seasons), WYO. STAT. § 41-3-313 (outlet so that system may be evacuated or maintained at any water level required by the state engineer), § 41-30-7(b) (dams constructed prior to enactment of the statute may be breached when public safety requires if they have no outlet or means for lowering the reservoir water level).

In addition, California (but not formalized or codified), Idaho (1-year flood frequency), Illinois (capable of passing design frequency flood without overtopping), Nebraska (based on hazard), Nevada (all dams must have emergency spillway), New Hampshire (100 year stream), New Jersey (100 year flow), Pennsylvania, Rhode Island (100 year stream), Washington (100 year flood), and Wisconsin (100 year flow), require outlets and spillways. *See* Dam Safety Program, *supra* note 7, at A-130 to A-133.

256. For example, the statutes require a conduit sufficient to pass all normal stream flow. *See e.g.* ARK. STAT. ANN. § 21-1306(1), COLO. REV. STAT. § 1371-87-119, MD. CODE ANN. § 13-2-1-3(2), OK. STAT. ANN. tit. 60 § 60, OR. REV. STAT. § 540.330 (if necessary for protection of other areas, may require an outlet allowing the natural flow of the stream).

technology.[257] Indeed, West Virginia commands its agency to review the criteria annually.[258] This type of proposal, if widely implemented, would greatly advance dam safety.

Twenty-four states specifically authorize their agencies to issue rules and regulations governing dam safety and construction.[259] Tennessee[260] and Indiana[261] provide for variations in rules based upon differences in topography, geology, soil conditions, climate, hydrology and the potential perils to life and property. In states where these powers have not been expressly given the agency, the agency might still possess them pursuant to either an administrative procedures act, or pursuant to the general delegation of powers to the specific agency.

Another general provision is one which relieves the state of any liability in its act,[262] while many statutes provide that irrespective of the dam-safety legislation, the owner of a dam remains liable.[263]

Other state provisions, of a idiosyncratic nature, are designed to promote dam safety. For example, Ohio borrows from a well-proven method of ensuring viable strip-mine reclamation,[264] and requires applicants to post a bond, equal

257. CAL. WATER CODE § 6120, IOWA CODE ANN. § 469-10, N.C. GEN. STAT. § N3-215.34, TENN. CODE ANN. §§ 70-2505(b), 2505(g), W. VA. CODE ANN. § 20-50-4(j).
258. W. VA. CODE ANN. § 20-50-4(j).
259. ARIZ. REV. STAT. §§ 45-702(b), 712(a), ARK. STAT. ANN. § 21-1304, CAL. WATER CODE §§ 6078, 6101, CONN. GEN. STAT. ANN. § 25-110, FLA. STAT. ANN. § 373.413, IDAHO CODE § 42-1714, IND. STAT. ANN. § 13-2-20-3, IOWA CODE ANN. § 455A-17, KAN. STAT. ANN. § 82a-303, MD. ANN. CODE art. 8 § 733, MICH. COMP. LAWS ANN. § 281.133, NEB. REV. STAT. § 46-209, N.J. STAT. ANN. § 58:5A-3, N. MEX. STAT. ANN. § 75-5-1, N.Y. WATER LAW tit. 5 § 430, N.C. GEN. STAT. § 143-215.34, N. DAK. CENT. CODE § 61-02-14, OHIO REV. CODE ANN. § 1521.06, PA. STAT. ANN. tit. 32 § 685, S.C. CODE § 49-11-240(c) (including minimum safety design, standards for impoundments, safety inspection standards and water discharge or drawdown rate and levels in unsafe impoundments), S. DAK. COMP. LAWS ANN. §§ 16-5-10, 11, TENN. CODE ANN. § 70-2504(c), TEX. REV. CIR. STAT. ANN. tit. 2 § 12-052(a), VA. CODE ANN. §§ 62.1-100, 104.1 (ensure impoundment structures are properly and safely constructed, maintained and operated), WASH. REV. CODE § 86.16.026, W. VA. CODE ANN. § 20-50-4(d).
260. TENN. CODE ANN. § 70-2504(c).
261. IND. STAT. ANN. § 13-2-20-3.
262. ARIZ. REV. STAT. § 45-715(a), CAL. WATER CODE § 6028, COLO. REV. STAT. § 37-87-115 (including employees), CONN. GEN. STAT. ANN. § 25-115, FLA. STAT. ANN. § 373.443, IDAHO CODE § 42-1717, IND. STAT. ANN. § 13-2-20-8, NEV. REV. STAT. § 535.040, N.C. GEN. STAT. § 143-215.35, S.C. CODE § 49-11-250, WASH. REV. CODE § 86.16.100, WIS. STAT. ANN. § 31.26(4), WYO. STAT. § 41-3-316.
263. ARIZ. REV. STAT. § 45-715(B), CAL. WATER CODE § 6029, COLO. § 37-87-113, CONN. GEN. STAT. ANN. § 25-115, GA. CODE ANN. § 85-1306, IDAHO CODE § 42-1717, MASS. ANN. LAWS ch. 253 § 49, N.C. GEN. STAT. § 143-215.35, OR. REV. STAT. § 540-350(2), S.C. CODE § 49-11-250, TENN. CODE ANN. § 70-2528, TEX. REV. CIV. STAT. ANN. tit. 2 § 12.052, W. VA. CODE ANN. §§ 20-50-10, 13, WIS. STAT. ANN. § 31.26(4), WYO. STAT. § 41-3-317.
264. *See* Binder, *A Novel Approach to Reasonable Population of Strip Mining*, 35 U. PITT. L. REV. 339, 335 (1973).

in amount to 50% of the estimated cost of the project, conditioned upon completion of the dam, dikes or levee in accordance with the terms of the permit, and the approved plans and specifications. Monies collected from a bond forfeiture go into a "Dam Safety Fund" to complete sites for which bonds have been forfeited, or otherwise render them non-hazardous.[265] One year after approval of construction, and no fact has appeared to indicate that the construction was not performed in the approved manner, and that as constructed, it will not endanger life, health or property, the bond shall be released.[266] Thus, a waiting period is established, hopefully sufficient in length, to appraise the safety of the dam as constructed.

New York may also require the posting of a bond by the permittee, conditioned upon compliance with the terms of the permit.[267] As to the problem of maintaining a dam in safe condition, New York places an affirmative duty on the licensee of water power works to keep them in good repair and in efficient working order.[268] Wisconsin will not issue a permit unless the applicant furnishes proof of ability to operate and maintain the dam in good condition, for a reasonable period of time, but not less than 10 years.[269] The problem with this provision is that the physical life of a dam may exceed its economic life, and a "reasonable period of time" might not be construed to mean the physical life of the structure.

On the other hand, South Carolina requires the dam owner to be solely responsible for maintaining the dam or reservoir in a safe condition throughout the life of the structure.[270] Indiana requires the owner to maintain it using prudence and sound and accepted engineering principles.[271]

Florida[272] and Minnesota[273] both have statutory presumptions of non-use so that the state can take over an

265. OHIO REV. CODE ANN. § 1521.061.
266. *Id.* at § 1521.06.
267. N.Y. WATER LAW tit. 5 § 15-0509.
268. *Id.* at tit. 17 § 15-1727(i).
269. WIS. STAT. ANN. § 31.14.
270. S.C. CODE § 44-11-150. Arkansas requires construction and maintenance for the permit 271 Life of the Structure. ARK. STAT. ANN. § 21-1306(1).
271. IND. STAT. ANN. § 13-2-20-2.
272. FLA. STAT. ANN. § 373.426 (three years).
273. MINN. STAT. ANN. § 110.37 (fifteen years). The Minnesota statute applies the presumption to the dam site and appurtenant flowage easements as well as to the dam itself. *Id.*

"abandoned" dam so as to afford a means of allowing the state to alleviate a potential problem.[274] Texas authorizes its agency to condemn existing works if they become a public menace or dangerous to life or property.[275]

New Hampshire authorizes the New Hampshire Water Resources Board to acquire dams in disrepair and reconstruct and maintain them;[276] it can appoint an advisory board to help.[277] If the owner of a dam in disrepair fails to take corrective measures,[278] then the town can acquire the dam through eminent domain,[279] as in Texas.[280] If the owner is under a legal disability or his residence is unknown, a guardian ad litem can be appointed to represent his interests.[281] This measure could serve as a model for other states with old and abandoned dams, which create a potential hazard to life or property.

Finally, Montana has an interesting provision which, unfortunately, is not self-executing:

> No person must fill, or procure to be filled with water, any reservoir which is not so thoroughly and substantially constructed as to safely hold water that might be turned therein.[282]

Nor can he construct a dam except in a thorough, secure and substantial manner.[283]

The result of this exhaustive excursion through the state statutes is to show just how deficient the existing state

274. Of course, this type of provision may impose a huge cost obligation on the state to render the dam and reservoir safe, or to remove it. The cost implications have not, as yet, been faced. The Minnesota statute provides that when the cost of repair or reconstruction is less than $50,000, the agency can order the necessary work. Up to $100,000 requires the consent of the state executive council. Once $100,000 is required, then the agency must proceed to the legislature. MINN. STAT. ANN. § 105.482(5).

275. TEX. REV. CIV. CODE ANN. art. 6.063, N.H. REV. STAT. ANN. § 482:36. A dam in disrepair is defined as one which is a menace to public safety, or incapable of safely impounding flood waters to its crest, or incapable of maintaining a reasonably constant level of waters impounded, or one which does not contain adequate gates and sluiceways to provide for the holding or controlled discharge of water impounded. *Id.* at § 482.1(ii).

276. *Id.* at § 482:37.

277. *Id.* at § 482:46. The owner of a dam is now statutorily charged with the duty of not allowing it to become a dam in disrepair. *Id.* at § 482:42.

278. *Id.* at § 482:47.

279. TEX. REV. CIV. CODE ANN. art. 2 § 12.015.

280. VER. STAT. ANN. tit. 10 § 1095(b).

281. N.H. REV. STAT. ANN. § 482.55.

282. MONT. REV. CODE ANN. § 89-701. Indiana also requires the owner of a dam to keep it in repair. IND. STAT. ANN. § 13-2-20-2.

283. MONT. REV. CODE ANN. § 89-702.

regulatory system is. In pointing out individual state provisions that differ from the general pattern, it should be realized that there are relatively few exceptions to the general pattern which, in itself, is deficient.

Several figures illustrate these inadequacies. Only eleven statutes cover any dam which may pose a threat to human life or property. Only sixteen states authorize the use of outside experts. Only a few states require detailed baseline studies. Only 24 states require permits for repairs, alterations, modifications or reconstruction and only ten provide for removal of a dam.

Perhaps the best way of illustrating the statutory vagaries is that Tennessee, with an excellent statute, has had a sporadic enforcement record, whereas California, with but a relatively standard statute, has made the most of it. California's regulations were spurred by a major dam break in 1928, which killed 450, thereby spurring a rigorous safety effort, and serving as the progenitor of dam safety measures. It is encouraging that South Carolina, Tennessee, West Virginia and Wyoming have recently enacted comprehensive dam safety measures, illustrating that states are increasingly perceiving the need for meaningful dam safety regulation.

VI. CONCLUSION

It is clear that minimum dam safety and inspection criteria must be enforced by the states if dam safety is to be advanced. It is equally clear, as seen in the preceding section, that the existing state regulatory pattern is grossly inadequate. The existing state statutes are inconsistent, and at variance with each other. Few of them provide adequate dam safety and inspection programs. Third, dams, reservoirs and raging rivers are not respectful of a state's borders. Consequently, an excellent dam safety program in one state may not protect its citizens against a dam break upriver in another state, where dam safety programs are inadequate.

Consequently, as in the areas of air and water pollution, surface mining, solid waste disposal, and other areas, a need exists for uniform minimal national dam safety and inspec-

tion criteria. An independent federal agency should be established to carry out this purpose. The approach should be the now familiar cooperative effort between the federal and state governments. Federal funds would be provided the states, which would possess primary line authority to implement the act, contingent upon meeting the minimum national standards. Failure of a state to implement the requisite plan would result in promulgation of a federal plan for the state.

As for federal dams, the existing agencies should be allowed to construct their own dams, conditioned again upon meeting the national standards and the use of outside review boards. Society would thereby have the benefit of their expertise and diversity of approaches.

The overall federal program should be run by an independent federal agency, which would possess the duty and power to inspect federal dams.[284] In this way, federal dams would be investigated by an independent agency, and drawing upon the results learned from these investigations and state reports, be in a position to adopt new safety and inspection criteria.

Realistically, this proposal is not politically possible at the present time. Major opposition by the states could be expected. Water rights have traditionally been a hallowed area of state rights under Western water law; some states currently maintain the present federal inspections program infringe their rights.[285] A major reason for the 5-year hiatus in actual inspections was a belief by the Nixon and Ford administrations that dam inspections should be a matter of state responsibility. In this respect, the proposal places primary emphasis upon the states.

In conclusion though, let us reiterate that the history of dam safety legislation has been a crisis-reaction syndrome.[286]

284. This recommendation also appears in a Congressional report. Teton Dam Failure, *supra* note 18, to 81.

285. For example, C. Stephan Allred, Director of the Idaho Department of Water Resources, testified to Congress that they did not want federal inspections or standards. He testified "we do not need nor will we accept federal requirements that we adopt a common approach or that we observe nationwide standards," and suggested the current Corps inspections stepped on states' rights. Denver Post, Feb. 5, 1978 at p. 45, col. 1.

286. One final example should suffice. North Carolina passed its dam safety act in 1967. It was not until 1977 that the first money was appropriated or an administrator ap-

Now is the time to adopt a preventative program before many more dams break.

pointed to carry out its provisions. A staff of two was then established to operate the purposes. 300 dams were inspected between 1974 and 1976. In February 1976 Bear Wallow Dam collapsed, killing four. A crash program of dam inspections was then undertaken. 22 individuals were hired, 3,082 dams were inspected. 100 dams have subsequently undergone more extensive examination, extensive repair, or removal. Dam Safety, *supra* note 4, at 18-19.