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A Comparative Review of Environmental Policies and Laws Involving Hazardous Private Dams: 'Appropriate' Practice Models for Safe Catchments

John D. Pisaniello

A COMPARATIVE REVIEW OF ENVIRONMENTAL PROTECTION POLICIES AND LAWS INVOLVING HAZARDOUS PRIVATE DAMS: 'APPROPRIATE' PRACTICE MODELS FOR SAFE CATCHMENTS

JOHN D. PISANIELLO*

ABSTRACT

Generally, the world's largest dams have been erected and managed by governments, while individual owners have been responsible for private dams. Both kinds of dams have experienced technical failures that have resulted in tragic losses of life as well as disastrous damage to property and environment, and this has generated serious concerns regarding dams' safety worldwide. In Australia, despite the fact that attention has been focused on the physical and technical integrity of medium- to large-scale dams, the smaller private dams have been virtually ignored with regard to their serious potential and actual problems. Specifically, private dams pose threats to downstream communities and environment in larger catchments due to these dams having potential cumulative safety dangers. This paper establishes the significance of this problem. The main issues and concerns surrounding the (lack of) implementation of private dam safety assurance and environmental protection laws have been identified and illustrated with Australian case studies. An international comparative review of private dam safety assurance policies, laws, and management practices has been conducted in order to provide a basis for addressing these issues. The practices analyzed comprise Australia (including New South Wales, Victoria, and Tasmania), the United States

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(including Michigan and Washington), Canada (including Alberta), the United Kingdom, South Africa, and Finland. The review/analysis has identified benchmarks for and elements of "best" and "minimum" practice that can and do exist successfully to control the safety management of private dams and minimize both individual and cumulative dam safety threats within catchments. These elements have led to the development of models of "best" and "minimum" practice and guidelines for selecting "appropriate" practice suitable for varying jurisdictional circumstances; their application is illustrated with an Australian case study. The models and associated comparative guidance provided here enable appropriate law and policy arrangements for private dam safety assurance to be determined and/or checked for any jurisdiction worldwide.

INTRODUCTION[1]

Serious concern over private dam safety was first evident in Ancient Babylon nearly 3800 years ago.[2] King Hammurabi (c.1800 B.C.), the greatest king of Babylon, created a legal code containing rules and regulations relating to many aspects of the operation of dams.[3] Failure to conform with the code attracted severe penalties.[4]

During the twentieth century, many communities throughout the world came to rely on dams because they provided many benefits to people, such as regular farm irrigation and municipal water supplies.[5] However,

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[1] Portions of the Introduction are derived from John D. Pisaniello & Jennifer M. McKay, *International Best Practice Safety Assurance Policy and Cost-Effective Spillway Design/Review for Small Dams: Protecting Downstream Communities, in* NEW TRENDS IN WATER AND ENVIRONMENTAL ENGINEERING FOR SAFETY AND LIFE 89 (Ugo Maione et al. eds., 2000) [hereinafter Pisaniello & McKay, *International Best Practice*]; John D. Pisaniello & Jennifer M. McKay, *Cost-Effective Private Dam Safety Assurance Policy and Spillway Design/Review*, 15 WATER RES. DEV. 261 (1999) [hereinafter Pisaniello & McKay, *Cost-Effective*]; John D. Pisaniello, Wu Zhifang & Jennifer M. McKay, *Small Dams Safety Issues—Engineering/Policy Models and Community Responses from Australia*, 8 WATER POL'Y 81 (2006); John D. Pisaniello & Jennifer M. McKay, *The Need for Private Dam Safety Assurance Policy—Demonstrative Case Studies Ten Years Later*, AUSTL. J. OF EMERGENCY MGMT., Aug. 2005, at 15 [hereinafter Pisaniello & McKay, *Private Dam Safety*].

[2] *See* NORMAN SMITH, A HISTORY OF DAMS 9 (1st Am. ed., Citadel Press 1972) (1971).

[3] *Id.*

[4] *Id.*

[5] *See id.* at 219.

this increase has coincided with a number of horrific failures worldwide and triggered serious concerns over dam safety.[6] It is true that large dams' failures are more spectacular and receive more "newsworthy" attention than those of smaller dams.[7] However, small dam failures and in particular those that are privately-owned are far more frequent in their occurrence; consequently, small dams' total annual costs can be much higher than the rare (if admittedly more spectacular) failures of large dams.[8] Also, past events have occurred where failures of relatively small dams have caused disastrous consequences. For example: Skelmorlie Dam (United Kingdom), five meters high with only twenty-four megaliters of water, failed in 1925 and caused five deaths;[9] the Shimantan and Banquia dams (China) failed in 1975 due to the cumulative failure of sixty smaller upstream dams and resulted in 230,000 deaths;[10] Kelly Barnes Dam (United States), only 11.6 meters high, failed in 1977 and killed thirty-nine people;[11] Lawn Lake Dam (Colorado), eight meters high, failed in 1982, drowned three people, and caused US $31 million in damages;[12] the Stava Tailings Dam (Italy) failed in 1985 and released only 180 megaliters of tailings material but killed 268 people and caused a serious environmental impact;[13] the Evans and Lockwood dams (United States), around five meters high with eighty-nine and thirty-nine megaliters of water respectively, overtopped and failed in a cascade manner in 1989 and

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[6] *See generally* Patrick McCully, *And the Walls Come Tumbling Down*, WORLD RIVERS REV., June 2005, at 1, *available at* http://www.internationalrivers.org/files/WRR.V20.N3.pdf.
[7] Barry Lewis & James Harrison, *Risk and Consequences of Farm Dam Failure*, 27 AUSTL. INST. OF ENGINEERS HYDROLOGY &WATER RES. SYMP. (2002).
[8] *See id.*; *see, e.g.*, O. G. Ingles, *A Short Study of Dam Failures in Australia, 1857–1983*, 1 CIVIL ENG'G SYS. 190, 190–94 (1984) (showing tables of dam failures in Australia by size and dam use along with their costs).
[9] MARK MORRIS, HENRY HEWLETT & CRAIG ELLIOT, RISK AND RESERVOIRS IN THE UK 5 (2000), *available at* http://www.environment.fi/download.asp?contentid=16869&lan=EN.
[10] *See* DAI QING, THE RIVER DRAGON HAS COME! THE THREE GORGES DAM AND THE FATE OF CHINA'S YANGTZE RIVER AND ITS PEOPLE 23 (John G. Thibodeau & Philip B. Williams eds., Yi Ming trans., 1998).
[11] ROBERT L. CRISP ET AL., FEDERAL INVESTIGATIVE BOARD, THE 1977 TOCCOA FLOOD, REPORT OF FAILURE OF KELLY BARNES DAM FLOOD AND FINDINGS, §§ Authority, Purpose (1977), *available at* http://ga.water.usgs.gov/publications/ToccoaFIBReport/.
[12] KATIE KELLERLYNN, U.S. NAT'L PARK SERV., ROCKY MOUNTAIN NAT'L PARK GEOLOGIC RES. EVALUATION REPORT 6 (2004), *available at* http://www.nature.nps.gov/geology/parks/romo/romo_gre_rpt_view_low.pdf.
[13] Jonathan Engels & Darron Dixon-Hardy, *Stava Tailings Dam Failure Near Trento, Italy,* TAILINGS.INFO, http://www.tailings.info/stava.htm (last visited Jan. 24, 2011).

killed two people;[14] and most recently, the twelve meters high earthen Ka Loko Dam (Hawaii) overtopped and failed due to a blocked spillway in 2006 and resulted in the death of seven people and widespread environmental damage,[15] followed by Situ Gintung dam (Indonesia), only ten meters high, which overtopped and burst in 2009 and killed around 100 people in addition to causing widespread damage near Jakarta.[16]

Wayne Graham studied dam failures in the United States resulting in fatalities from 1960 to 1998 and found that the failure of dams less than fifteen meters high (the typical height range of smaller dams) caused eighty-eight percent of deaths.[17] The failure of small dams less than six meters high caused two percent of deaths.[18] These past events show that without appropriate design, construction, maintenance, and surveillance, poorly managed small dams pose significant individual and cumulative threats that can cause considerable human, property, and environmental losses to the community. Hence, ensuring adequate management of these structures is critical and is the focus of this article.

There are many factors in dam design that have changed over time—including population distributions, infrastructure patterns, meteorological information, engineering methods, and design standards—and when combined with the condition of the dams, serious doubts about dam adequacy are raised.[19] Unfortunately, no dam can be made one-hundred percent safe as there is an incomplete understanding of the uncertainties associated with natural and human factors, materials behavior, and construction processes.[20] Therefore, there is a risk of failure at every dam.[21] The adverse consequences at some dams are such that risks need to be periodically checked by professional engineers and, if necessary, reduced

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[14] WAYNE J. GRAHAM, BUREAU OF RECLAMATION, U.S. DEP'T OF THE INTERIOR, DSO-99-06, A PROCEDURE FOR ESTIMATING LOSS OF LIFE CAUSED BY DAM FAILURE 8 (1999), *available at* www.usbr.gov/ssle/damsafety/Risk/Estimating%20life%20loss.pdf.

[15] ROBERT C. GODBEY, REPORT OF THE INDEPENDENT CIVIL INVESTIGATION OF THE MARCH 14, 2006, BREACH OF KA LOKO DAM 14–15, 84 (2007), *available at* http://the.honoluluadvertiser.com/pdf/kaloko/Kaloko-Report.pdf.

[16] *Death Toll Rises to 96 in Indonesia Dam Failure*, ASSOC. PRESS, Mar. 29, 2009, *available at* http://www.msnbc.msn.com/id/29937788/; *Indonesia Dam Burst Kills Dozens*, BBC NEWS (Mar. 27, 2009), http://news.bbc.co.uk/2/hi/7967205.stm.

[17] GRAHAM, *supra* note 14, at 9.

[18] *Id.*

[19] *See* McCully, *supra* note 6, at 1, 8.

[20] *Id.* at 8.

[21] *Id.* at 8–9.

to modern acceptable standards.[22] Also, owners must continually maintain dams.[23]

Since it is the role of governments to protect their countries, communities, and their natural environment, governments must also implement appropriate policies, laws, and regulations, which assure the community of owner participation, and protect people from dangerous or compromised practices involving the management of dam safety. Many countries have attempted to meet these needs in various ways, acknowledging the value of downstream life, property, and the environment.[24] This to some extent includes Australia, but certainly not South Australia ("SA").[25] Policy and law benchmarks, models, and guidelines will be developed here for best meeting these needs based on a comparative analysis of selected leading international dam safety assurance practices. SA provides an illustrative case study of how to use the derived law and policy models and guidelines to determine "appropriate" practice for any jurisdiction.[26]

The article proceeds as follows: Part I considers dam safety in Australia and the main concerns associated with private dams, including an outline of the *policy deficient* state of SA. Part II reviews, in detail, the dam safety assurance practices of selected Australian and international jurisdictions. Part III establishes general minimum and best practice

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[22] The potential danger posed by dams is commonly categorized by a hazard rating of either high, significant, or low. *See, e.g.*, FED. EMERGENCY MGMT. AGENCY, U.S. DEP'T OF HOMELAND SEC., FEDERAL GUIDELINES FOR DAM SAFETY: HAZARD POTENTIAL CLASSIFICATION SYSTEM FOR DAMS 5–6 (2004), *available at* http://www.ferc.gov/industries/hydropower/safety/guidelines/fema-333.pdf; AUSTL. NAT'L COMM. ON LARGE DAMS, GUIDELINES ON DAM SAFETY MANAGEMENT (2003) [hereinafter ANCOLD MANAGEMENT GUIDELINES]. These categories vary only slightly in definition in the different countries reviewed in this paper. For example, the Canadian province of British Columbia uses the hazard ratings very high, high, low, and very low. British Columbia Dam Safety Regulation, R.S.B.C. 44/2000 (Can.). The Australian National Committee on Large Dams ("ANCOLD") classifies dam hazard as either very low, low, significant, high C, high B, high A, or extreme. AUSTL. NAT'L COMM. ON LARGE DAMS, GUIDELINES ON ASSESSMENT OF CONSEQUENCES OF DAM FAILURE 13 tbl.3 (2000) [hereinafter ANCOLD, CONSEQUENCES OF DAM FAILURE]. For the purposes of this paper, the ratings can be generally summarized as follows: "high hazard"—failure *will* endanger many lives in a downstream community and *will* cause extensive damage to property and/or environment; "significant hazard"—failure *may* endanger some lives and *will* cause extensive damage to property and/or environment; "low hazard"—failure poses negligible risk to life and will cause limited damage.

[23] *See, e.g.*, British Columbia Dam Safety Regulation, R.S.B.C. 44/2000 § 3 (Can.) (detailing a dam owner's maintenance responsibilities); ANCOLD MANAGEMENT GUIDELINES, *supra* note 22.

[24] *See infra* Parts II.A–II.F.

[25] *See infra* Part I.B.

[26] *See infra* Part I.B.

benchmarks in private dam safety assurance policy. Part IV then provides a comparative analysis of each of the reviewed practices in order to identify elements of better practice, which together form a model of "best practice." Part V similarly identifies the key elements necessary to establish a model of "minimum practice." Guidelines for selecting the "appropriate" private dam safety assurance policy from the developed models are then derived in Part VI. A summary of lessons and implications, including an example application of the policy guidelines, as well as conclusions, are provided in the final parts.

I. DAM SAFETY IN AUSTRALIA[27]

In Australia, like most common law countries, owner obligation exists under the common law of negligence to take reasonable care of dams according to current prevailing standards.[28] In the case of *Burnie Port Authority*, the High Court of Australia concluded, "Under those [negligence] principles, a person [taking] advantage of [the] control of premises to introduce a dangerous substance . . . [or] to carry on a dangerous activity . . . owes a duty of reasonable care to avoid a reasonably foreseeable risk of injury or damage to the person or property of another."[29] It is inevitable that any significant private dam will attract the issue of duty of care because there will be proximity between the dam owner and the assets of the plaintiff damaged when such a failure occurs.[30]

The responsibility of evaluating public dams in terms of following current guidelines has been assumed by most Australian government dam-owning agencies. These agencies have the task of implementing appropriate action, costing much money, to reduce the risks of dam failure so that modern acceptable standards are attained.[31] For example, in New South

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[27] Portions of Part I are derived from John D. Pisaniello, *How to Manage the Cumulative Flood Safety of Catchment Dams*, 35 WATER SA 361 (2009) [hereinafter Pisaniello, *How to Manage*]; John D. Pisaniello, Analysis and Modelling of Private Dam Safety Assurance Policy and Flood Capability Design/Review Procedures (Aug. 1997) (unpublished Ph.D. thesis, University of South Australia) [hereinafter Pisaniello, Ph.D. Thesis]; Pisaniello & McKay, *Cost-Effective*, *supra* note 1; Pisaniello & McKay, *Private Dam Safety*, *supra* note 1.

[28] *See* Robert Wensley, *Legal Constraints in the Use of Risk Assessment*, *in* ACCEPTABLE RISKS FOR MAJOR INFRASTRUCTURE 23, 27 (Paul Heinrichs & Robin Fell eds., 1995); Jennifer M. McKay & John D. Pisaniello, *What Must the Reasonable Private Dam Owner Foresee?*, MACEDON DIGEST, Summer 1995, at 27, 27.

[29] *Burnie Port Auth. v. Gen. Jones Pty. Ltd.* (1994), 179 CLR 520, 556–57 (Austl.) (per five of the seven judges in joint judgment).

[30] McKay & Pisaniello, *supra* note 28, at 27.

[31] N.S.W. DAMS SAFETY COMM., ANNUAL REPORT 2002/2003, at 6 (2003), *available at* http://www.damsafety.nsw.gov.au/DSC/Download/Annual_Reports_PDF/AR%202002_03.pdf.

Wales ("NSW") safety upgrades on the Pindari and Warragamba dams were recently completed at a cost of AU $68.8 million and AU $100 million, respectively.[32] Recent extensive safety studies and subsequent upgrading in SA have been commissioned for most public dams, for example, Mount Bold Reservoir,[33] Kangaroo Creek Dam,[34] and Happy Valley Reservoir.[35] However, for private dams the situation is different, and the reasons why are explained in more detail below.

A. The Private Dam Safety Problem in Australia[36]

"In Australia, a clear problem exists with private dam safety: Australia has a large number of relatively small, privately owned dams (farm dams especially . . .) and those which have failed number in the thousands."[37] There are an estimated 480,000 farm dams in Australia.[38] In 1992, the Australian National Committee on Large Dams ("ANCOLD")[39] estimated that for NSW alone, twenty-three percent of its farm dams had failed.[40] In Victoria, around 1000[41] of the 300,000[42] farm dams are

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[32] *See id.* at 19 tbl.4; STATE WATER CORP., DAM FACTS AND FIGURES: PINDARI DAM (2009), *available at* http://www.statewater.com.au/_Documents/Dam%20brochures/Pindari%20Dam%20Brochure.pdf.

[33] *See generally* TREVOR DANIELL & PETER HILL, UNIV. OF ADELAIDE, FLOOD HYDROLOGY STUDY OF THE ONKAPARINGA RIVER (1993).

[34] *See generally* LANGE DAMES CAMPBELL (SA) PARTY LTD. & SNOWY MOUNTAINS ENG'G CORP., REF. NO. SA485, RIVER TORRENS FLOOD HYDROLOGY STUDY (1995).

[35] *See generally* BC TONKIN & ASSOC., REF. NO. 95.0296, HAPPY VALLEY RESERVOIR EXTREME FLOOD HYDROLOGY STUDY (1997).

[36] Portions of Part I.A are derived from John D. Pisaniello & Jennifer M. McKay, *Australian Community Responses to Upgraded Farm Dam Laws and Cost-Effective Spillway Modelling*, 21 WATER RES. DEV. 325, 328 (2005) [hereinafter Pisaniello & McKay, *Australian Community Responses*]; John D. Pisaniello & R.L. Burritt, Farm Dam Safety Accounting and Reporting Policy in Australia (2010) (unpublished conference paper) (on file with author); Pisaniello, Zhifang & McKay, *supra* note 1; Pisaniello, *How to Manage*, *supra* note 27; Pisaniello, Ph.D. Thesis, *supra* note 27.

[37] Pisaniello, *How to Manage*, *supra* note 27, at 361; Pisaniello, Ph.D. Thesis, *supra* note 27, at 1.

[38] Janine Price, Barry Lewis & Ian Rutherfurd, *Water Quality in Small Farm Dams*, 28 INT'L HYDROLOGY &WATER RES. (2003).

[39] This is the main body in Australia which sets the standard on dam safety. *See* John Marsden et al., *Dam Safety, Economic Regulation and Society's Need to Prioritise Health and Safety Expenditure*s, 33 IPENZ PROC. OF TECHNICAL GROUPS 1, 1–2 (2008).

[40] *Status of Dam Safety in Australia*, ANCOLD BULL. (Austl. Nat'l Comm. on Large Dams, Hobart, Tas., Austrl.), 1992, at 9, 11.

[41] *Id.* at 11; K. Murley, *Referable Dams in Victoria-Spillway Inadequacy*, ANCOLD BULL. (Austl. Nat'l Comm. on Large Dams, Hobart, Tas., Austrl.), April 1987, at 24–26.

[42] P. S. Lake & Nick R. Bond, *Australian Futures: Freshwater Ecosystems and Human Water Usage*, 39 FUTURES 288, 290 (2007).

hazardous. While the costs of private dam failures associated with public and private infrastructure and the environment are significant, there is unfortunately no systematic means of determining this because failures are rarely publicized and/or documented.[43] Pisaniello[44] attempted to estimate these costs in Australia on the basis of thirty-seven available *recorded* dam failures[45] going back to 1857, finding that: (i) of all the failures, only a *privately* owned dam caused loss of life (fourteen lives lost),[46] and (ii) the dams five meters to twenty meters high—this being the typical size range of significant private dams—represent sixty percent of all the recorded failures; of these, fifty percent are private dams.[47] Thus, some indication has been provided of the type of costs associated with private dam failures, and furthermore the need to have policies and regulatory frameworks to resolve such problems.

A major concern with private dams is that contractors are often hired by landholders to build their dams.[48] "These contractors are, typically, not properly trained or skilled in the design and construction of dams. Thus, many private dams are not built to an adequate standard."[49] Also, private owners tend to neglect the need for reviewing their dams and instead develop a sense of complacency, believing that as the dams have not failed up to now, then they will never fail.[50] The outcome is that no ongoing maintenance, upgrading or series of safety checks is made on private dams, and this ultimately puts at risk the downstream communities.[51]

Another serious problem is that small dams' individual lack of safety can lead to cumulative failure during medium to large floods which can result in severe, destructive, or catastrophic downstream outcomes.[52] For example, this occurred with the Shimantan and Banquia dam failures in China and the Evans and Lockwood dam failures in the United States

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[43] *See* Ingles, *supra* note 8, at 190.
[44] *See generally* Pisaniello, Ph.D Thesis, *supra* note 27.
[45] Failure refers to "a lack of performance as originally intended, which has resulted in a loss of life and/or substantial costs for rectification" (i.e. more than AU $1 million) and/or damage to the environment. Ingles, *supra* note 8, at 190.
[46] This dam being the Briseis Mining dam in Tasmania in 1929. Pisaniello, Ph.D. Thesis, *supra* note 27, at 2.
[47] *Id.*
[48] *Id.* at 10.
[49] Pisaniello, Ph.D. Thesis, *supra* note 27, at 10. *See* Pisaniello & McKay, *Australian Community Responses*, *supra* note 36, at 328.
[50] *See* K. C. Webster & R. J. Wark, *Australian Dam Safety Legislation*, ANCOLD BULL. (Austl. Nat'l Comm. On Large Dams, Hobart, Tas., Austl.), 1987, at 63, 66.
[51] *See* Pisaniello, Zhifang & McKay, *supra* note 1, at 87.
[52] *See id.*

as described previously in this paper.[53] This major problem has been demonstrated in a flood study of the large public Kangaroo Creek Dam in South Australia's Torrens catchment.[54] This particular study discovered that the peak inflow to Kangaroo Creek Dam would rise *fourfold* and cause it to fail, in the event that all the small dams in the catchment failed simultaneously in an extreme design flood event of only 1-in-200 years, compared to the flow estimated if the dams remained intact.[55] These small dams' cumulative failure represented a reasonable assumption and even more so when a later study concluded that most small dams in southeastern Australia would not withstand the 1-in-100 years design flood event.[56] The River Torrens study thus recognized the need for "controlling the standard of construction of farm dams and their spillways."[57] An added problem is that global warming is making extreme "flash" flood events much more likely.[58] Consequently Australia is at great risk of experiencing disastrous and cumulative-style dam failures in the future.

ANCOLD has for some time been aware of and expressed its concerns regarding the problems outlined above and encouraged the States to implement uniform dam safety legislation.[59] There have been, however, high levels of political ambivalence and subsequently attempts to enact dam safety bills have not been successful in most states.[60] NSW is currently the only state to have a specific dam safety act,[61] and it is only in recent times that Queensland and Victoria have amended their existing water laws by introducing some private dam safety regulations.[62] Nonetheless, despite these three states' efforts, their relevant policies are not pervasive because they only address the problems associated with larger, more significant dams. They fail to consider the cumulative safety threats

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[53] *See supra* notes 10, 14 and accompanying text.
[54] LANGE DAMES CAMPBELL, *supra* note 34, at 2–3, 43.
[55] *Id.*; *see also* Pavel Kazarovski, *Farm Dams Do Not Have Impact on Large Floods or Do They?*, 23 AUSTL. INST. OF ENG'RS HYDROLOGY &WATER RES. SYMP. 725, 725–26 (1996).
[56] *See* Pisaniello & McKay, *Australian Community Responses*, *supra* note 36, at 332–33.
[57] LANGE DAMES CAMPBELL, *supra* note 34, at 43.
[58] *See* U.N. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, SUMMARY FOR POLICY MAKERS, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS 7–8 (Susan Solomon et al. eds., 2007).
[59] ANCOLD first became aware of these problems and expressed concern in its publication. *See* Webster & Wark, *supra* note 50, at 63, 66.
[60] Pisaniello & McKay, *Cost-Effective*, *supra* note 1, at 264; Pisaniello, Ph.D Thesis, *supra* note 27, at xix.
[61] *Dams Safety Act 1978* (N.S.W.) (Austl.).
[62] *See Water Act 2000* (Queensl.) (Austl.); *Water Act 1989* (Vict.) (Austl.).

that many smaller dams in catchments pose.[63] Tasmania is the only state to now have an extensive dam safety assurance policy which encompasses all dams, large and small, private and public, lesser and greater hazard.[64] The NSW, Victorian, and Tasmanian policies will be comparatively analyzed in greater detail later in this paper in order to derive elements of better practice in private dam safety assurance.

Why does a high level of political ambivalence exist when it comes to regulating this area? Because dam safety legislation is often considered too "extreme," there is concern that it "may place significant cost burdens upon both government and private owners to administer and conform with it."[65] However, "[s]tates which fail to establish some form of safety assurance policy on the management of potentially hazardous private dams are, in effect, unconsciously devaluing the lives of [people] living downstream of these dams compared with . . . those living downstream of public dams to which attention has or is being given."[66] This is especially the case in SA.

B. South Australia—A Policy Deficient *State*[67]

In SA, many people have, for more than twenty years, expressed their concern over the need for private dam safety assurance.[68] A dam safety bill similar to the NSW act[69] was introduced in parliament in the mid-1980s, but due to a changing government with different priorities, the bill lapsed.[70] In 1990, a Flood Warning Consultative Committee SA study found that

> there is no means of controlling construction or maintenance of farm dams . . . . [L]ack of power to ensure safety

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[63] Pisaniello & McKay, *Private Dam Safety*, *supra* note 1, at 15.
[64] *See Water Management Act 1999* (Tas.) (Austl.); *Water Management (Safety of Dams) Regulations 2003* (Tas.) (Austl.).
[65] Pisaniello, Zhifang, & McKay, *supra* note 1, at 87.
[66] John D. Pisaniello & Jennifer McKay, *The Need for Private Dam Safety Assurance Policy—A Demonstrative Case Study*, AUSTL. J. EMERGENCY MGMT., Spring 1998, at 46, 46 [hereinafter Pisaniello & McKay, *A Demonstrative Case Study*].
[67] Portions of Part I.B are derived from Pisaniello & McKay, *Australian Community Responses*, *supra* note 36; Pisaniello & Burritt, *supra* note 36.
[68] Pisaniello & McKay, *A Demonstrative Case Study*, *supra* note 66, at 47.
[69] *Dams Safety Act 1978* (N.S.W.) (Austl.).
[70] *See* Norm Sheuard, *Dam Safety Requirements, in* 1993 PROCEEDINGS OF THE SEMINAR ON FARM DAMS 43, 43 (Hydrological Soc'y of S. Austl. ed., 1993); *see also Information Service*, AMPLA BULL. (Australian Mining Petroleum Law Ass'n, Melbourne, Austl.) 1985, at 44, *available at* http://kirra.austlii.edu.au/au/journals/AUMPLawB/1985/16.pdf (explaining the introduction of the bill into the legislature).

> during and after construction has in the past and will in the future, inevitably lead to failures and the exacerbation of flood flows in the river systems. The . . . Committee . . . urges the Government to introduce legislation and controls . . . for the construction and maintenance of farm dams.[71]

During 1992, following extreme and damaging weather throughout the Mount Lofty Ranges, a number of issues concerning the safety of farm dams arose.[72] A study on the consequences of the floods found that farm dam failures provided additional problems and contributed to damage costs.[73] In an attempt to address these important and escalating issues, a seminar was held in April, 1993 by the Hydrological Society of SA.[74] It was suggested as a result of the proceedings that the time had come to jump-start a Dam Safety Bill.[75] However, no further progress was made.[76] In 1995, a study of the Kangaroo Creek Dam commissioned by the SA government demonstrated the cumulative safety threats of catchment dams.[77] The study urged the government to regulate farm dam construction and safety.[78] However, the government did not respond.[79]

To test conditions, general maintenance, and spillway capabilities, Pisaniello undertook case studies of hazardous private dams in SA.[80] Results provided evidence and greater certainty on the need for dam safety policy.[81] Pisaniello also developed a cost-effective spillway design/review procedure for the benefit of farmers.[82] Widely publicized outputs were brought to the attention of regulators and farmers.[83] Policy response,

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[71] Pisaniello, Ph.D. Thesis, *supra* note 27, at 5-6; S. AUSTL. FLOOD WARNING CONSULTATIVE COMM., FLOOD WARNING MANAGEMENT PLAN FOR SOUTH AUSTRALIA 26–27 (1990).
[72] Pisaniello & McKay, *Australian Community Responses*, *supra* note 36, at 334.
[73] J.F. HARRISON, DISTRICT COUNCIL OF STIRLING, SA, CENTRAL HILLS REGION COUNCILS—STUDY OF FLOODING ON 30TH AUGUST, 1992 AND 8TH OCTOBER, 1992 1–15 (1992).
[74] Pisaniello & McKay, *Australian Community Responses*, *supra* note 36, at 334.
[75] Sheuard, *supra* note 70.
[76] *See* Pisaniello & McKay, *Australian Community Responses*, *supra* note 36, at 334.
[77] *See supra* note 55 and accompanying text.
[78] LANGE DAMES CAMPBELL, *supra* note 34, at 43.
[79] *See* Pisaniello, *How to Manage*, *supra* note 27, at 362.
[80] *See generally* Pisaniello, Ph.D. Thesis, *supra* note 27 (thesis is cumulation of case studies of hazardous private dams in SA as well as other countries).
[81] *See* Pisaniello & McKay, *A Demonstrative Case Study*, *supra* note 66, at 46.
[82] *See generally* John D. Pisaniello, J. R. Argue & Jennifer M. McKay, *Flood Capability Design / Review of Dams on Small Catchments—A Simple and Cost-Effective Regionalised Procedure*, 3 AUSTL. J. OF WATER RES. 177 (1999).
[83] *See* Pisaniello & Burritt, *supra* note 36, at 16.

however, was not forthcoming.[84] In 2005, Pisaniello and McKay repeated the spillway flood capability case studies and surveyed farmers on the cost-effective spillway design/review procedure, and the results show that providing more time, awareness, and encouragement to farmers addresses the private dam safety problem to a minimal extent.[85] Adequate assurance can only be provided through appropriate policy, which requires the backing of lawmakers.[86]

Currently, local councils have only limited control over situating and constructing dams.[87] They are responsible for assessing certain dam applications for development authorization under SA's Development Act 1993.[88] Natural Resources Management ("NRM") Boards under SA's Natural Resources Management Act 2004 ("NRMA") have control over farm dams in respect to storage capacity, mainly for water allocation.[89] The NRMA provides a permit/license process to build or alter dams that may restrict the capacity or require environmental flow.[90] A permit/license under the NRMA is issued in accordance with only the factors listed in the act, and the issuing authority is not obligated to consider questions of building or flood safety.[91] In fact, section 135(19) specifically provides that an authority "is not liable for injury, loss, or damage caused by, or resulting from, the manner in which an activity [authorized by the permit] is carried out[,] . . . the design of a dam . . . or the materials used for . . . construction . . . ."[92] Therefore, neither act provides the capacity to assess how a dam is designed or built, nor any ongoing supervision to ensure both new and existing dams are maintained properly.

While SA has been fortunate that no dam has failed with lives lost,[93] overseas experience indicates that this is no cause for complacency.[94] When it developed the integrated NRMA, the SA government could have included dam safety assurance measures in its water laws.[95] It did not,

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[84] *Id.*
[85] *See generally* Pisaniello & McKay, *Australian Community Responses*, *supra* note 36.
[86] *See* Pisaniello & Burritt, *supra* note 36, at 16–17.
[87] *Id.* at 17.
[88] *Development Act 1993* (S. Austl.) s 24.
[89] *Natural Resources Management Act 2004* (S. Austl.) s 31.
[90] *Id.* at s 146.
[91] Pisaniello & Burritt, *supra* note 36, at 17.
[92] *Natural Resources Management Act 2004* (S. Austl.) s 135, para 19.
[93] Pisaniello & Burritt, *supra* note 36, at 4.
[94] *See* Pisaniello & McKay, *A Demonstrative Case Study*, *supra* note 66, at 48.
[95] John D. Pisaniello, *The Need for 'Adequate' Farm Dam Safety Management Accountability to Avoid Dam Failure Emergencies*, AUSTL. J. EMERGENCY MGMT., July 2010, at

despite research and evidence, and is "not considered critical enough by policy-makers."[96] It is possible that a policy will be developed only when an actual disastrous dam failure occurs.[97] This reflects the sad reality that this approach in SA is reactive and not proactive. The potential outcome could devastate downstream communities that bear the risks. The current legislative arrangements are clearly inadequate, given that around a hundred private dams exist in the Mount Lofty Ranges alone that are individually of "ANCOLD referable"[98] size and potentially hazardous,[99] and thousands of smaller dams exist[100] which pose considerable cumulative safety threats in catchments.[101] The following comparative analysis provides guidance on more appropriate policy.

II. SUMMARY OF SELECTED INTERSTATE AND OVERSEAS PRIVATE DAM SAFETY ASSURANCE PRACTICES

This part summarizes the legislative arrangements for dam safety assurance in Australia (NSW, Victoria, and Tasmania), the United States (including Michigan and Washington), Canada (including Alberta), the United Kingdom, South Africa, and Finland, enabling comparative analysis in Parts III through V.

A. Australia

As indicated above, NSW is the only state to have a specific dam safety act, Victoria has recently moved to improve its dam safety assurance

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31, 32, *available at* http://www.ema.gov.au/www/emaweb/rwpattach.nsf/VAP/%289A5D88DBA63D32A661E6369859739356%29~Pisaniello.PDF/$file/Pisaniello.PDF [hereinafter Pisaniello, *Farm Dam Safety*].

[96] *Id.* at 32–33.

[97] *See id.* at 33.

[98] *Id.* at 33–34. ANCOLD's *Guidelines on Dam Safety Management* considers a dam to be "referable" (i.e. large enough to pose significant hazard upon failure) when it is higher than five meters and larger than fifty megaliters in capacity or when it is higher than ten meters and larger than twenty megaliters. AUSTL. NAT'L COMM. ON LARGE DAMS, GUIDELINES ON DAM SAFETY MANAGEMENT iii (1994).

[99] *See* Pisaniello, Ph.D Thesis, *supra* note 27, at 128; 20 PARLIAMENTARY DEBATES 3934–92 (S. Austl. 1985).

[100] *See* DOUG MCMURRAY, DEP'T OF WATER, LAND AND BIODIVERSITY CONSERVATION, REPORT NO. DWLBC 2004/02, ASSESSMENT OF WATER USE FROM FARM DAMS IN THE MOUNT LOFTY RANGES SOUTH AUSTRALIA 7 (2003); DOUG MCMURRAY, DEP'T OF WATER, LAND AND BIODIVERSITY CONSERVATION, REPORT NO. DWLBC 2004/48, FARM DAM VOLUME ESTIMATIONS FROM SIMPLE GEOMETRIC RELATIONSHIPS 7–8 (2004).

[101] LANGE DAMES CAMPBELL, *supra* note 34, at 2–3; Kazarovski, *supra* note 55; *see also* Part I.A.

policy, and Tasmania is the only state that has attempted to comprehensively address the problems associated with the multitudes of smaller, private dams in catchments.[102] Lessons can be gained from each of these jurisdictions; hence, they are reviewed respectively below.

1. New South Wales—An Example of Good Practice[103]

The Dams Safety Act 1978 ("DSA") in NSW established the Dam Safety Committee ("DSC").[104] The DSA provides the DSC with statutory powers to monitor the state's private and public prescribed dams and ensure they are maintained to an acceptable standard of safety by their owners.[105] Dams are prescribed on the recommendation of the DSC.[106] A dam is normally prescribed if it is more than fifteen meters in height or if it is a smaller dam posing a considerable hazard to life, property, and/or environment.[107] The hazard classification system adopted by the DSC comprising high, significant, and low hazard categories, is similar to that recommended by ANCOLD. In summary: "high hazard"—failure *will* endanger many lives in a downstream community and *will* cause extensive damage to property and/or environment; "significant hazard"—failure *may* endanger some lives and *will* cause extensive damage to property and/or environment; "low hazard"—failure poses negligible risk to life and will cause limited damage.[108] The DSC, consisting of nine part-time members, is independent of any government agencies which construct or own dams.[109] The DSC is funded by the state government and currently operates on a small annual budget of approximately AU $1 million.[110]

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[102] *See supra* notes 61–64 and accompanying text.
[103] Portions of Part II.A.1 are derived from Pisaniello & McKay, *Australian Community Responses*, *supra* note 36; Pisaniello, *How to Manage*, *supra* note 27; Pisaniello, Ph.D. Thesis, *supra* note 27.
[104] *Dams Safety Act 1978* (N.S.W.) s 7 (Austl.).
[105] *See id.* at s 14.
[106] *Id.*
[107] *See* N.S.W. DAMS SAFETY COMM., DSC2, ROLE, POLICY AND PROCEDURES 3 (1999).
[108] *See supra* note 22; N.S.W. DAMS SAFETY COMM., DSC13, CONSEQUENCE CATEGORIES FOR DAMS 9 (2002).
[109] *Dams Safety Act 1978* (N.S.W.) s 8 (Austl.). Section 8(2) of the DSA requires four DSC members to be nominated by the four major dam owning authorities of NSW, two by the Institution of Engineers, Australia, one by the minister administering the Public Works Act 1912, and a final one by the minister administering the Mining Act 1973. *Id.* Members must be experienced in dam engineering. *Id.*
[110] N.S.W. DAMS SAFETY COMM., DAMS SAFETY COMMITTEE ANNUAL REPORT 2006/2007, at 9 (2007).

The DSC has the responsibility for setting standards and monitoring their observance—its standards are based on Australian guidelines developed in accordance with international practice.[111]

The DSC is required, under section 14 of the Act, to perform a number of duties: (a) maintaining "surveillance of prescribed dams;" (b) examining and investigating their "location, design, construction, modification, operation, and maintenance;" (c) "obtain[ing] information and keep[ing] records on matters relating to the safety of dams;" and (d) "formulat[ing] measures to ensure the safety of dams."[112] The Act, generally, does not include specific rules or standards but establishes power to make any regulations, consistent with the Act, which the DSC considers are necessary to control/ensure dam safety.[113] A regulation may impose a maximum penalty of AU $550 if violated.[114] Violations of any provision of the Act, or a notice given by the DSC, attract a maximum penalty of AU $1600.[115]

The DSC also operates an extensive recording and surveillance system as follows: (1) all prescribed dam owners are required to have surveillance reports prepared and submitted to the DSC at least once every five years; (2) requisite type and content of surveillance reporting depends on dam size and hazard rating, ranging from highly sophisticated reports prepared by a team of experts for high hazard dams to simple surveillance sheets completed by the dam owner for significant hazard dams lower than fifteen meters; (3) the DSC also conducts its own formal periodic inspections (usually every two years), reviewing information provided in previous surveillance reports.[116] The DSC also requires owners of all high and significant hazard dams to have emergency action plans ("EAPs") in place.[117] These plans notify all potentially affected persons downstream of the risk they are living under, and the actions they are to take should dam failure occur, and for the larger dams, this information must be coordinated with detailed flood maps and warning sirens through the State Emergency

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[111] *See id.* at 11. Also, note the NSW DSC keeps current on international practice through its contacts with ANCOLD and the International Committee on Large Dams ("ICOLD"). *See id.* at 4; *International Commission on Large Dams*, WORLD WATER COUNCIL, http://www.worldwatercouncil.org/index.php?id=1511 (last visited Jan. 24, 2011).
[112] *Dams Safety Act 1978* (N.S.W.) s 14 (Austl.).
[113] *See id.* s 32.
[114] *See id.*; *Crimes (Sentencing Procedure) Act 1999* (N.S.W.) s 17 (Austl.).
[115] *See Dams Safety Act 1978* (N.S.W.) s 30, 32 (Austl.); *Crimes (Sentencing Procedure) Act 1999* (N.S.W.) s 17 (Austl.).
[116] *See* N.S.W. DAMS SAFETY COMM., DSC15, REQUIREMENTS FOR SURVEILLANCE REPORTS 1–4, 10–11 (2003).
[117] N.S.W. DAMS SAFETY COMM., *supra* note 110, at 16.

Service ("SES").[118] The DSC normally aims to function through consulting and cooperating with dam owners, making extensive provision for owner education, and guidance through many publications, manuals, and videos on the various aspects of dam safety management.[119] The "Dam Safety Committee Library of Information Sheets"[120] are an excellent example of this.

2. Victoria—An Example of Improving Practice[121]

As indicated previously, in Victoria around 1000 of the 300,000 private/farm dams are hazardous.[122] The Victorian government has, in recent years, attempted to address farm dam safety by first recognizing it as a problem and then partnering with the farming and downstream community to execute the law reform process.[123] In early 2000, a Farm Dams Irrigation Review Committee was established and a discussion paper titled, "Sustainable Water Resources Management and Farm Dams," was later released seeking submissions from the community.[124] The paper addressed capacity-sharing issues for off-stream dams and also recommended that potentially hazardous dams be regulated.[125] "From the responses received, over 70 per cent [*sic*] were in favor of regulating potentially hazardous dams."[126]

The amended Water Act 1989 emerged from these reforms and this statute deems dam owners responsible and liable for any damage caused

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[118] *See* ANCOLD, *supra* note 98, at 30–31; N.S.W. DAMS SAFETY COMM., DSC12, OPERATION, MAINTENANCE, AND EMERGENCY MANAGEMENT REQUIREMENTS FOR DAMS 3–4 (2003).
[119] *See, e.g.*, N.S.W. DAMS SAFETY COMM., *supra* note 110, at 25.
[120] *See Publications: Guidance Sheets*, N.S.W. DAMS SAFETY COMM., http://www.damsafety.nsw.gov.au/DSC/infosheets.shtm (last updated Dec. 22, 2010).
[121] Portions of Part II.A.2 are derived from Pisaniello, Zhifang & McKay, *supra* note 1; Pisaniello & McKay, *Australian Community Responses*, note 36; Pisaniello, *Farm Dam Safety*, *supra* note 95; Pisaniello, *How to Manage*, *supra* note 27; Pisaniello & McKay, *Private Dam Safety*, *supra* note 1.
[122] *See supra* notes 41–42 and accompanying text.
[123] *See, e.g.*, *Sustainable Water Resources Management and Irrigation Farm Dams: Final Report Released 24th July 2001*, VICTORIAN FARM DAMS (IRRIGATION) REV. (July 2001), http://web.archive.org/web/20010804121956/http://home.vicnet.net.au/~farmdams/welcome.htm (accessed by searching for Victorian Farm Dams Review in the Internet Archive index).
[124] *Id.*
[125] *See* VICT. DEP'T OF SUSTAINABILITY AND ENV'T, STREAM FLOW MANAGEMENT PLANS 3 (2006), *available at* http://www.melbournewater.com.au/content/library/rivers_and_creeks/waterway_diverters/stream_flow_management/A_brief_history_of_Stream_Flow_Management_Planning_in_Victoria.pdf.
[126] Pisaniello & McKay, *Private Dam Safety*, *supra* note 1, at 16 (citation omitted).

by their dams and that potentially hazardous dams must be designed, constructed, operated, and maintained in line with appropriate standards and best practices.[127] A requirement of the Water Act 1989 is that all dams must have a license to "take and use" water.[128] At the same time, operating licenses are imposed on potentially hazardous "referable dams," which includes those which have a wall height greater than five meters and at least fifty megaliters storage capacity or those with a wall height greater than ten meters and at least twenty megaliters capacity.[129] The provisions of the Water Act 1989 sets forth the following safety measures:

- Section 67: Dam licenses can be made subject to various conditions, including dam safety requirements.
- Section 71: Defines the conditions that can be attached to a license, such as standards of construction, future operation and maintenance, and the qualifications of people undertaking these works.
- Section 80: The minister can order dam owners to make specified improvements or take other measures to make a dam safe.
- Section 81: Allows the minister to carry out works and recover costs.[130]

The Water Act 1989 also requires owners of referable dams to submit their designs, surveillance plans, and emergency plans, certified by a qualified engineer, to licensing authorities.[131] A qualified engineer reviews the dam surveillance program during the license renewal process. Furthermore, the Water Act compels dam owners to supply the emergency-coordinating agency with a copy of their emergency plans.[132]

The minister's powers under the Water Act 1989 are administered by the Department of Sustainability and Environment.[133] "The department maintains a dams database, which includes most referable and large dams in the state."[134] Rural Water Authorities have been established in various

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[127] *Water Act 1989* (Vict.) s 80 (Austl.).
[128] *Id.* at s 51.
[129] *Id.* at s 67.
[130] *Id.* at ss 67, 71, 80–81.
[131] *Id.* at s 71.
[132] VICT. DEP'T OF SUSTAINABILITY & ENV'T, YOUR DAM, YOUR RESPONSIBILITY: A GUIDE TO MANAGING THE SAFETY OF FARM DAMS 43 (2007).
[133] *See Water Act 1989* (Vict.) ss 3, 22 (Austl.).
[134] Pisaniello & McKay, *Australian Community Responses*, *supra* note 36, at 335.

regions of the state and are responsible for administering the Act and licensing requirements.[135] Victoria's Water Act 1989 has penalties for those owners who fail to comply with its provisions.[136] For example, a penalty of twenty "penalty units" is attached to a breach of section 80.[137]

Victoria has taken a further significant step in publishing the booklet *Your Dam, Your Responsibility—A Guide to Managing the Safety of Farm Dams* that targets the smaller yet hazardous dams, which are usually ignored in most jurisdictions, and educates dam owners on their responsibilities and potential liabilities.[138] This particular publication also educates the owners of non-hazardous dams, advising that even if a dam does not require an operating license, it is in the farmer's best interest to ensure the dam is safe and well maintained; otherwise, the life of the asset could be severely diminished.[139] The booklet uses simple language and illustrates the necessary processes to keep any farm dam in an acceptable and safe condition.[140] It also contains a template dam safety emergency plan that is simple to understand and comply with.[141]

"[T]o [help] address the problem of . . . placing unreasonable cost burdens upon the farming community, the Victorian Government . . . commissioned the University of South Australia to extend the cost-effective flood safety procedure [to Victoria]."[142] The government then assisted the University of South Australia in testing farmer responses to the cost-effective engineering procedure.[143] The survey demonstrated more effort is required to raise farmers' awareness, since many farmers believe that as their particular dam has not previously failed, it is not likely to do so in the future.[144] Most participants said their dams are safe, but did not spend money maintaining them.[145] Nor did farmers check the situation "despite the availability of the affordable spillway design/review technology."[146]

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[135] *See* VICT. DEP'T OF SUSTAINABILITY & ENV'T, *supra* note 132, at 9.
[136] *Water Act 1989* (Vict.) s 84 (Austl.).
[137] *Water Act 1989* (Vict.) s 80. Currently twenty penalty units = AU $2340, as the value of a penalty unit is approximately $117. JOHN LENDERS, VICT. GOV'T, NO. S 132, NOTICE UNDER SECTION 6 FIXING THE VALUE OF A FEE UNIT AND A PENALTY UNIT (2009).
[138] *See generally* VICT. DEP'T OF SUSTAINABILITY & ENV'T, *supra* note 132.
[139] *See id.* at 4.
[140] *See id.* at 1.
[141] *Id.* at 81.
[142] Pisaniello & McKay, *Australian Community Responses*, *supra* note 36, at 336; *see also* Part I.B (describing the cost-effective flood safety procedure).
[143] *Id.*
[144] *Id.* at 338.
[145] *Id.*
[146] *Id.* at 338–39.

The government also helped to test spillway capabilities of hazardous private dams in Victoria under the current policy.[147] Nearly all the dams tested have inadequate spillways.[148] These surveys and case studies show efficient and effective administration of dam safety laws is vital.

Such research enables the Victorian government to keep abreast of law reforms and understand where further policy refinements can be made. Victoria's proactive approach contrasts with SA's reactive strategy.[149] The Victorian government is now undertaking a review of the state's regulation of dam safety.[150] Issues to be examined by the review include (1) whether the current regulatory framework delivers adequate public safety, and (2) how Victoria compares with regulatory models of other state and international jurisdictions.[151]

3. Tasmania—An Example of Comprehensive Practice[152]

The Tasmanian dam safety legislation provides for specific safety measures to be required for the design, construction, and operation of all dams that hold one or more megaliter of water or waste, based on their hazard potential to the community.[153]

Under the Water Management Act 1999 ("WMA"), all proposed new dams must obtain a permit,[154] and all existing dams have to be registered.[155] The WMA is administered by the Department of Primary Industries, Parks, Water, and Environment ("DPIPWE"),[156] and an "Assessment Committee" constituted under the WMA.[157] The main role of the Assessment Committee

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[147] *See* Pisaniello & McKay, *Private Dam Safety*, *supra* note 1, at 19.
[148] *See id.*
[149] *See supra* Parts I.B, II.A.2.
[150] Shane McGrath, *Dam Safety Regulation Review—Victoria*, 2 AUSTL. NAT'L COMM. ON LARGE DAMS, April 2009, at 5.
[151] *Id.* at 5.
[152] Portions of Part II.A.3 are derived from Pisaniello, *How to Manage*, *supra* note 27.
[153] *Water Management Act 1999* (Tas.) s 165A (Austl.); *Water Management (Safety of Dams) Regulations 2003* (Tas.) ss 3(1), 6(1) (Austl.).
[154] *Water Management Act 1999* (Tas.) pt 8 (Austl.).
[155] *Id.* at pt. 8A.
[156] *Water Management (Safety of Dams) Regulations 2003* (Tas.) s 13(3) (Austl.); DPIPWE was formerly known as the Department of Primary Industries and Water ("DPIW"), and the DPIPWE combined two departments. *See About DPIPWE: Annual Reports*, DEP'T. OF PRIMARY INDUS., PARKS, WATER, & ENV'T, http://www.dpipwe.tas.gov.au/inter.nsf/Attachments/PWOD-89S4DP/$FILE/DPIPWE_AR_0910_complete.pdf (last visited Jan. 24, 2011).
[157] *Water Management Act 1999* (Tas.) s 138 (Austl.).

is to assess all new dam permit applications.[158] The minister must appoint six members to the Committee and these persons are nominated by various organizations so that collective expertise is available to advise on issues such as water resources, dams engineering and safety, integrated natural resource management, and best practice environmental management.[159] Furthermore, the permit process legally requires public advertisement of any new dam proposals before any permit is granted.[160] This makes it possible for DPIPWE to consider any objections to a proposal from the community.[161] The ongoing safety of existing dams is supervised by the minister and the minister's delegates—primarily officers of DPIPWE.[162]

All private dam owners have a duty expressly imposed by the WMA to, "so far as is reasonably practicable, maintain and operate [their] dam[s] so as not to cause, or be likely to cause, material environmental harm or serious environmental harm or danger to any person or property."[163] The minister is granted wide powers in part 8A of the WMA to supervise and ensure the safety of all registered dams and ensure that dam owners are not breaching their responsibility.[164] In this capacity, the minister has specific functions under the WMA to:

- Maintain a register of all dams.
- Ensure all dams comply with requisite standards of design, construction, maintenance, and review as specified under the regulations.
- Obtain information and keep records on matters concerning dam safety.[165]

Dam owners must provide information on their dams either as a condition of a permit under the WMA[166] or from a direct order from the minister under various sections relating mainly to ongoing surveillance and maintenance.[167]

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[158] *Id.* at s 143.
[159] *Id.* at s 139.
[160] *Dam Work Permits*, DEPT. OF PRIMARY INDUS., PARKS, WATER, AND ENV'T, http://www.dpiw.tas.gov.au/inter.nsf/WebPages/RPIO-4YG57U?open (last visited Jan. 24, 2010).
[161] *See id.* (noting the reasons that notification is required).
[162] *See Water Management Act 1999* (Tas.) ss 165C, 165D (Austl.).
[163] *Id.* at s 165G.
[164] *Id.* at ss 165C, 165D.
[165] *Id.* at s 165C.
[166] *Id.* at s 157.
[167] *See, e.g.*, *Water Management Act 1999* (Tas.) ss 165F(2), 165H, 165J, 165M, 165N (Austl.).

The Water Management (Safety of Dams) Regulations 2003 ("Regulations"), for the most part, provide prescribed standards for the competency of persons undertaking design, construction, maintenance, and surveillance of dams, based on their hazard categories.[168] Such persons' levels of competency are classified as "any person," "the owner"—persons of either "Class A," "Class B," or "Class C," competence—or an "expert team."[169] Definitions of these classes of persons in section 6 of the Regulations include:

- Class A—a professional engineer with "relevant experience in the investigation, design, construction and day-to-day safety management of dams of a height, type and hazard category similar to the relevant dam."
- Class B—a professional engineer with "relevant experience in dam technology appropriate to the relevant dam."
- Class C—a professional technical specialist with "relevant tertiary qualifications; and relevant specialist experience in the investigation, design, construction or day-to-day safety management of dams of a height, type and hazard category similar to the relevant dam."
- An Expert Team—at least one of the persons has Class B competence; and the persons collectively have [a knowledge and understanding of the causes and modes of dam failure and also have] professional expertise in [all] areas [that] relate to the relevant dam and activity."[170]

Section 7 of the Regulations provides for varying "required competency standards" criteria based on the height of the dam, hazard category of the dam, and the type of activity or reporting to be undertaken or provided.[171] An example of these criteria is provided in Table 1, which is

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[168] *See Water Management (Safety of Dams) Regulations 2003* (Tas.) ss 3, 5 (Austl.).
[169] *Id.* at s 7(2).
[170] *Id.* at s 6.
[171] *Id.* at s 7.

applicable to dams up to ten meters in height.[172] Other similar criteria are also provided in section 7 of the Regulations for dams between ten meters and twenty-five meters high and for those greater than twenty-five meters high.[173] The Regulations require that hazard categories be assessed in accordance with national guidelines published by the ANCOLD:[174] these generally comprise three main categories of high, significant, and low similar to NSW, but further sub-categories are included and determined on a more quantitative basis, e.g., very low, high C, high B, high A, and extreme.[175] Similarly, all standards of design and safety management must comply with ANCOLD guidelines: this includes spillway design standards,[176] the frequency and thoroughness of surveillance, and review and any requirements for EAPs.[177]

TABLE 1: REQUIRED COMPETENCY STANDARDS UNDER TASMANIAN LEGISLATION FOR ALL DAMS UP TO TEN METERS IN HEIGHT[178]

Activity	ANCOLD Hazard Category[179]						
	Very Low	Low	Significant	High C	High B	High A	Extreme
1. Supervision of construction	Owner	Class A	Class A	Class A	Expert Team	Expert Team	Expert Team
2(a). Pre-construction investigation, design and report, other than spillway design	Owner	Owner	Class A and Class C	Class A and Class C	Expert Team	Expert Team	Expert Team
2(b). Spillway design	Owner	Class A	Class A and Class C	Class A and Class C	Expert Team	Expert Team	Expert Team
3. Design plans and specifications	Any person	Any person	Class A	Class A	Expert Team	Expert Team	Expert Team

[172] *Id.* at s 7(2).
[173] *Id.* at s 7.
[174] *Water Management (Safety of Dams) Regulations 2003* (Tas.) s 9(1) (Austl.).
[175] ANCOLD, CONSEQUENCES OF DAM FAILURE, *supra* note 22, at 13 tbl.3.
[176] AUSTL. NAT'L COMM. ON LARGE DAMS, GUIDELINES ON SELECTION OF ACCEPTABLE FLOOD CAPACITY FOR DAMS 21 (2000).
[177] *See generally* ANCOLD MANAGEMENT GUIDELINES, *supra* note 22.
[178] *Water Management (Safety of Dams) Regulations 2003* (Tas.) s 7 (Austl.).
[179] ANCOLD provides further details on these hazard classifications. *See id.*; ANCOLD, CONSEQUENCES OF DAM FAILURE, *supra* note 22, at 3–9.

Activity	ANCOLD Hazard Category						
	Very Low	Low	Signifi-cant	High C	High B	High A	Extreme
4. Work-as-executed ("WAE") report	Any person	(a) Class A, if the dam is more than 7 meters high; or (b) Owner, if the dam is not more than 7 metres high.	Class A	Class A	Expert Team	Expert Team	Expert Team
5. Compre-hensive or intermediate surveillance inspections and reports	Any person	Owner	Class B	Class B	Expert Team or Class B	Expert Team or Class B	Expert Team or Class B
6. Safety reviews	Any person	Class B	Class B and Class C	Class B and Class C	Expert Team	Expert Team	Expert Team
7. Design and supervision of decommis-sioning	Any person	(a) Class B, if the dam is more than 7 meters high; or (b) Owner, if the dam is not more than 7 meters high	Class B	Class B	Class B	Class B	Class B

The Tasmanian legislation clearly encompasses all dams, large and small, low and greater hazard and sets out the level of ongoing safety surveillance.[180] DPIPWE indicates that the owners of significant to high hazard dams are required to arrange safety inspections and reports by an experienced dam engineer after the initial filling of the reservoir and generally every five years during the life of the dam[181]—for typical higher hazard irrigation dams in this category, these reports can be expected to cost around AU $2000.[182] In order to avoid placing significant cost burdens

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[180] *See generally Water Management (Safety of Dams) Regulations 2003* (Tas.) (Austl.).
[181] *See* TAS. DEP'T OF PRIMARY INDUS. & WATER, GUIDELINES FOR 5 YEAR DAM SAFETY SURVEILLANCE REPORTS 3 (2009), *available at* http://www.stors.tas.gov.au/au-7-0054-00316. As noted earlier, DPIW is now DPIPWE. *See supra* note 156.
[182] Tas. Dep't of Primary Indus., Water, & Env't, *Making Dams Safe for Everyone*, TAS-REGIONS: INCORPORATING AGRICULTURE TASMANIA, Feb. 2003, at 16, 16.

upon owners of smaller, less hazardous dams, these dams do not require full engineering reports; instead, the owners can prepare these reports by completing a pro forma document supplied by DPIPWE.[183] The hazard category for such dams can be determined using ANCOLD guidelines, which provide for quantitative assessment of hazard based on a matrix of both population at risk ("PAR") and severity of damage and loss:[184] these parameters can be determined from the "dam failure flood affected zone," which can be readily estimated using a simplified procedure for smaller dams as outlined by ANCOLD.[185] DPIPWE makes available a simple on-line spreadsheet on which this hazard assessment process is displayed.[186] DPIPWE has also recognized that a cost-effective spillway design/review mechanism such as that developed by Pisaniello for SA,[187] if developed in Tasmania, would complement their pro forma process very well.[188] "Hence, [DPIPWE] in June 2008 commissioned the University of South Australia to undertake a pilot project to develop such technology in Tasmania. The results will be reported in a future paper."[189]

Registering dams does not entail any fee.[190] This policy is designed to encourage the registration of all existing dams; whereas the permit application fee covers the registration of new dams when they are granted a permit.[191] Fees for permits are set by the Water Management Regulations.[192] Current fees are 381 fee units plus:

- 54 fee units for each hour spent in processing the application (excluding the first 7 hours); and

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[183] TAS. DEP'T OF PRIMARY INDUS. & WATER, *supra* note 181, at 3, 11 (showing a copy of this pro forma document in appendix three).
[184] ANCOLD, CONSEQUENCES OF DAM FAILURE, *supra* note 22, at 3–9.
[185] *See id.*
[186] TAS. DEP'T OF PRIMARY INDUS. & WATER, *supra* note 181, at 5, 10 (showing an example spreadsheet in appendix two).
[187] *See, e.g.*, Pisaniello, Ph.D. Thesis, *supra* note 27, at 226; Pisaniello, Argue & McKay, *supra* note 82.
[188] Pisaniello, *How to Manage*, *supra* note 27, at 366.
[189] *Id.*
[190] *Id.*
[191] *Id. See also Dam Work Permits: Applying for a Dam Works Permit*, TAS. DEP'T OF PRIMARY INDUS., PARKS, WATER, & ENV'T, http://www.dpiw.tas.gov.au/inter.nsf/WebPages/RPIO-4YG57U?open (last updated Sept. 24, 2010) (explaining the process for dam permit approval); *Dam Permit Approval*, IRIS TASMANIA, http://www.iris.tas.gov.au/planning_and_development/other/text_dam_permit (last updated Nov. 9, 2007) (explaining the process for dam permit approval).
[192] *Water Management Regulations 2009* (Tas.) sch 3, pt 2 (Austl.).

- 214 fee units where the application requires a notice under section 149 of the Act [most dam permits require advertising so this is the advertising cost]; and
- 421 fee units where the assessment is made by the Assessment Committee.[193]

Fee units are currently worth AU $1.36.[194] It is important to note that applications for smaller, straightforward dams can be assessed by the DPIPWE under delegation from the Assessment Committee.[195] This should work well to minimize costs and fast-track these simpler applications.

Regional Water Management Officers employed by the DPIPWE make the initial assessment of a dam's hazard when they do a field inspection of the proposed or existing dam site.[196] The assessment is then checked internally by the DPIPWE, and a conservative approach may be taken or the proponent may be required to have an engineer formally review the assessment if any doubt remains after the DPIPWE's internal assessment.[197] A dam's hazard potential will then determine the DPIPWE's mandates as to the frequency of surveillance inspections, reports, safety reviews, and EAPs in line with ANCOLD guidelines.[198]

Owners of dams are required by the Regulations to pay a fee to the Crown for assessing "design, construction, maintenance, surveillance or decommissioning report[s]" in respect of one or more dams as follows: 115 fee units for the first dam and 77 fee units for each hour or part of an hour spent in assessing the report.[199] This, together with the incremental fee structure for permits outlined above, provides an innovative and equitable user-pays type method for subsidizing the dam-safety assurance policy in Tasmania.

The WMA provides significant monetary penalties and these attach to any person who fails to comply with any provisions of the WMA or orders

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[193] *Id.*
[194] *Fee Units Act 1997 and the Value of a Fee Unit*, TAS. DEP'T OF TREASURY AND FIN., http://www.treasury.tas.gov.au/domino/dtf/dtf.nsf/alls-v/DCA3C64AFF202E06CA2570FA0083D521 (last visited Jan. 6, 2011).
[195] *See* IRIS TASMANIA, *supra* note 191 (explaining that applications may be directly examined by the DPIPWE).
[196] *Cf. Water Management Regions*, TAS. DEPT. OF PRIMARY INDUS., PARKS, WATER & ENV'T, http://www.dpiw.tas.gov.au/inter.nsf/WebPages/RPIO-4YHANN (last updated Aug. 25, 2010) (explaining the duties of regional water management officers).
[197] Pisaniello, *How to Manage*, *supra* note 27, at 366–67.
[198] *See generally* ANCOLD MANAGEMENT GUIDELINES, *supra* note 22.
[199] *Water Management (Safety of Dams) Regulations 2003* (Tas.) s 13(1) (Austl.).

made under the WMA.[200] For example, a maximum fine of 100 penalty units applies to any person failing to provide information to the minister on the safety of their dam under section 165H,[201] and a maximum fine of 200 penalty units and a daily fine not exceeding twenty penalty units (for each day during which the offence continues) attaches to any person failing to comply with a maintenance order under section 165L.[202] Body corporates attract fines 2.5 times these levels.[203] Penalty units are currently worth AU $130.[204]

The DPIPWE also provides for substantial owner education and guidance through the publication of website information and articles in departmental and other publications.[205]

The DPIPWE reported that "implementation of dam safety legislation and regulations following amendment to the Act in 2002 now ensures that best practice safety procedures are followed in the construction, maintenance and surveillance of dams [in Tasmania]."[206] As of 2005, there were 5674 registered dams in Tasmania.[207] Currently there are around 8000.[208] "This increase is [due to] the new dams (around 200 per year) that have been built since 2005[,] as well as many existing dams having been identified and registered for the first time—evidence that the policy is being effectively administered."[209] Approximately 500 of the registered dams are

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[200] *Water Management Act 1999* (Tas.) s 165 (Austl.).
[201] *Id.* at s 165H.
[202] *Id.* at s 165L.
[203] *Id.*
[204] Value of Indexed Amounts in Legislation, TAS. DEP'T OF JUSTICE, http://www.justice.tas.gov.au/legislationreview/value_of_indexed_units_in_legislation (last visited Jan. 24, 2011).
[205] *See, e.g.*, TAS. DEP'T OF PRIMARY INDUS. & WATER, DAM WORKS CODE 2007 (2007), *available at* http://www.dpiw.tas.gov.au/inter.nsf/Attachments/JMUY-79F933/$FILE/Dam%20Works%20Code%202007.pdf; TAS. DEP'T OF PRIMARY INDUS. & WATER, GUIDELINES FOR THE CONSTRUCTION OF EARTH-FILL DAMS (2008), *available at* http://www.dpiw.tas.gov.au/inter.nsf/Attachments/JMUY-7L38XP/$FILE/Guidelines%20for%20earth-fill%20dams.pdf; IRIS TASMANIA, *supra* note 191; TAS. DEP'T OF PRIMARY INDUS., PARKS, WATER, & ENV'T, *supra* note 191; TAS. DEP'T OF PRIMARY INDUS. & WATER, *supra* note 181; Tas. Dep't of Primary Indus., Parks, Water, & Env't, *supra* note 182.
[206] WATER RES. DIV., TAS. DEP'T OF PRIMARY INDUS., WATER & ENV'T, REPORT ON THE OPERATION OF THE WATER MANAGEMENT ACT 1999, at 21 (2005), *available at* http://www.dpiw.tas.gov.au/inter-nsf/Attachments/LBUN-6CN8YS/$FILE/Review%20of%20WMA%20FINAL.pdf.
[207] *Id.*
[208] *State of the Environment Tasmania 2009: Water Extraction and Storage*, TASMANIAN PLANNING COMM'N, http://soer.justice.tas.gov.au/2009/wat/3/issue/91/ataglance.php (last updated Mar. 1, 2010); Interview with S. Ditchfield, Dams Safety Engineer, Tas. Dep't of Primary Indus. & Water, in Tasmania (Mar. 2009).
[209] Interview with S. Ditchfield, *supra* note 208.

of either significant hazard or higher, i.e., being sufficiently dangerous to require extensive ongoing statutory safety surveillance and reporting.[210] All of these dams have been placed on a "prescribed dams" register within the DPIPWE dam database.[211] Approximately 350 (two-thirds) of the prescribed dams are privately owned.[212]

Taking considerable time, effort, and resources, DPIPWE identifies all existing dams in Tasmania that should be included on the register to ensure they comply.[213] DPIPWE has limited resources for this task, so significant and high hazard dams have priority in terms of strict enforcement of standards.[214] Even low hazard dams are targeted when potential cascade or cumulative failure scenarios arise,[215] and such scenarios are common.[216] DPIPWE carefully considers each scenario and adjusts smaller dams' hazard ratings when appropriate, thus imposing stronger surveillance, reporting, and safety standards.[217] DPIPWE indicated many low hazard dams will be found using field surveillance officers, satellite imagery, and other mapping techniques.[218] The five-yearly surveillance reports mandated by regulation will be strictly imposed.[219] Inevitably, as dams throughout Tasmania are discovered and come onto the register, the cumulative threats posed by small dams in large catchments will decline.

B. United States[220]

In the United States, fears about dam safety were fueled when two tragic failures were experienced in 1972: Canyon Lake's failure caused up to 237 lives to be lost,[221] and Buffalo Creek's failure caused 125 lives to be lost.[222] In the wake of these disasters, dam safety became a major target for

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[210] *Id.*
[211] *Id.*
[212] Interview with S. Ditchfield, Dams Safety Engineer, Tas. Dep't of Primary Indus. & Water, in Tasmania (June 2008).
[213] *Id.*
[214] *Id.*
[215] *Id.*
[216] *Id.*
[217] *Id.*
[218] Interview with S. Ditchfield, *supra* note 212.
[219] *Id.*
[220] Portions of Part II.B are derived from Pisaniello, Ph.D. Thesis, *supra* note 27.
[221] *Dam Failures and Incidents*, ASS'N OF STATE DAM SAFETY OFFICIALS, http://www.damsafety.org/news/?p=412f29c8-3fd8-4529-b5c9-8d47364c1f3e (last visited Jan. 24, 2011).
[222] *Id.*

investigation.[223] As a result, significant federal initiatives on dam safety have been provided to the states: (1) the National Dam Inspection Program, conducted under federal legislation beginning in 1972, showed the extent of the public and private dam safety problem,[224] and (2) extensive work performed by the Federal Emergency Management Agency ("FEMA") has provided encouragement and guidelines to the states to establish effective dam safety programs.[225] This work by FEMA is discussed in greater detail in Part IV.B below.

1. Summary of State Legislation

In response to the federal initiative, all fifty states, with the exception of Alabama, have established dam safety control programs, most of which are being implemented effectively.[226] The approaches used to control dam safety vary; however, the key components of the FEMA guidelines are consistent among most state programs.[227] For example, requirements of EAPs for high and significant hazard dams, and their associated minimum criteria, are consistent among the majority of practices.[228] Slight variations between states may be evident in aspects such as size criteria used for identifying applicable dams, methods of enforcing rules and regulations, and frequency and thoroughness of inspections.[229] Michigan is an example of good practice, while Washington is an example of alternative practice, both warranting further discussion.[230]

2. Michigan: An Example of Good Practice

Following an inventory in the late 1980s finding around 330 hazardous privately owned dams,[231] Michigan enacted the Dam Safety Act

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[223] *See* WATER & POWER RES. SERV., U.S. DEP'T OF THE INTERIOR, SAFETY EVALUATION OF EXISTING DAMS 2 (1980).
[224] *See* National Dam Inspection Program of 1972, Pub. L. No. 92-367, 86 Stat. 507 (codified at 33 U.S.C. § 467); WATER AND POWER RES. SERV., *supra* note 223, at 1–4.
[225] *See* FED. EMERGENCY MGMT. AGENCY, NO. 316, MODEL STATE DAM SAFETY PROGRAM iii (1998).
[226] FED. EMERGENCY MGMT. AGENCY, NO. P-759, DAM SAFETY IN THE UNITED STATES 11 (2009).
[227] *See id.*
[228] *See id.* at 12, 15, 18.
[229] *See id.* at 11, 18.
[230] *See* discussion *infra* Parts II.B.2, II.C.3.
[231] FED. EMERGENCY MGMT. AGENCY, 1991 SUPPLEMENT TO THE 1989 REPORT ON REVIEW OF STATE NON-FEDERAL DAM SAFETY PROGRAMS 174 (1992); ASS'N OF STATE DAM SAFETY

of 1989.[232] In 1995, this act was recodified into part 315 of the Natural Resources and Environmental Protection Act of 1994,[233] and will be referred to in this part as "the Act." The Act has two main purposes: to regulate the construction, repair, alteration, abandonment, and operation of dams; and to provide for their regular inspection.[234] The applicable dams are those higher than six feet (1.8 meters), and the dams are registered through a permit (user-pays) system.[235] The Michigan Department of Natural Resources ("MDNR") is responsible for administering the Act.[236]

Michigan strictly defines, under statute, most of the standard requirements relating to dams and their safety.[237] Such standards include criteria on assigning hazard ratings (based on a high, significant, and low hazard rating system similar to NSW), frequency and thoroughness of inspections, minimum spillway capacities, and EAPs.[238] The Act also contains strict surveillance and inspection provisions: in general, owners must submit to the MDNR inspection reports prepared by licensed professional engineers, at minimum frequencies of once every three, four, and five years for high, significant, and low hazard dams, respectively.[239] If surveillance identifies a dam to be deficient, the MDNR can order the owner to undertake and pay for whatever actions it considers are necessary to eliminate the deficiency.[240]

Under section 324.31523 of the Act, a provision for emergency preparedness procedures requires owners of all high and significant hazard dams to prepare action plans containing, at minimum, the following information: (a) "the name, address, and telephone number of the person, and . . . an alternate person, responsible for operation of the dam; [(b)] the name and telephone number of local emergency management coordinators; and [(c)] a listing of occupied facilities, buildings, and residences that may

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OFFICIALS, MICHIGAN DAM SAFETY LAWS AND REGULATIONS (2007), *available at* http://www.damsafety.org/media/Documents/STATE_INFO/LAWS_&_REGS/Michigan_L&R.pdf.

[232] MICH. COMP. LAWS §§ 281.1301-281.1365 (repealed 1994); ASS'N OF STATE DAM SAFETY OFFICIALS, *supra* note 231.

[233] Natural Resources and Environmental Protection Act of 1994 pt. 315, 1994 Mich. Pub. Acts 451 (codified as amended MICH. COMP. LAWS §§ 324.31501-324.31529 (2010)); ASS'N OF STATE DAM SAFETY OFFICIALS, *supra* note 231.

[234] *See id.* at §§ 324.31507, 324.31509, 324.31518.

[235] *Id.* at §§ 324.31502, 324.31509.

[236] *Id.* at § 324.31506.

[237] *See generally id.* at §§ 324.31501-324.31529.

[238] *Id.* at § 324.31516.

[239] MICH. COMP. LAWS § 324.31518 (2010).

[240] *Id.*

be threatened with flooding due to failure of the dam."[241] The Act specifies that civil action may be taken against any dam owner or other person that is in violation of any of the terms of the Act, or any rule, order, or permit issued pursuant to the Act, and a finding of guilt in court is subject to a maximum civil fine of "$10,000.00 for each day of violation."[242] The MDNR is also authorized to establish, by rule, administrative monetary penalties for minor violations of the Act.[243] The MDNR has also provided for owner education and guidance through periodic seminars and production of many useful owner guideline publications.[244] This educative approach promotes dam safety by informing dam owners of the possible liabilities of dam ownership and guiding them to meet their responsibility to safely operate, maintain, and repair their dams.[245]

3. Washington: An Example of Alternative Practice

Washington is another state which displays sound and highly prescriptive dam safety assurance policy. The policy is based on dam safety statutes contained in chapters 90.03, 43.21A, and 86.16 of the Revised Code of Washington ("RCW"), and dam safety rules contained in chapters 173–75 of the Washington Administrative Code.[246] The statutes provide the Department of Ecology's ("DoE") Dam Safety Office with wide powers to regulate and control the safety of dams.[247] The dams subject to regulation are all those with a maximum storage volume of ten or more acre-feet (twelve megaliters).[248] As of July 2003, 940 Washington dams were regulated by the Dam Safety Office.[249] About 330 of the 940 dams are located

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[241] *Id.* at § 324.31523.
[242] *Id.* at §§ 324.31524–324.31525.
[243] *Id.* at § 324.31525.
[244] For the full range of current dam owner guideline publications, see MICH. DEP'T OF NATURAL RES. & ENV'T, http://www.mi.gov/damsafety (last visited Jan. 25, 2011). In particular, see *Michigan Dam Owners Workshop*, MICH. DEP'T OF NATURAL RES. & ENV'T, http://www.michigan.gov/deq/0,1607,7-135-3308_3333_4168-215641--,00.html (last visited Jan. 25, 2011) (displaying the recording of a recent seminar).
[245] *Id.* Also see MICH. DEP'T OF NATURAL RES., MICHIGAN DAM SAFETY GUIDEBOOK (1991), which still represents a useful, practical reference for private dam owners.
[246] WASH. DEP'T OF ECOLOGY, DOC. NO. 92-55A, DAM SAFETY GUIDELINES PART I: GENERAL INFORMATION AND OWNER RESPONSIBILITIES 5–6 (2004), *available at* http://www.ecy.wa.gov/pubs/9255a.pdf.
[247] *Id.* at 5–6.
[248] *Id.* at 5.
[249] *Id.* at 3.

above populated areas and are therefore classified as having high or significant downstream hazards, and, of these, 140 are small dams less than fifteen feet (4.6 meters) in height.[250] A three-level hazard rating system, comprised of low, significant, and high hazard categories, was adopted based on criteria similar to that of NSW and Michigan.[251]

The main duties of the DoE, as specified under the statutes, include:

- determination of reservoir capacity;
- conducting periodic inspections and reviews;
- record keeping and reporting;
- approving the construction of new dams and the subsequent issuing of permits; and
- the promulgation of necessary rules.[252]

As indicated above, the DoE's Dam Safety Office is responsible for implementing appropriate inspection and review programs for all dams.[253] An appropriate fee is charged to the dam owner for this service.[254] This responsibility is also extended to checking and supervising the design and construction of new dams.[255] Such directed surveillance is in contrast to typical dam safety assurance policies, which usually place this responsibility upon the dam owner, who is required to consult a professional engineer (as in NSW, Tasmania, and Michigan).[256] The DoE performs periodic inspections and reviews of existing dams at least every five years for high hazard dams, at least every ten years for significant hazard dams, and as considered necessary for low hazard dams.[257] "Owners are [also] required to conduct annual surficial inspections and submit a copy of the inspection checklist to the department within 30 days following the inspection."[258]

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[250] *Id.* at 4.
[251] *See* WASH. DEP'T OF ECOLOGY, DOC. NO. 92-55B, DAM SAFETY GUIDELINES PART II: PROJECT PLANNING AND APPROVAL OF DAM CONSTRUCTION OR MODIFICATION 14 (2008), *available at* http://www.ecy.wa.gov/pubs/9255b.pdf.
[252] WASH. DEP'T OF ECOLOGY, *supra* note 246, at 6–8.
[253] *Id.*
[254] *See id.* at 52–54.
[255] *See id.* at 6–7.
[256] *See* MICH. COMP. LAWS § 324.31508; N.S.W. DAM SAFETY COMM., DSC3G, GENERAL DAM SAFETY CONSIDERATIONS 5–6 (2010); *Dam Safety*, TAS. DEP'T OF PRIMARY INDUS., PARKS, WATER, & ENV'T, http://www.dpiw.tas.gov.au/inter.nsf/WebPages/JMUY-7N22DQ?open (last updated Nov. 29, 2010).
[257] WASH. DEP'T OF ECOLOGY, *supra* note 246, at 7.
[258] *Id.* at 10 (emphasis omitted). Information to assist owners in performing these inspections can be found in chapter 5 of WASH. DEP'T OF ECOLOGY, DOC. NO. 92-55C, DAM SAFETY

The DoE has published guidelines which consist of four basic parts: (1) general information and procedures,[259] (2) project planning and approval,[260] (3) an owner's guidance manual,[261] and (4) dam design and construction.[262] The guidelines "are intended to provide dam owners, operators, and design engineers with information on . . . procedures[] and [statutory] requirements . . . ."[263] The DoE requires EAPs of varying levels for all high and significant hazard dams.[264] Typically, the EAP should include the following information:

- Notification procedures . . . and responsibilities for notifying downstream residents in the event of an impending dam failure.
- A notification list that includes the names and telephone numbers of all affected downstream residents, dam owner and operator, local emergency officials, and appropriate government agencies (including the Dam Safety Office).
- Specific instructions to be followed by responsible parties at the dam site in response to emergencies such as floods, equipment failures, or other unusual events where the situation might lead to dam failure and immediate remedial action can be effective to prevent failure or reduce hazards to downstream residents.[265]

The statutes assign power to the DoE to levy civil penalties for the violation of either statutory provisions, rules, permits, or regulatory orders.[266] Penalties as modest as $100 per day of violation to as much as $5000 per day of violation can result.[267] However, the laws and rules do

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GUIDELINES PART III: AN OWNER'S GUIDANCE MANUAL 21–29 (1992), *available at* http://www.ecy.wa.gov/pubs/9255c.pdf.

[259] WASH. DEP'T OF ECOLOGY, *supra* note 246.

[260] WASH. DEP'T OF ECOLOGY, *supra* note 251.

[261] WASH. DEP'T OF ECOLOGY, *supra* note 258.

[262] WASH. DEP'T OF ECOLOGY, DOC. NO. 92-55D, DAM SAFETY GUIDELINES PART IV: DAM DESIGN AND CONSTRUCTION (1993), *available at* http://www.ecy.wa.gov/pubs/9255d.pdf.

[263] WASH. DEP'T OF ECOLOGY, *supra* note 246, at 1.

[264] *See id.* at 46.

[265] *Id.* at 11.

[266] *See id.* at 48.

[267] *Id.* at 48–49.

not specifically address owner or departmental liabilities.[268] This is a critical issue discussed further in Part IV.B below.

C. Canada[269]

Canada has no federal initiative to encourage dam safety; responsibility for assuring dam safety rests entirely with the provinces.[270]

1. Outline of Province Legislation

Of the ten provinces and two territories, only Alberta, British Columbia, and Quebec have specific dam safety legislation.[271] With one exception, the remaining provinces and territories acknowledge the need for dam safety and address this concern through less extensive de-facto dam safety programs under their current water legislation.[272] In 1978, Alberta became the first province in Canada to enact specific dam safety legislation.[273] "This legislation is unique in that it was not brought about by any major dam failure in Alberta or the rest of Canada, but indirectly by a series of failures in the United States, notably Teton and Taccoa Falls."[274] A brief overview of the Alberta practice, which is representative of good practice in Canada, follows.

2. Alberta: An Example of Good Practice

The Dam & Canal Safety Regulations of 1978 (amended in 1998) provide the Minister of Environment with wide powers, many of which are delegated to the Dam Safety and Water Projects Branch ("DSB") Head, to control the safety of all licensed[275] dams which are over 2.5 meters high or larger than 30 megaliters.[276] The DSB uses a three-level hazard rating

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[268] *See* WASH. DEP'T OF ECOLOGY, *supra* note 246, at 5–6 (showing a lack of discussion concerning owner or departmental liabilities).
[269] Portions of Part II.C are derived from Pisaniello, Ph.D. Thesis, *supra* note 27.
[270] *See* Grant F. Smith, *The Status of Dam Safety Legislation in Canada*, CAN. DAM ASS'N BULL., Spring 2003, at 10, 15.
[271] *See id.* at 11, 16 tbl.1.
[272] *See id.* at 15, 16 tbl.1.
[273] ALBERTA DEP'T OF ENV'T, PUB. NO. T/444, WATER ACT, DAM AND CANAL SAFETY GUIDELINES 1 (1991).
[274] Pisaniello, Ph.D Thesis, *supra* note 27, at 66.
[275] Registration is via a user-pays licensing system. *See* ALBERTA DEP'T OF ENV'T, *supra* note 273, at 1–2.
[276] Water Act, Water (Ministerial) Regulation, A. Reg. 205/98 c. 1 (Can.).

system and obligates dam owners to monitor (via professional engineer) and maintain their dams, and provide for Emergency Preparedness Plans in a similar fashion to NSW, with surveillance/reporting frequency being five-yearly.[277] Formal dam safety inspections by the DSB are also conducted periodically.[278] If surveillance reveals inadequacy, the DSB Head has power to direct the dam owner to undertake remedial action.[279] Persons failing to comply with any statutory provisions are guilty of a criminal offense, which can lead to suspension or cancellation of license.[280] The DSB has also published extensive guidelines for dam owners.[281]

D. United Kingdom[282]

In 1925, two significant dam failures triggered the need for the Reservoirs (Safety Provisions) Act ("1930 Act") which was subsequently enacted in 1930.[283] The 1930 Act applied to all reservoirs larger than 22.7 megaliters, made owners entirely responsible for maintaining their reservoirs, required all reservoirs to undergo statutory inspection by a qualified "statutory panel" engineer at least once every ten years, and be issued with a safety certificate following panel approval.[284] In 1966, the Institution of Civil Engineers reported a need for better administration of the 1930 Act.[285] Hence, in 1975, a revised bill of the 1930 Act was proposed, which provided more explicit powers to enforcement authorities and stepped up dam surveillance.[286] However, the new act was not passed due to negative political response.[287] In 1983, renewed pressure to implement the Reservoirs Act 1975 ("1975 Act") emerged when a Select Committee study revealed a disturbing picture of the number of dams still escaping inspection under the 1930 Act: of the 1500 applicable dams, at least 190 were found with no recorded owner and 93 had no safety certificates.[288]

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[277] *See* ALBERTA DEP'T. OF ENV'T, *supra* note 273, at 4, 11.
[278] *Id.* at 5.
[279] *See id.* at 5–6.
[280] *See* Water Act, Water (Ministerial) Regulations, A. Reg. 193/98 c. 2 (Can.).
[281] ALBERTA DEP'T OF ENV'T, *supra* note 273, at 1.
[282] Portions of Part II.D are derived from Pisaniello, Ph.D. Thesis, *supra* note 27.
[283] A. I. B. Moffat, *British Reservoir Legislation and the Reservoirs Act, 1975*, *in* THE EVALUATION OF DAM SAFETY: ENGINEERING FOUNDATION CONFERENCE PROCEEDINGS 39, 40–41 (1976).
[284] *Id.* at 41.
[285] *See id.* at 42.
[286] *See* A. Charnock, *Dam Data Fuels Fears on Safety*, NEW CIVIL ENG'R, Feb. 3, 1983, at 18, 18.
[287] *Id.*
[288] *Id.*

In 1986, the 1975 Act was enacted and has since remained in force.[289] The role of an Enforcement Authority under the 1975 Act is essentially a compliance audit role.[290] Under this act, responsibility for enforcement was for many years delegated to local county councils with their obligations and powers being clearly defined.[291] However, in the late 1990s, an inconsistent application of the 1975 Act by local authorities in England and Wales was identified by Sims and Parr.[292] This led England and Wales to transfer the responsibility for enforcement of the 1975 Act to the Environment Agency on October 1, 2004, through the Water Act 2003.[293]

The 1975 Act applies to all dams larger than twenty-five megaliters and requires local authorities to keep registers of all such dams.[294] The 1975 Act provides for regular surveillance of dams in addition to the ten-yearly statutory inspections of the 1930 legislation.[295] To perform these inspection and surveillance procedures, the 1975 Act establishes "panel engineers"[296] and "supervising engineers."[297] The 1975 Act requires panel engineers to be independent of the owners and designers of the dams in their charge.[298] The function of panel engineers is twofold: they can either conduct statutory inspections or supervise the design, construction, or alteration of dams.[299] Individual panel engineers cannot be commissioned to perform both functions for the same project.[300] The supervising engineer is a qualified engineer employed by the dam owner to continually monitor the condition of a dam during its life (between statutory inspections).[301] A

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[289] Pisaniello, Ph.D Thesis, *supra* note 27, at 71.
[290] *See Reservoir Safety*, THE BRITISH DAM SOC'Y, http://www.britishdams.org/reservoir_safety (last visited Jan. 25, 2011).
[291] *See* Charnock, *supra* note 286, at 19.
[292] *See* G. P. Sims & N. M. Parr, *The Review of the Reservoirs Act 1975, in* THE PROSPECT FOR RESERVOIRS IN THE 21ST CENTURY 66, 67–68 (Paul Tedd ed., 1998).
[293] THE SCOTTISH GOV'T, THE FUTURE OF FLOOD RISK MANAGEMENT IN SCOTLAND 66 (2008).
[294] HEALTH & SAFETY EXEC., OC 847/10, RESERVOIRS AND HSW ACT: INSPECTION POLICY 1–2 (2003), *available at* http://www.hse.gov.uk/foi/internalops/fod/oc/800-899/847_10.pdf.
[295] Sandelands, Noble & Findlay, *Risk Assessment of Individual Dams, in* THE PROSPECT FOR RESERVOIRS IN THE 21ST CENTURY 25 (Paul Tedd ed., 1998).
[296] *See* Reservoirs Act, 1975, c. 23 § 4 (U.K.). The "panel" is a body of specialist engineers appointed by the secretary of state on the basis of their having sufficient supervisory experience in the design and construction of dams. *Id.* Panel status applies for a maximum five-year term. *Id.*
[297] *Id.* at § 12.
[298] *See, e.g.*, *id.* at §§ 4, 10.
[299] *See* FLOOD EMERGENCIES PROGRAMME, FREQUENTLY ASKED QUESTIONS FOR RESERVOIR OWNERS IN ENGLAND AND WALES—VERSION 2, at 11 (2009), *available at* http://www.defra.gov.uk/environment/flooding/documents/reservoir/seminar-faq.pdf.
[300] *See id.* at 11–12.
[301] *See id.* at 12.

statutory inspection may be recommended to an owner by the supervising engineer at any time considered necessary.[302] Owners have a strict statutory obligation to supply information to the panel.[303] If an inspection report includes any recommendation on measures to be taken in the interest of safety, the 1975 Act obligates owners to promptly carry out the recommendations.[304] Section 22 attaches criminal liability to any owner who fails to comply with the provisions of the 1975 Act, and maximum fines range from £250 to £800.[305] No provision for emergency plans is evident under legislation, as the general approach to dam safety in the United Kingdom has been based on the concept of hazard prevention rather than hazard preparedness.[306] However, in recent years, the Institution of Civil Engineers have given this a renewed focus and impetus in the United Kingdom in line with worldwide practice.[307] This led to the Water Act 2003 establishing a need for reservoir flood plans.[308] Much work towards developing guides for such plans has occurred in recent years.[309] This should eventually encourage owners of hazardous dams to establish plans comprising three components: impact assessment, on-site plan, and off-site response.[310]

E. South Africa[311]

In 1984, in light of worldwide experience, South Africa passed the Water Amendment Act 1984,[312] and later specific Regulations (1986), to be administered by the Dam Safety Office ("DSO").[313] This act provides the

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[302] Reservoirs Act, 1975, c. 23 § 12(3) (U.K.).
[303] *See id.* at § 12.
[304] *See id.* at § 10.
[305] *Id.* at § 22 (depending on which provision is breached).
[306] *See* SHANE MCGRATH, PROJECT: TO STUDY INTERNATIONAL PRACTICE AND USE OF RISK ASSESSMENT IN DAM MANAGEMENT 12 (2000), *available at* http://www.churchilltrust.com.au/site_media/fellows/McGrath_Shane_2000.PDF.
[307] *See ICE: Flooding and Emergency Planning Seminar*, INST. OF CIVIL ENG'R, http://www.floodrisknet.org.uk/events/Event.2003-03-10.5112/view (last visited Jan. 25, 2011).
[308] *See* Tim Ambler, *Reservoir Flood Plans: Impact Assessment (17 December 2009)*, ADAM SMITH INST. (Apr. 1, 2010, 06:00), http://www.adamsmith.org/blog/regulation-and-industry/reservoir-flood-plans%3A-impact-assessment-(17-december-2009)/#.
[309] *See, e.g.*, *Make a Flood Plan*, ENV'T AGENCY, http://www.environment-agency.gov.uk/homeandleisure/floods/38329.aspx (last updated Jan. 19, 2011).
[310] *See* INST. OF CIVIL ENG'R, *supra* note 307.
[311] Portions of Part II.E are derived from Pisaniello, Ph.D. Thesis, *supra* note 27.
[312] Water Amendment Act 96 of 1984 (S. Afr.) (repealed 1998, current legislation National Water Act 36 of 1998 (S. Afr.)).
[313] *About Dam Safety Office*, DAM SAFETY OFFICE, S. AFR. DEP'T WATER AFFAIRS, http://www.dwa.gov.za/DSO/About.aspx (last visited Jan. 25, 2011) (established to implement

DSO with wide powers to control the safety of dams higher than five meters and larger than fifty megaliters.[314] Under section 15 of the Regulations (1986), the DSO is responsible for maintaining a register of applicable dams, classified according to size and hazard potential based on criteria similar to NSW.[315]

The Regulations (1986) specify strict rules relating to the construction or alteration of dams, and these rules include requiring that designs be produced by an approved professional engineer and requiring permits to be issued at various stages of works.[316] Dam owners must provide safety inspection reports at intervals not longer than five years, and the required level of inspection and associated reporting varies for dams of different size and hazard rating, similar to NSW.[317] By rule, the DSO requires the owners of all high or significant hazard dams to provide EAPs for their dams—to varying levels depending on hazard—similar to Michigan and Alberta.[318] Section 11.8 of the Regulations (1986) also requires each owner keep up-to-date records of all materials relating to their dam's safety in a safe place where it can be consulted conveniently by all parties concerned, especially in emergency cases.[319] The Regulations (1986) attach criminal liability for any non-compliance with a maximum fine of R10,000, plus R50 a day until there is compliance, or a maximum of six months imprisonment.[320]

F. Finland

Dam safety legislation in Finland, first proclaimed in 1984, consists of the Dam Safety Act ("DS Act") and Dam Safety Decree ("DSD").[321] The DS Act outlines principle dam safety provisions while the DSD consists

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and administer the Dam Safety Regulations published in 1986 and still in force under the National Water Act 36 of 1998).

[314] S. AFR. DAM SAFETY OFFICE, REF. NO. 12/16/2, SUMMARY OF LEGAL REQUIREMENTS FOR PROSPECTIVE AND EXISTING DAM OWNERS 1 (2004), *available at* http://www.dwa.gov.za/DSO/Guidelines.aspx.

[315] Dam Safety Regulations, Government Notice (GN) R.1560/1986 § 15 (S.Afr.), *available at* http://www.dwa.gov.za/DSO/Documents/notice156025Jul86.pdf.

[316] *See id.* at § 6.

[317] *See id.* at § 12.1.

[318] *See* DAM SAFETY OFFICE, S. AFR. DEP'T OF WATER AFFAIRS, 2009–2010 ANNUAL REPORT 19 (2010). Appendix A discusses the goal for all South African dams to possess an EAP and briefly notes the difference between the requirements for dams in different categories. *Id.*

[319] *See* Dam Safety Regulations, Government Notice (GN) R. 1560/1986 §§ 11.8-11.10 (S.Afr.).

[320] *Id.* at §§ 19.1.3, 19.2.

[321] FIN. MINISTRY OF AGRIC. & FORESTRY, DAM SAFETY CODE OF PRACTICE 5, 7 (1997), *available at* http://www.ymparisto.fi/download.asp?contentid=17581&lan=EN.

of more detailed regulations relating to the DS Act's execution.[322] The National Board of Waters ("NBW") is responsible for administering the DS Act.[323] The DS Act applies to all dams higher than three meters and any lower dams which, upon failure, pose an apparent hazard to human life, health, property, or environment.[324] The general responsibilities and obligations of dam owners under the legislation are similar to those under Alberta practice in relation to maintenance, surveillance and reporting, and emergency preparedness procedures.[325] The NBW is responsible for approving all surveillance programs together with ensuring and supervising their implementation.[326] Dam owners must keep all material relating to their dam's safety in a special safety file.[327] The file must be stored at a place where, if an accident threatens, is easily assessable to those concerned.[328] The DS Act attaches severe criminal liability and penalties for any non-compliance.[329]

III. BENCHMARKING DAM SAFETY ASSURANCE POLICY[330]

The analysis of the international context above demonstrates that schemes to manage dam safety vary between and within countries. However, key components in certain practices can be identified, including: common law, federal involvement, legislation, command and control regulation, administration, registration and classification of dams, surveillance,

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[322] *See* Patoturvallisuuslaki (kumottu) [Dam Safety Act] 1.6 1984/413 (Fin.); Patoturvallisuusasetuksen [Dam Safety Decree] 27.7.1984/574 (Fin.) (amended by Patoturvallisuusasetuksen [Dam Safety Regulation] 91/1995); FIN. MINISTRY OF AGRIC. & FORESTRY, *supra* note 321 at 78–81.

[323] *See* FIN. MINISTRY OF AGRIC. & FORESTRY, *supra* note 321, at 6, 7. Administration of the DSA was later under the responsibility of the Ministry of Agriculture and Forestry. *See* Patoturvallisuuslaki [Dam Safety Act] 1.6 1984/413 § 7 (amended by Laki patoturvallisuuslain muuttamisesta [Dam Safety Act amendment] 90/1995 § 7).

[324] Dam Safety Act 1.6 1984/413 § 3.

[325] *See supra* Part II.C.2.

[326] *See* Dam Safety Act 1.6 1984/413 §§ 6, 7 (amended by Dam Safety Act Amendment 90/1995 § 7) (safety observation program or approval of changes now decided by the Regional Environment Center; the Minister of Agriculture and Forestry Ministry may issue further guidance on the monitoring program).

[327] *See id.* at § 5.

[328] *See id.*

[329] *See id.* at §§ 12, 13 (amended by Laki patoturvallisuuslain 12 ja 13 § :n muuttamisesta [Dam Safety Act Amendments, §§ 12, 13] 596/1995). Penalties vary and are dependent on which provision is breached. For example, non-compliance under section 4 of the DS Act—to maintain the dam in a safe condition—shall be punished by fines or imprisonment up to a period of two years. *See id.* at § 11 (amended by Dam Safety Act Amendment 90/1995 § 11).

[330] Portions of Part III are derived from Pisaniello & Burritt, *supra* note 36.

accounting and reporting, codes and/or standards of conduct, community education and preparedness, punitive enforcement, and owner education and guidance.

For example, in many countries, including Australia, owner responsibility exists under common law to manage and maintain dams according to current standards.[331] In Australia, these standards are set by ANCOLD.[332] Hence, owners should manage and review their dams, and take appropriate action where necessary, in order to minimize the risk of failure and avoid liability for possible consequences of failure. However, many jurisdictions in Australia and overseas have found that it is not enough to rely solely on common law responsibility to protect downstream communities, property, and the environment from poor dam safety management practices.[333] Some form of statutory dam safety management accountability and assurance policy is required where privately owned dams exist in order to achieve sustainable and safe catchments. ANCOLD states that:

> A role of government is to enact legislation to protect the community. Legislation should establish regulatory authorities that ensure dam owners, and potential dam owners, are taking appropriate actions in regard to dam safety.[334]

A contrasting mechanism is for government to use an information strategy that informs and educates stakeholders of potential risks and liabilities.[335] Overall, three main independent methods for providing increased dam safety assurance to the public can be identified from the set of possibilities:

- *Owner education, encouragement, and guidance*—providing guidelines and information publications to dam owners in the *hope* that they act responsibly and in line with common law.[336]
- *Community preparedness through EAPs*—requiring the owners of all potentially hazardous dams to have

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[331] McKay & Pisaniello, *supra* note 28, at 27; Wensley, *supra* note 28, at 23, 30.
[332] *See supra* note 22.
[333] *See supra* notes 9–16 and accompanying text.
[334] ANCOLD MANAGEMENT GUIDELINES, *supra* note 22, at 3; Pisaniello & Burritt, *supra* note 36, at 6.
[335] *See* NEIL GIBSON, PETER GRABOSKY & DARREN SINCLAIR, SMART REGULATION: DESIGNING ENVIRONMENTAL POLICY 60–61 (1998).
[336] *See id.*

> EAPs in place by law. This also requires the government to establish and maintain a dams register to enable mandating of EAPs of increasing sophistication for increasing hazard potential, while also enabling the general status of dam safety management to be kept in check. Such law satisfies the "community right to know" principle as downstream communities are made aware of the risks and hazards they are living under and provided with the opportunity for escape in the event of dam failure.[337]
>
> • *Command and control—strict regulation and supervision by means of dam safety legislation*—setting specific rules, standards, codes, and regulations on dam safety management which dam owners must legally follow, and providing for supervision to ensure compliance.[338]

The first method potentially places the public at greatest risk as the final decision to act is left entirely up to the dam owner. The second method still leaves critical safety management decisions to the dam owner, but at least the downstream public is made aware of the risks and hazards that they are voluntarily living under and provided with the opportunity for salvation in the event of an emergency. Brown and Graham demonstrate that through an analysis of deaths following major dam failures and flash floods, effective warnings—through EAPs—can save lives.[339] The third method is the most reliable, as owners are required to account for their dam safety management and comply with current acceptable practice, while their decision-making is supervised by a regulatory authority.

Incorporating all three methods into a dam safety assurance policy would provide maximum assurance to the public and would also represent a best-practice model. At the same time, varying combinations of the three methods may provide adequate assurance in certain circumstances. However, a reasonable minimum-level benchmark for areas where hazardous dams exist would be for owners to always be educated and guided, and downstream communities *at least* know the risks and hazards they are living under. Therefore, a dam safety assurance policy should always

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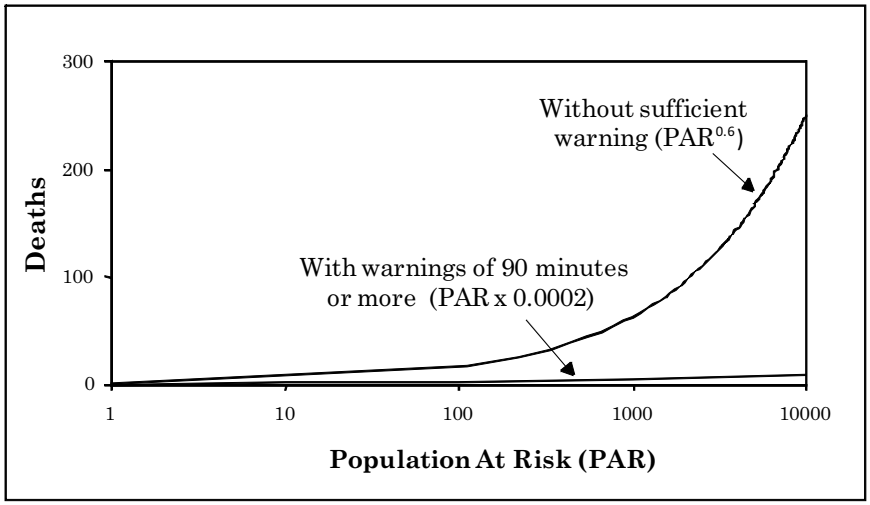
[337] *See id.* at 63–64.
[338] *See id.* at 38–39.
[339] *See* Curtis A. Brown & Wayne J. Graham, *Assessing the Threat to Life From Dam Failure*, 24 WATER RES. BULL. 1303, 1306 (1988); *infra* Figure 1.

incorporate both the first and second methods in any area where hazardous dams exist.

For example, in order to provide appropriate dam safety assurance to downstream communities, it is not only necessary to educate private dam owners regarding their responsibilities and liabilities in accordance with the dictates of common law. It is also important to ensure downstream communities are warned of the dangers they are living under and be provided the opportunity for rescue if disaster occurs. Then, depending on the circumstances of particular jurisdictions, in particular the number of potentially hazardous dams that exist at a point in time and the number that are poorly managed, it may also be important to establish regulatory control and supervision over dam management practices. The aim here is to ensure that owners manage their dams in line with current standards.

The main characteristics of each selected practice in Part II are next analyzed comparatively to identify examples of "better" practice. In turn, these are used to develop more detailed policy models and guidelines for determining "appropriate" safety assurance policy for any jurisdiction. The models comprise best practice and minimum practice as follows in the proceeding parts.

Figure 1: Analysis of Deaths following Major Dam Failures and Flash Floods[340]



[340] *Id.* at 1307.

IV. COMPARATIVE ANALYSIS: ELEMENTS OF "BEST PRACTICE" IN PRIVATE DAM SAFETY ASSURANCE

The above international review indicates that the policy approaches used to provide private dam safety assurance vary from one system to another, and while there are a number of common features, each contains certain unique elements, which may be considered as essential to best practice. These elements are comparatively discussed in Parts IV.A to IV.H. These elements together form a model of "best practice." Part IV.I then provides a summary of relevant key work undertaken by the World Bank in 2002 entitled, *Regulatory Frameworks for Dam Safety*.[341] This summary supports many of the elements identified below and well acts as a complement to the best practice policy model established here.

A. Federal/National Involvement

Out of the countries selected for review, Australia and Canada are the only countries in which dam safety is not a federal/national issue.[342] In these two countries, the responsibility of private dam safety is left entirely up to the states.[343] Although the United States' format is similar, this country has, in contrast, provided for significant federal initiative to investigate and encourage private dam safety.[344] The United States' approach to achieving uniform dam safety policy under a federal system of governance, which is similar to Australia, is one that works well;[345] hence a brief overview is warranted as follows.

In the early 1980s, the United States' FEMA was assigned the responsibility of coordinating and promoting dam safety in order to encourage the establishment and maintenance of effective state dam safety programs.[346] FEMA has since formed close relationships with the states to provide such encouragement and has published a number of guidelines, one of the most significant of them being the *Model State Dam Safety Program*, to help the states establish effective and efficient programs.[347]

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[341] DANIEL D. BRADLOW, ALESSANDRO PALMIERI & SALMAN M. A. SALMAN, THE WORLD BANK, REGULATORY FRAMEWORKS FOR DAM SAFETY: A COMPARATIVE STUDY (2002).
[342] *See supra* Parts II.A, II.C.
[343] *See supra* Parts II.A, II.C.
[344] *See* FED. EMERGENCY MGMT. AGENCY, *supra* note 225, at iii.
[345] *See* A. Danilevsky, *Dam Safety Legislation in the USA*, WATER POWER & DAM CONSTR., Aug. 1993, at 24, 24–27.
[346] *Id.* at 26.
[347] *See id.*; *see also* FED. EMERGENCY MGMT. AGENCY, *supra* note 225, at iii.

This model is in line with the Michigan practice reviewed above.[348] As a result of the added attention given to the states by FEMA, there was a significant improvement in the control of dam safety practices throughout the United States.[349] A review of the state dam safety programs, conducted by FEMA in 1992, found that forty-one states had adequate programs, which met the minimum guidelines of the model program, and only two states completely lacked a dam safety policy.[350] However, the 1992 review also discovered that many states with established acceptable programs were unable to effectively implement the programs, mainly because of a lack of funding to provide sufficient staff and administration.[351] In brief, less than twenty percent of the states were found to have a ratio of less than 100 dams per full-time-equivalent staff member.[352] For many of the other states, this ratio was significantly higher, in some cases even being over 1000 dams per staff member.[353]

In response to this problem, the federal government established the National Dam Safety Program ("NDSP"), initially authorized under the Water Resources and Development Act of 1996, and re-authorized most recently (through to fiscal year 2011) under the Dam Safety Act of 2006.[354] The NDSP includes the provision of grants to the states for the improvement of state dam safety programs, but these grants are only distributed among the states which successfully established dam safety programs approved under the terms of the act, i.e., in line with the above model program.[355] As a result of the work of FEMA and the NDSP, all of the fifty states, with the exception of Alabama, now have regulatory programs in place for dam safety and participate in the NDSP.[356] FEMA reports that "[s]ince the National Dam Safety Program was first authorized more than 10 years ago, there have been [significant] improvements in the safety of many of our Nation's dams that are a [direct] result of National Dam Safety Program funding for state assistance, training, and research."[357]

The above approach from the United States shows that federal involvement can work positively in obtaining national cooperation. It

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[348] *See supra* Part II.B.2.
[349] *See* FED. EMERGENCY MGMT. AGENCY, *supra* note 231, at xii.
[350] *Id.*
[351] *Id.*
[352] *Id.* at xiii tbl.1.
[353] *Id.*
[354] *See* FED. EMERGENCY MGMT. AGENCY, *supra* note 226, at 2.
[355] *See id.* at 11–12.
[356] *Id.* at 11.
[357] *Id.* at 2.

therefore sets a good example for Australia—and any other country with a federal-style system of governance—to follow in order to encourage more responsible state policies to be enacted, achieve more uniform dam safety assurance policy across the country, and ensure more efficient and effective administration of the policies.

B. Legislative Purposiveness[358]

All practices have created dam safety legislation either in the form of specific or enabling legislation: Specific legislation—strict provisions are established within a specific dam safety act, e.g., NSW, Michigan, and Finland.[359] Enabling legislation—certain provisions are incorporated within existing water law enabling dam safety management to be regulated and controlled, e.g., Victoria, Alberta, the United Kingdom, and South Africa.[360] Michigan sets a good example in the manner in which it strictly and clearly defines, under statute, most of the *minimum* standard requirements relating to dams and their safety (including criteria on classifying dams, frequency and thoroughness of inspections, flood capability, and EAPs), thus removing any possibility for indecision.[361] Tasmania similarly specifies, under regulation, that all such aspects must satisfy ANCOLD standards; hence, it effectively establishes ANCOLD guidelines as a de facto code of practice.[362] Other dam safety legislation leaves such aspects to the controlling authority's discretion.[363]

In all of the practices except Washington state, the legislation provides a "quality assurance" (i.e., compliance audit) role, consistently placing the ultimate responsibilities and liabilities associated with private dams upon their owners, in accordance with the dictates of common law.[364] Under the "quality assurance" approach, government merely assures itself, in the interest of public safety, that dam owners are taking responsible

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[358] Portions of Part IV.B are derived from Pisaniello, Ph.D. Thesis, *supra* note 27.
[359] *See supra* Parts II.A.1, II.B.2, II.F.
[360] *See supra* Parts II.A.2, II.C.2, II.D, II.E.
[361] *See supra* Part II.B.2.
[362] *See supra* Part II.A.3.
[363] *See, e.g.*, Memorandum from President Carter to The Sec'y of the Interior et al. (Apr. 23, 1977), *in* FED. EMERGENCY MGMT. AGENCY, FEDERAL GUIDELINES FOR DAM SAFETY 2 (2004) (Presidential memorandum stating that each relevant federal agency head was responsible for a specific aspect of dam safety and implementation).
[364] *See supra* Part II.B; *Dam Safety*, WASH. DEP'T OF ECOLOGY, http://www.ecy.wa.gov/programs/wr/dams/Inspections.html (last visited Jan. 25, 2011) (explaining that it is the department's job to make routine inspections to verify that dam construction is proceeding as promised).

steps to achieve adequate quality at all of the necessary phases associated with dam safety.[365] Washington State is an exception in the manner in which it has adopted a "directed surveillance" approach rather than that of the more common "quality assurance."[366] Under Washington legislation, the state has assumed responsibility for checking all stages of dam-related activity, which includes mainly evaluating the adequacy of design, inspecting structural adequacy, and supervising maintenance.[367] While this approach may provide the greatest assurance to the public, it is not commonly adopted because of the following two significant problems:

1. A large number of adequate personnel, appropriately trained in dam design review, are required under the one state agency.[368] Sowers suggests that it is very difficult and expensive to find, train, and *maintain* such personnel as engineering design review "is seldom a challenging experience," and "the more imaginative [and] innovative engineers" become quickly "bored and seek other employment."[369]
2. By assuming responsibility for design checking and approval and surveillance, it is logical that *liability* is also assumed.[370] It is most likely that, for this reason, Washington law does not specifically address owner or departmental liabilities. While an agency can legislate for legal immunity as is apparent under a similar system adopted in California,[371] individual liability could still prevail under the law of ordinary negligence:

> [E]ven though the law provides for immunity, there is generally nothing that will prohibit an injured citizen from suing a second citizen if that second citizen has been negligent. Therefore, it may be possible for a

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[365] *See, e.g.*, MICH. COMP. LAWS §§ 324.31517, 324.31518 (2010) (explaining that inspection is the responsibility of the dam owner).
[366] *See supra* Part II.B.3; *Dam Safety*, *supra* note 364.
[367] *See Dam Safety*, *supra* note 364.
[368] George F. Sowers, *Dam Safety Legislation: A Solution or a Problem, in* ENGINEERING FOUNDATION CONFERENCE PROCEEDINGS: SAFETY OF SMALL DAMS 65, 89–90 (1974).
[369] *Id.* at 90.
[370] *See id.* at 92.
[371] *Id.*

> person who is injured by the failure of a dam to sue the individuals employed by the state agency although the agency itself may be legally immune.[372]

Further guidance on how to best frame the purpose of dam safety assurance regulation is provided in Part IV.I.

C. Administrative Enforcement and Funding

Responsibility for enforcing the legislation typically goes to some federal/national or state water agency.[373] However, the United Kingdom and NSW are slight exceptions.[374] The UK's panel system is very simple and avoids centralized and bureaucratic state control because administrative responsibility rests mostly with independent engineers.[375] The system provides flexibility, avoids indecision, and facilitates rapid decision-making; research shows this approach "has had a record the equal of that under any other system."[376] NSW's independent dam safety committee system is also highly effective and operates with minimal funding.[377] Adequately funding the administration is critical to achieve effective and efficient administration of the policy as demonstrated in Victoria and also the United States.[378] Funding the administration can be sourced through a permit or license system, and Tasmania provides a good example of an innovative user-pays system in this regard.[379] Alternatively, NSW relies solely on government funding and operates on a relatively modest annual budget of AU $1 million; however, some user-pays would be required if

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[372] *Id.*
[373] *See, e.g.*, *Dam Safety Overview*, BUREAU OF RECLAMATION, U.S. DEP'T OF THE INTERIOR, http://www.usbr.gov/ssle/damsafety/ (last updated Jan. 25, 2011) (example of a federal agency responsible for enforcing dam safety legislation).
[374] *See* Reservoirs Act, 1975, c. 23 (U.K.) (describing the United Kingdom's panel system); *Dams Safety Act 1978* (N.S.W.) (Austl.) (describing NSW's Dam Safety Committee).
[375] *See supra* notes 294–305 and accompanying text (describing the 1975 Reservoirs Act).
[376] MORRIS ET AL., *supra* note 9, at 7; Moffat, *supra* note 283, at 53.
[377] *See* N.S.W. DAMS SAFETY COMM., *supra* note 110, at 3.
[378] *See supra* Part II.B (describing Victoria's proactive spillway testing and farm testing); *supra* Part IV.A (describing the national Dam Inspection Program and FEMA as efficient and effective administration).
[379] *See Water Management (Safety of Dams) Regulations 2003* (Tas.) s 13(1) (Austl.); Pisaniello, *How to Manage*, *supra* note 27, at 367.

the DSC extended its remit.[380] Federal/national funding assistance is also a good approach.[381]

D. Registration and Classification of "Applicable" Dams[382]

Most practices maintain a register of "applicable dams"[383] using a permit or licensing system.[384] They also assign general hazard ratings based on a three-level system such as that used in NSW.[385] ANCOLD provides for some additional sub-classifications of hazard, which are determined on a more quantitative basis.[386] Tasmania adopts the ANCOLD approach to achieve more finite distinction between the levels of surveillance and safety standards expected for different registered dams.[387] This ensures the dam safety management burdens imposed upon dam owners are spread proportionally and equitably.

Typically, a minimum height and/or capacity is specified under statute for standardizing which dams are registered and subject to the legislation.[388] The most conservative practices are Michigan, Tasmania, Washington, and the United Kingdom, covering dams as low as 1.8 meters and as small as one megaliter, twelve megaliters, and twenty-five megaliters, respectively.[389] Also, Alberta's 1998 amendments to the Dam and Canal Safety Regulations of 1978 brought its criteria for licensing dams more in line with these conservative practices.[390] In fact, New Zealand

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[380] *See* N.S.W. DAMS SAFETY COMM., *supra* note 110, at 9.
[381] See *supra* Part IV.A for a discussion on this approach.
[382] Portions of Part IV.D are derived from Pisaniello, *How to Manage*, *supra* note 27.
[383] I.e., dams subject to the provisions of the legislation.
[384] *See, e.g.*, CORPSMAPS NAT'L INVENTORY OF DAMS, http://geo.usace.army.mil/pgis/f?p=397:1:2598971599601747 (last visited Jan. 25, 2011) (noting that the National Inventory of Dams collects data from forty-nine states in which most dams are regulated by permits via state agencies).
[385] *See, e.g.*, N.S.W. DAMS SAFETY COMM., *supra* note 108, at 9 (noting NSW's three classifications: high, significant, and low).
[386] *See supra* Table 1.
[387] *See Water Management (Safety of Dams) Regulations 2003* (Tas.) ss 3–4 (Austl.).
[388] *See, e.g.*, MICH. COMP. LAWS § 324.31502 (2010); *Water Management Act 1999* (Tas.) s 165A (Austl.); WASH. DEP'T OF ECOLOGY, *supra* note 246, at 5; HEALTH & SAFETY EXEC., *supra* note 294.
[389] MICH. COMP. LAWS § 324.31502 (2010); *Water Management Act 1999* (Tas.) s 165A (Austl.); WASH. DEP'T OF ECOLOGY, *supra* note 246, at 5; HEALTH & SAFETY EXEC., *supra* note 294.
[390] Alberta's Dam and Canal Safety Regulations of 1978 originally only required dams "higher than twenty-five feet (eight meters) or larger and fifty acre-feet (sixty ML

will soon join the list of countries with dam safety assurance legislation.[391] The New Zealand approach, which would have become effective from July 1, 2010,[392] is very similar to that of Tasmania and will regulate dams as small as three meters high and with a minimum storage capacity of only twenty megaliters.[393] This demonstrates that more and more jurisdictions are gradually recognizing the need to assure the safety of even the smallest of dams.

In NSW and Finland, this size criterion is not as conservative and, to compensate, is also based upon dam hazard potential.[394] This "ensures that [all] dams smaller than the specified size criterion [which have] significant or high hazard potential [are] . . . included among those controlled" while owners of small, low hazard potential dams are not burdened.[395] However, in NSW, without a user-pays system, the DSA does not provide for an adequate register of *all* dams (including small ones) in the state, nor does it provide for an adequate budget to enable the DSC to supervise more dams than are already prescribed.[396] In 2007, there were 334 prescribed dams in NSW, with only around 100 being privately owned.[397] Hence, many smaller off-stream dams which are hazardous *may* only be prescribed if and when they come to the attention of the DCS; otherwise, they go unnoticed. This was clearly demonstrated in a recent study.[398]

While NSW has a strong dam safety assurance policy in place for controlling its prescribed dams (i.e., ones that pose considerable individual hazard), it "needs to address the considerable risks associated with cumulative failure of small dams" in catchments.[399] If small dams are located upstream with potential to cause cascade failure of larger, more hazardous dams, then ANCOLD warns that "the combined effect of multiple dam

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[megaliters])" to be licensed, per section 1(c) of the original Regulations. *See* Pisaniello, Ph.D. Thesis, *supra* note 27, at 67. But, after the 1998 amendments, this criteria was reduced to higher than 2.5 meters or larger than thirty megaliters. *See supra* Part II.C.2.

[391] *See Dam Safety Scheme Deferred*, N.Z. DEP'T OF BLDG. & HOUS., http://www.dbh.govt.nz/dam-safety (last visited Jan. 25, 2011).

[392] *Id.*

[393] *Dam Safety Review: Report of Findings of an Independent Review of the Dam Safety Scheme*, N.Z. DEP'T OF BLDG. & HOUS. (Apr. 14, 2010), http://www.dbh.govt.nz/dam-safety-report#aid7.

[394] *See* Pisaniello, Ph.D Thesis, *supra* note 27, at 92.

[395] *See id.*

[396] *See* Pisaniello, *How to Manage*, *supra* note 27, at 368.

[397] *See* N.S.W. DAM SAFETY COMM., *supra* note 110, at 36.

[398] Pisaniello, *How to Manage*, *supra* note 27, at 363–65.

[399] *Id.* at 368. *See supra* Part II.A.

failures should be the basis of the hazard category of the upper dams."[400] This guideline, interpreted strictly (and together with the recent research in South Australia),[401] would deem that in certain circumstances, all small dams in a catchment upstream of a large, high-hazard public reservoir should also be treated as high hazard (due to their potential cumulative failure impact), and should therefore each individually meet the same design standard.[402] This area does require further research into the sort of small-dam populations and overall storage volumes that are critical for different catchment circumstances. However, it has nevertheless become clear that *all* small dams in catchments of large public dams should be registered and at least controlled for spillway adequacy regardless of their size and individual hazard potential.[403] They should be mandated to at least meet ANCOLD's minimum fall-back design criteria for low hazard dams (i.e., 1-in-100 to 1-in-1000 years design flood),[404] and upgraded to a higher standard when clearly warranted in cumulative or cascade failure scenarios as per the Tasmanian approach.[405] Capturing all such dams can only be achieved by setting the registration cut-off to a very small size, as is the case in Tasmania, Michigan, Washington, and the United Kingdom.[406]

E. Surveillance, Inspection, and Safety Reviews

Each practice provides for surveillance, inspection, and safety reviews in order to ensure that owners maintain their dams in a safe condition.[407] Primary responsibility for dam safety rests with the dam owner.[408] Dam owners are required to arrange for a minimum level of surveillance of their dams—the level depends on hazard potential—by contracting experienced engineers and subsequently reporting all information to the relevant enforcement authority.[409] The authorities also

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[400] ANCOLD, CONSEQUENCES OF DAM FAILURE, *supra* note 22, at 10; Pisaniello, *How to Manage*, *supra* note 27, at 363.
[401] *See* LANGE DAMES CAMPBELL, *supra* note 34; Kazarovski, *supra* note 55.
[402] *See* LANGE DAMES CAMPBELL, *supra* note 34, at 2–3.
[403] *See id.*
[404] *See* AUSTL. NAT'L COMM. ON LARGE DAMS, *supra* note 176, at 21.
[405] *See supra* Part II.A.3.
[406] *See supra* notes 388–89 and accompanying text.
[407] *See supra* Part II (survey of the different dam safety assurance practices discussed in this paper, with their policies for surveillance and inspection).
[408] *See supra* Part IV.B.
[409] *See, e.g.*, MICH. COMP. LAWS § 324.31518 (2010) (Michigan statute directing dam owners to contact professional engineers to conduct surveillance on their dams and reporting the results is such an example).

periodically conduct formal inspections to review surveillance information.[410] The more strict, frequent, and thorough a surveillance and inspection system is, the more effective it will be in reducing risk and increasing safety assurance. Therefore, Michigan sets best practice in this regard with requisite three-yearly and four-yearly surveillance for high and significant hazard dams, respectively.[411]

As indicated above, the cumulative flood threats of catchment dams should also be monitored. In this respect, Tasmania is the only state in Australia to acknowledge that even small, low hazard dams need to be supervised, albeit to a modest extent.[412] Cost burdens to small dam owners can be minimized by more finely varying the level of sophistication *and* expertise required for surveillance and review activities according to dam size *and* hazard potential[413] and by making affordable design/review processes, such as the simple pro-forma used in Tasmania,[414] available and the Pisaniello cost-effective flood capability design/review procedure.[415] This is a good way that governments can ensure that not only the larger potentially hazardous dams are kept safe, but also the cumulative safety threats posed by small dams are kept in check.

F. Community Education and Preparedness[416]

Most practices provide for community education, awareness, and preparedness through requiring EAPs for high and significant hazard dams.[417] This allows all people living downstream of potentially hazardous dams to acknowledge the risks and hazards they are living under and provides an opportunity for escape should failure occur. Such provision is similar to the United States' community right-to-know legislation, which applies to hazardous uses or storage of chemicals.[418] The EAPs are

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[410] *See id.*
[411] *Id.*
[412] *See supra* Part II.A.3.
[413] *See, e.g.*, *supra* Table 1.
[414] *See supra* Part II.A.3.
[415] *See generally* Pisaniello, Ph.D Thesis, *supra* note 27, at 112, 193–233 (development of Pisaniello's cost-effective flood capacity design/review procedure); Pisaniello, Argue & McKay, *supra* note 82.
[416] Portions of Part IV.F are derived from Pisaniello, Ph.D. Thesis, *supra* note 27.
[417] *See supra* Part II (describing each practice and their individual EAPs, where applicable).
[418] *See* Peter H. Sand, *The Right to Know: Environmental Information Disclosure by Government and Industry*, *in* 2002 CONFERENCE ON "HUMAN DIMENSION OF GLOBAL ENVIRONMENTAL CHANGE: KNOWLEDGE FOR THE SUSTAINABILITY TRANSITION" 1, 4 (2002).

required at varying levels for different dams depending on both their size and hazard rating.[419] For small remote dams, EAPs must include at *minimum* a listing of all occupied facilities, buildings, and residences possibly threatened in the event of failure together with a basic description of the intended actions of all parties involved.[420] For larger, more hazardous dams, more extensive plans, including the provision of detailed flood maps and warning sirens, coordinated with the SES, must be expected. Finland and South Africa also set good examples by establishing an enforced level of owner responsibility by requiring maintenance of a special safety file in an easily accessible location.[421]

The Tasmanian approach further satisfies the community right-to-know principle through its permit application process for new dams.[422] The permit process requires public advertisement of any new dam proposals prior to any permit being granted.[423] This enables the dam safety authority to hear and consider any objections to the proposal from the community.[424]

G. Punitive Enforcement[425]

Each statute attaches criminal liability and penalty to any owners not complying with standard requirements, rules, directions, or regulations specified or promulgated under statute.[426] The somewhat intimidating criminal fines adopted in Michigan (maximum US $10,000 per day of violation), or even those of South Africa or Tasmania, are appropriate considering the possible consequences of dam failures.[427]

This paper refers to the United States' federal Emergency Planning and Community Right-to-Know Act, which established a Toxic Release Inventory, in addition to at least twenty-five U.S. states' "right-to-know" laws—the United States' experience is what prompted Australia to also establish the Pollutant Release and Transfer Register in the late 1990s. *Id.* at 4–5.

[419] Pisaniello, Ph.D Thesis, *supra* note 27, at 101.

[420] *See, e.g.*, MICH. COMP. LAWS § 324.31523 (2010) (strictly defining what information the EAP must contain).

[421] Patoturvallisuuslaki [Dam Safety Act] 1.6 1984/413 § 5 (Fin.); Dam Safety Regulations, Government Notice (GN) R. 1560/1986 §§ 11.8-11.10 (S. Afr.).

[422] *See supra* notes 160–62 and accompanying text.

[423] *See supra* notes 160–62 and accompanying text.

[424] *See supra* notes 160–62 and accompanying text.

[425] Portions of Part IV.G are derived from Pisaniello, Ph.D. Thesis, *supra* note 27.

[426] *See supra* Part II (describing criminal liability for violating dam safety requirements of each statute, where applicable).

[427] *See* MICH. COMP. LAWS §§ 324.31524-324.31525 (2010); *Water Management Act 1999* (Tas.) s 82 (Austl.); Water Act 36 of 1998 § 69 (S. Afr.).

H. Owner Education and Guidance[428]

All practices provide for extensive owner education and guidance through publication of guidelines to help owners understand the responsibilities and liabilities associated with their dams in line with the law.[429] This works positively in assuring private dam safety. Victoria provides an excellent example of a guideline publication that well informs private/farm dam owners, both hazardous and non-hazardous, on how to properly manage their dams.[430]

I. A Review/Summary of the 2002 World Bank Publication of Regulatory Frameworks for Dam Safety *to Complement the Best Practice Policy Model*[431]

In 2002, the World Bank undertook a comprehensive comparative study of dam safety regulations around the world and commissioned the University of South Australia to contribute towards this work.[432] This work led to the publication entitled *Regulatory Frameworks for Dam Safety*.[433] This sub-section reviews the *Part 3: Essential Elements, Desirable Elements, and Emerging Trends for Dam Safety,* which is the principal part of this important World Bank publication.[434] The policy model of "best practice" established by the above eight parts,[435] in essence, incorporates the World Bank's "essential" and "desirable" elements[436] of a regulatory scheme, as is evident in the following summary. The following summary therefore well complements the best practice policy model as it can be used as an additional checklist, of regulatory elements in particular, when any jurisdiction endeavors to develop a best practice private dam safety assurance policy.

The fundamental premise of all existing, and any proposed, dam safety regulatory scheme is that the dam owner is the person "responsible for making the dam safe and for operating and maintaining it in a safe

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[428] Part IV.H is derived from Pisaniello, Ph.D. Thesis, *supra* note 27.
[429] *See supra* Part II.
[430] *See* VICT. DEP'T OF SUSTAINABILITY & ENV'T, *supra* note 132, at v.
[431] *See* BRADLOW, PALMIERI & SALMAN, *supra* note 341. Portions of Part IV.I are derived from Pisaniello, Ph.D. Thesis, *supra* note 27.
[432] *See id.* at xi, 1.
[433] *Id.*
[434] *See generally id.* at 71–91.
[435] *See supra* Parts IV.A–IV.H.
[436] *See generally* BRADLOW, PALMIERI & SALMAN, *supra* note 341, at 71–91.

condition. The regulator is responsible for protecting the safety of the public by [(1)] establishing the dam safety standards . . . and [(2)] monitoring compliance [by the owners]."[437]

The "essential" and "desirable" elements discussed below are intended to achieve this by (i) "clarify[ing] that the dam owner is [primarily] responsible for dam safety and the regulators are responsible for monitoring . . . performance in this regard" and (ii) specifying that owners have responsibilities toward operations and maintenance and how owners should review their dam, and "explain[ing] the ways in which the regulatory authority can perform its monitoring functions, which can include . . . inspections" and penalties for non-complying owners.[438]

1. Essential Elements of a Regulatory Scheme

a. Clearly Articulated Laws

The regulatory structure is made up of clearly spelled out documents, publicly available, that stipulate in clear terms the responsibilities above.[439] The forms of these differ widely in the world.[440] A national scheme with national guidelines that a provincial government administers is a good arrangement.

b. Clear Identification of Regulatory Agencies Involved, Clear Power and Funding to Enforce the Regulations

The essential element here is to separate the agency from those who make decisions about whether to build dams and from those who own and/or operate dams.[441] This regulatory separation of powers is a fundamental tenet of Australian water law and administration since the Council of Australian Governments' reforms of 1994.[442]

Adequate budget to operate laws are essential or the law becomes meaningless. A clear requirement is a vote from Parliament. In NSW, such is the case and the Dams Safety Committee operates in this way.[443]

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[437] *Id.* at 72–73.
[438] *Id.* at 73.
[439] *Id.*
[440] *See supra* Part II (explaining the different acts that created dam oversight).
[441] *Id.* at 74.
[442] *See* JOHN TISDELL, JOHN WARD & TONY GRUDZINSKI, COOP. RESEARCH CENTRE FOR CATCHMENT HYDROLOGY, REPORT 02/5, THE DEVELOPMENT OF WATER REFORM IN AUSTRALIA 29–30 (2002).
[443] *See supra* Part II.A.1.

c. Powers of the Regulatory Authority

These should include:

- Power to identify and enforce national norms.[444]
- A voice in the issue of permits.[445]
- Power to monitor inspection by others and to regulate the qualification of inspectors.[446]
- Power to conduct own inspections.[447]
- Power to approve the inspector selected by the owner.[448]
- Responsibility to maintain a register of regulated dams.[449]
- "Responsibility to advise dam owners and other interested parties, such as affected communities," about dam safety issues.[450]
- Responsibility to make publicly available reports on dam safety.[451]
- "Power to enforce the dam safety framework."[452]

d. Content of the Scheme

"The regulatory scheme should include the following:"[453]

- Establishment of clear criteria for determining which dams should be regulated, e.g., criteria based on size and hazards created by the dam.[454]
- Address dam safety in a life cycle approach.[455]
- Clarification that owner is primarily responsible but that the operator can be deemed the owner.[456]

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[444] BRADLOW, PALMIERI & SALMAN, *supra* note 341, at 75.
[445] *Id.*
[446] *Id.* at 76.
[447] *Id.*
[448] *Id.* at 77.
[449] *Id.*
[450] BRADLOW, PALMIERI & SALMAN, *supra* note 341, at 77.
[451] *Id.* at 78.
[452] *Id.*
[453] *Id.* at 79.
[454] *Id.*
[455] *Id.* at 80.
[456] BRADLOW, PALMIERI & SALMAN, *supra* note 341, at 80.

- Stipulation of standards either international, such as International Committee on Large Dams ("ICOLD"), or locally based, such as ANCOLD.[457]
- Stipulation of periodic reports that owners must supply to regulators with stipulation of frequency, which may reflect characteristics such as life stage, size, etc.[458]
- Owner must maintain complete records at a convenient location.[459]
- Requirement that all dams have an operations maintenance manual and an adequate budget.[460]
- Imposition of fees by the regulatory authority that cover the cost of dam safety activities of the regulatory authority.[461]
- Requirement of an emergency plan for high hazard dams, as implemented in NSW.[462]

2. Desirable Attributes of Regulatory Scheme

This list covers items in addition to the ones above; many of these are aspirational:

- Dam safety agency exclusively devoted to dam safety.[463]
- Dam safety advisory committee with a skill base of "technical experts and representatives of affected" communities.[464]
- Dam safety agency which has overarching coordination roles.[465]

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[457] *Id.* at 82. *See, e.g.*, *International Commission on Large Dams*, WORLD WATER COUNCIL, http://www.worldwatercouncil.org/index.php?id=1511 (last visited Jan. 25, 2011); AUSTL. NAT'L COMM. ON LARGE DAMS, http://www.ancold.org.au/ (last visited Jan. 25, 2011).
[458] BRADLOW, PALMIERI & SALMAN, *supra* note 341, at 80.
[459] *Id.* at 83.
[460] *Id.* at 84.
[461] *Id.*
[462] *Id.* at 85.
[463] *Id.* at 86.
[464] BRADLOW, PALMIERI & SALMAN, *supra* note 341, at 86.
[465] *Id.*

- Power for periodic inspection by the dam safety agency of all hazardous dams with technical archives of the dam available to the agency.[466]
- Dam licenses require a failure impact assessment with regard to communities, property, and the environment.[467]
- Benchmarks developed to measure dam safety at all dams and these be broadly based including "structural, environmental, social, health, and economic factors."[468]
- Periodic review by dam owner of all dams to test compliance with the regulatory authority who also has the power to conduct these itself.[469]
- Annual reports on dam safety.[470]
- Education activities implemented.[471]

V. ELEMENTS OF "MINIMUM PRACTICE" IN PRIVATE DAM SAFETY ASSURANCE[472]

The above elements together set "best practice," but countries or states with less critical circumstances (i.e., smaller populations and/or fewer aging, hazardous dams) may consider it sufficient to only adopt certain aspects of this model to varying degrees. Nevertheless, there are certain critical elements which should prevail in any system where potentially hazardous dams exist in order to provide some minimal level of deserved safety assurance to downstream communities: these were established generally by a minimum level benchmark in Part III, above. These elements are now developed further in practical terms, and together they form a model of "minimum practice."

A. Dams Registration and Classification[473]

Require local authorities (e.g., local councils) to: (i) maintain a register of dams (based on, for example, Michigan, Tasmania, or the

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[466] *Id.*
[467] *Id.* at 87.
[468] *Id.*
[469] *Id.* at 88.
[470] BRADLOW, PALMIERI & SALMAN, *supra* note 341, at 88.
[471] *Id.*
[472] Part V derived from Pisaniello, Ph.D. Thesis, *supra* note 27.
[473] Part V.A derived from Pisaniello, Ph.D. Thesis, *supra* note 27.

United Kingdom's size criteria), within each of their jurisdictions, and (ii) assign subjective hazard ratings based on NSW's three-level hazard rating system. This at least provides a database for governments to monitor the density of potentially hazardous dams and also the seriousness of the "cumulative" dam safety problem in catchments as downstream areas develop.

B. Community Education and Preparedness[474]

Establish community right-to-know provisions as amendments under existing water legislation, requiring all owners of hazardous dams to provide EAPs. The required level of EAPs should depend on the size and hazard rating of the dam, with minimum requirements similar to those set under Michigan or NSW law.[475] Naturally, powers must be given to some existing water authority, with staff experienced in emergency planning, to initially enforce this provision, with severe penalties for non-compliance. Subsequent responsibility for simple periodic checks to ensure the plans are continuously updated and maintained can then be delegated to local councils.

C. Owner Education and Guidance[476]

Provide for owner education and guidance to strongly *encourage* surveillance and maintenance of dams by producing and promoting numerous publications similar to those in Victoria or NSW.[477]

VI. GUIDELINES FOR IMPLEMENTING "APPROPRIATE" PRIVATE DAM SAFETY ASSURANCE POLICY[478]

As indicated above, the model of minimum practice should prevail in any system where potentially hazardous dams exist in order to provide some minimal level of deserved safety assurance to downstream communities. But, with the model of best practice in private dam safety assurance also established, the key question becomes: how many potentially

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[474] Part V.B derived from Pisaniello, Ph.D. Thesis, *supra* note 27.
[475] *See supra* Parts II.A.1 and II.B.2 (NSW and Michigan both require EAPs of varying degrees depending on the hazard rating of the dam).
[476] Part V.C derived from Pisaniello, Ph.D. Thesis, *supra* note 27.
[477] *See supra* Parts II.A.1, II.A.2.
[478] Portions of Part VI are derived from Pisaniello, Ph.D. Thesis, *supra* note 27.

hazardous private dams does a jurisdiction need to contain to necessitate a move towards a model of best practice? This question can be answered via the following simple, implicit analysis.

Each of the international jurisdictions analyzed above, with the exception of South Australia, have implemented a dam safety assurance policy that is either in line with the best practice model or has substantial coincidence with it.[479] Hence, by comparing the density of potentially hazardous private dams contained in some of the jurisdictions at the time of policy implementation,[480] a precedent guide may be established as to when it is appropriate to move towards the model of best practice. This analysis/comparison is discussed below.

- In NSW, information on how many hazardous private dams existed when the Dams Safety Act 1978 was implemented is not readily available. Nevertheless, in 1995, there were a total of 236 prescribed dams (i.e., hazardous dams) on the DSC's register, and of these, sixty-five were privately owned dams.[481] There are currently around 100 such privately owned dams.[482] Given this growth rate over the years, it is reasonable to assume that in 1978, the number of hazardous private dams on the register would have been less than or equal to sixty-five.
- In Victoria, the recent farm dam safety policy reforms resulted from estimates of there being some 300,000 farm/private dams in the state, and around *1000* of these were considered potentially hazardous.[483]
- When Tasmania implemented its 2003 dam safety reforms, there were approximately 5600 registered dams in the state.[484] This has recently grown to around 8000: 500 of these are hazardous and some *350* of these are privately owned (Part II.A.2).[485]

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[479] *See supra* Parts IV.A–IV.H (comparing the different dam safety assurance policies discussed throughout this article and measuring them up to best practice policies).
[480] The density of hazardous private dams at some point in time post-implementation may still provide some useful guidance.
[481] N.S.W. DAMS SAFETY COMM., ANNUAL REPORT 1994/95, at 31 (1995).
[482] N.S.W. DAMS SAFETY COMM., *supra* note 110, at 37–41.
[483] *See supra* notes 41–42 and accompanying text.
[484] WATER RES. DIV., TAS. DEP'T OF PRIMARY INDUS., WATER & ENV'T, *supra* note 206, at 21.
[485] *See supra* notes 209–12 and accompanying text.

- Michigan, in the late 1980s, identified 796 non-federal dams in a state inventory, and of these, approximately *330* were either high or significant hazard—this led to implementation of the Dam Safety Act, PA 300 of 1989.[486]
- Information on the number of hazardous privately owned dams that existed in Washington at the time its dam safety policy was first implemented is not readily available, but by July 2003, 940 dams were regulated by the DSO.[487] About 330 of the 940 dams are hazardous, and of these 140 are small dams less than 4.6 meters in height—given their small size, it would be reasonable to assume that most of these *140* dams are privately owned.[488]
- In the United Kingdom in 1982, a study identified over 1500 dams of considerable size warranting regulatory control.[489] Of these, 190 had no recorded owner; hence, most, if not all of these, *190* dams must have been private dams that escaped supervision under the old dam safety policy.[490] This demonstrated the seriousness of the dam safety problem in the country, which later led to the implementation of the Reservoirs Act 1975.[491]
- South Africa, in the mid-1980s, implemented strong enabling dam safety legislation and associated regulations in response to the growing number of privately owned dams evident throughout the country.[492] Information on the number of hazardous privately owned dams that existed at the time is not readily available, but by the mid-1990s, 1420 hazardous dams were in existence, and of these,

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[486] *See supra* notes 231–32 and accompanying text.
[487] *See supra* note 249 and accompanying text.
[488] *See supra* note 250 and accompanying text.
[489] *See supra* note 288 and accompanying text.
[490] Charnock, *supra* note 286, at 18.
[491] Reservoirs Act, 1975, c. 23 (U.K.); *see supra* Part II.C.3.
[492] *See* Water Amendment Act 96 of 1984 (S. Afr.) (repealed 1998, current legislation National Water Act 36 of 1998 (S. Afr.)).

> *1150* were privately owned.[493] It would be reasonable to assume that a considerable proportion of these dams existed at the time the legislation was implemented.

From the above analysis and comparison, it is difficult to identify a systematic relationship, especially as information on density of hazardous private dams at the time of policy implementation is not always available, and the policies implemented in the above cases may not have been the direct result of private dam safety considerations only. Nevertheless, a simple generic precedent can be identified as follows: if a country or State has more than sixty-five potentially hazardous private dams and/or more than, for example, 200 potentially hazardous dams in total (i.e., including public dams), then a dam safety assurance policy in line with the best practice model is warranted (as set by NSW practice).[494] Cases which fall well below the cut-off criteria within this precedent should be dealt with under the provisions of the model of minimum practice, and as circumstances draw closer toward this cut-off criteria, some additional elements from the best practice model should be developed.

VII. SUMMARY OF LESSONS, IMPLICATIONS, AND POLICY GUIDANCE

Improperly managed structures with considerable safety risks are associated with large and small dams, high and low hazard.[495] Such risks arise at the individual and cumulative level within catchments and are magnified by the attitudes, behaviors, and practices of dam owners and the responses of policy makers, demonstrated here by both overseas and local experiences with dam failures and the South Australian case study.[496]

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[493] *See* Pisaniello, Ph.D Thesis, *supra* note 27, at 80.

[494] This refers to the total number of potentially hazardous private dams contained within a country or state. For primary exploration, "potentially hazardous dams" can be taken as those which are significant in size and individually pose either a high or significant hazard potential, e.g., in line with NSW or ANCOLD classifications. *See supra* Part IV.D. Secondary consideration should then also be given to smaller catchment dams that pose considerable cumulative flood threats within catchments as discussed in Part I.A. *See* Pisaniello, *How to Manage*, *supra* note 27, at 363. The government would have to establish an inventory of all such dams in a region, if one is not already in place, which is required anyway under the model of minimum practice. *See* Pisaniello, Ph.D. Thesis, *supra* note 27, at 117.

[495] *See* Pisaniello & Burritt, *supra* note 36, at 20.

[496] *See supra* Parts I-II (discussing different countries' and states' reactions to dam failures and the steps that have been taken to prevent future failures).

A summary of the comparative lessons to be learnt from the reviews of the selected Australian practices are provided below. Policy implications and associated guidance for Australia in particular, and the world in general, follow.

A. Summary of Lessons from the Reviewed Australian Practices[497]

In SA, it is evident that complacency best describes the attitudes of farm dam owners.[498] Previous studies point to a gross underestimate of the importance of a dam's spillway and dam safety in general.[499] Policy-makers also seem complacent in that despite research and warnings the relevant government authorities are reactive in their policy responses.[500] This approach is tantamount to waiting for a disaster to happen and does not set a good example.

NSW and Victoria set good examples. Their proactive policies move in the direction of the best practice model and provide adequate management of dam safety risks.[501] However, the policies are not thorough enough and only address those problems associated with hazardous dams (usually larger, significant dams) without adequately considering problems linked to the many smaller dams.[502] Farmers need to be supervised to ensure adequate safety management of dams. Specifically, all farm dams in catchments of large public dams should be registered and controlled for at least spillway adequacy regardless of size and hazard potential. This is essential if cumulative disaster threats are to be effectively reduced and managed. They should be mandated to at least meet ANCOLD's fall-back design criteria for low hazard dams (1-in-100 to 1-in-1000 years design flood).[503] Overall, the registration of dams, extensive supervisory remit for authorities, provision of sufficient funding for extended supervisory remit, and efficient and effective administration of the policy are all needed.

Tasmanian policy represents the Australian jurisdiction most in line with the best practice model and sets a good example for the other states to follow.[504] Tasmania provides an innovative and equitable user-pay

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[497] Portions of Part VII.A are derived from Pisaniello, *How to Manage*, *supra* note 27; Pisaniello, Ph.D. Thesis, *supra* note 27; Pisaniello & Burritt, *supra* note 36.
[498] *See supra* Part I.B.
[499] *See supra* notes 80–86 and accompanying text.
[500] *See supra* notes 69–79 and accompanying text.
[501] *See supra* Parts II.A.1, II.A.2.
[502] *See supra* Parts II.A.1, II.A.2.
[503] *See supra* note 404 and accompanying text.
[504] *See* WATER RES. DIV., TAS. DEP'T OF PRIMARY INDUS., WATER & ENV'T, *supra* note 206, at 21.

method for governments to fund extensive dam supervision.[505] It also provides a user-friendly *one-stop-shop* for new dams and considers other important dam safety issues such as community feedback, sustainable water allocation, and environmental impact.[506] Nonetheless, additional funding and staffing to achieve more timely administration of Tasmania's policy may be required. According to feedback from the regulatory authority, much time, effort, and resources are needed to identify all existing dams in Tasmania that should be included on the register, and to ensure they comply with the policy.[507] This has led to implementing a priority system in terms of strict enforcement of standards, which could potentially allow many smaller dams that contribute to cumulative threats to go unchecked for too long.[508]

B. Policy Implications and Guidance for Australia and Abroad

The policy implications for the Australian states reviewed comprise:

- In *policy deficient* SA, there is clearly a need for a model of best practice based on application of the policy precedent and guidelines in Part VI. This is because SA has at least 100 individually hazardous private dams and thousands of smaller, lower hazard dams posing significant cumulative safety threats in catchments.[509] Policy options include (1) providing for empowering legislation via amendments under the NRMA so that an existing authority can be empowered to regulate and supervise dam safety similar to the Tasmanian system, or (2) establishing a specific dam safety act and authority similar to the NSW approach, but providing for a more extensive supervision than currently is the case in NSW.
- In NSW, the policy via the DSA and DSC is already strong.[510] However, the NSW government should: firstly, establish a more extensive register of dams;

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[505] *See supra* notes 191–95 and accompanying text.
[506] *See supra* Part II.A.3.
[507] *See supra* Part II.A.3.
[508] *See supra* Part II.A.3.
[509] *See supra* notes 98–101 and accompanying text.
[510] *See supra* Part II.A.1 (describing the dam safety policy of NSW).

and secondly, extend the DSC's supervisory remit and funding support so that each of the concerns in Part I.A are addressed. Cost-effective spillway design/review procedures and simple supervisory pro forma (e.g., from Tasmania) for smaller dams should also be put to use in NSW given the availability of such options.

- In Victoria, the recently developed policy is well-positioned but requires improvement in some key areas.[511] Victoria is currently reviewing its policy to identify any necessary improvements, and this should result in the regulator recognizing the need for additional funding to achieve more efficient and effective administration of the policy.[512] Victoria should also consider extending its register to include dams smaller than the current referable criteria (in line with the Tasmanian approach) in order to ensure that the cumulative threats associated with smaller catchment dams are kept in check. For such dams, currently available cost-effective spillway design/ review procedures and simple supervisory pro forma (e.g., from Tasmania) should also be put to use in Victoria.
- In Tasmania, the policy is comprehensive, well addressing each of the concerns in Part I.A and represents an exemplary model of best practice.[513] Any additional funding and support needed to facilitate more timely administration of the policy could be sourced from farmers under the user-pays system or it could be subsidized directly by the state government. But, perhaps it should come from the Commonwealth government and be made available to all states as discussed below.

The major implication of these findings for Australia is that there is a need for more uniform dam safety assurance policies nationally. Policies must ensure that communities and environments downstream

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[511] *See supra* Part II.A.2 (describing the dam safety policy of Victoria).
[512] *See supra* note 150 and accompanying text.
[513] WATER RES. DIV., TAS. DEP'T OF PRIMARY INDUS., WATER & ENV'T, *supra* note 206, at 21.

of hazardous private dams are valued equally, regardless of the state in which they exist. This accords with ANCOLD's ongoing encouragement since 1972 for Australian states to implement uniform dam safety legislation.[514] As demonstrated by this paper, despite many studies, warnings, and encouragement over recent decades, uniform policy in Australia is yet to be achieved. Federal government involvement in Australia is an option that should be encouraged.[515] Under the Australian Constitution, the Commonwealth Parliament is empowered to grant money to any state "on such terms and conditions as the Parliament thinks fit."[516] This can be in the form of "specific purpose grants," also known as the "tied grants" tool—since granting is tied to a particular purpose—commonly used by the federal parliament as an incentive or "carrot" to influence state policy matters in order to achieve uniform policy nationally.[517] The Commonwealth could therefore provide monetary support/incentives to the states on the condition that their dam safety assurance policy meets an international benchmark standard, such as the guidelines in Part VI. The level of support given to each state would depend on the number of dams requiring supervision. This approach is similar to that of the United States, which has been adopted successfully since the early 1980s.[518]

The strategy adopted in the United States shows that federal involvement can work positively in obtaining national cooperation.[519] It is a good example for Australia to follow because it encourages the enactment of more responsible state policies, achieves a more uniform dam safety assurance policy across the country, and ensures that policies are better administered. In other words, effectively implemented policy in each state will meet an acceptable international benchmark or standard such as that established in this paper.[520]

Internationally, this paper has shown that many countries and jurisdictions have enacted dam safety assurance policies that are workable

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[514] *See supra* note 59 and accompanying text.
[515] *See supra* Part IV.A.
[516] AUSTRALIAN CONSTITUTION s 96.
[517] TONY BLACKSHIELD & GEORGE WILLIAMS, AUSTRALIAN CONSTITUTIONAL LAW AND THEORY: COMMENTARY AND MATERIALS 909, 911, 919, 923, 925 (3d ed. 2002); *see* Scott Bennett, *Feature Article: Australian Federal System*, AUSTL. BUREAU OF STATISTICS, http://www.abs.gov.au/ausstats/abs@.nsf/Previousproducts/1301.0Feature%20Article4012008?opendocument&tabname=Summary&prodno=1301.0&issue=2008&num=&view= (last updated Jun. 3, 2010).
[518] *See supra* Part IV.A (describing the work of FEMA in creating federal dam safety guidelines for states to adopt).
[519] *See supra* Part IV.A.
[520] *See supra* Parts III, VI for discussion about these benchmarks and standards.

and not too costly for governments to implement and dam owners to comply with.[521] In Parts III through VI, comparative analysis of these policies, and selection of key elements of "best" and "minimum" practice amongst each, have enabled development of policy guidelines compromising the benchmarks and models of "best" and "minimum" practice and associated selection criteria. Hence, these guidelines are in line with international experience and best practice; their application has been illustrated with the South Australian case study above. Any country or jurisdiction worldwide can refer to the benchmarks, models, and guidelines in Parts III through VI, as well as the lessons and implications provided above, to check the appropriateness of their current dam safety policy and how best to devise any necessary improvements.

CONCLUSION[522]

There is a clear need in states with hazardous private dams to ensure that owners review and maintain their dams in line with current acceptable practice. This includes the owners of smaller private dams, because such dams do pose considerable individual and/or cumulative safety threats to downstream communities and the environment in catchments.[523] Adequate assurance can only be provided through the implementation of appropriate policy, which requires the backing of lawmakers. The comparative review, policy/law models, and guidance presented here should encourage such backing in Australia, especially for SA, which currently has no policy, and also in any other policy-deficient jurisdiction worldwide with hazardous private dams. Federal involvement and backing can also assist to achieve uniform dam safety assurance throughout a country.[524] In particular, the following elements are vital for programs to succeed in managing both individual and cumulative dam safety threats: registration of all dams, extensive supervisory capacity for authorities, adequate funding including equitable user-pays principle, and effective and efficient administration.

The comparative review demonstrates that the approaches and standards used vary, but that there are also a number of common features and that none of the practices is perfect—some contain elements which

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[521] *See supra* Part II (describing various dam safety practices worldwide with key elements of best practices).
[522] Portions of the Conclusion are derived from Pisaniello, *How to Manage*, *supra* note 27.
[523] *See id.* at 361.
[524] *See supra* Part IV.A.

are superior to others, thereby setting a good example even though they may be deficient in other areas. Nevertheless, the key lesson is that in order to provide appropriate dam safety assurance to downstream communities, it is necessary to educate private dam owners so they realize their responsibilities and liabilities in accordance with the dictates of common law, and also to establish some form of regulatory supervision and control over dam management practices to ensure that owners appropriately manage their dams in line with current standards. The review shows this can be best achieved by establishing properly organized, systematic dam safety programs based on dam safety legislation. At the very least, considering downstream communities ultimately bear the risks associated with dams, they should have the right to know the potential dangers they are living under and be provided with opportunity for salvation (should failure occur) through appropriate emergency preparedness procedures required under legislation. Hence, for SA, which has a considerable number of hazardous private dams compared to the other practices reviewed, the elements of "minimum practice" should, at the very least, be implemented immediately, with the additional elements of "best practice" to follow soon thereafter. This approach[525] provides guidance to any other jurisdiction worldwide with potentially hazardous private dams for either checking current policy or to develop new policy.

The experience of Tasmania, which provides an exemplar of the "best practice" model, is similar to what is happening internationally in that appropriately devised dam safety programs are workable and not too costly. Elements of best practice do exist successfully whereby the proper safety management of hazardous private dams, both at the individual and cumulative levels within catchments, provides increased dam safety assurance to the public. The ideals of reducing loss of life as well as containing environmental and economic losses are consequently being promoted.

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[525] I.e., determining appropriate legislative arrangements for SA using comparative jurisdictional circumstances and the developed policy/law models.