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Review of the *Dams Safety Act 1978* and Dams Safety Committee

Final Report

NSW Trade and Investment, Regional Infrastructure and Services

September 2013

GOVERNMENT ADVISORY SERVICES



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The findings in this report are based on a qualitative study and the reported results reflect a perception of NSW Trade and Investment but only to the extent of the sample surveyed, being NSW Trade and Investment's approved representative sample of stakeholders. Any projection to the wider stakeholders is subject to the level of bias in the method of sample selection.

No warranty of completeness, accuracy or reliability is given in relation to the statements and representations made by, and the information and documentation provided by, stakeholders consulted as part of the process, as detailed in Appendix A.

KPMG have indicated within this report the sources of the information provided. We have not sought to independently verify those sources unless otherwise noted within the report.

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The findings in this report have been formed on the above basis.

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Executive summary

The New South Wales Department of Trade and Investment, Regional Infrastructure and Services (NSW Trade & Investment) engaged KPMG to undertake an independent review of the *Dams Safety Act 1978* (the Act) and the Dams Safety Committee (DSC). The focus of the review is to consider the effectiveness of the Act and the DSC and, where applicable, make recommendations to improve their operation.

This is the first stage of a broader review. In the second stage, NSW Trade & Investment will report to the Minister for Primary Industries prior to undertaking broader community consultation regarding potential changes to the approach to dam safety management in NSW.

NSW Trade & Investment carries primary responsibility for this review and the broader review and is supported by a Steering Committee comprised of representatives of relevant NSW Government agencies.

The NSW Government has decided to review the Act and the DSC in response to concerns that the current regulatory framework leads to over-investment in dam safety. The costs of over-investment are passed on to the community through the cost of the goods provided by dam owners (e.g., irrigation and town water) and increased levels of taxation required to fund government expenditure on dam safety.

These concerns were raised in previous reviews conducted by the NSW Commission of Audit (CoA) (CoA 2012) and the Independent Pricing and Regulatory Tribunal (IPART) (IPART 2010), under broader terms of reference than those set for this review.

These reviews noted that state-owned bodies, such as the State Water Corporation, spend a large amount on dam safety investments and questioned whether this level of expenditure is efficient given the small reduction in risk achieved.

Approach

The focus of this review was on considering whether current dam safety regulatory arrangements in NSW are the most effective method for ensuring public safety and, where applicable, to make recommendations to improve the operation of the Act and the regulatory framework.

To undertake the review, KPMG:

- received specialist technical advice on dam safety and risk standards from GHD engineers; and
- obtained information on dam safety expenditure from across jurisdictions within Australia to compare outcomes in terms of the costs of each regulatory framework.

To develop recommendations for changes to the existing regulatory framework, KPMG:

- benchmarked the form of dam safety regulation across jurisdictions; and
- employed an assessment framework to consider both:

- better regulation principles developed by the Better Regulation Office (BRO); and
- options provided by generally accepted models of good regulatory practice.

To inform both questions, KPMG also:

- consulted with industry and government stakeholders at three workshops to understand the issues with the existing regulatory framework and whether the framework is leading to over-investment in dam safety; and
- developed and distributed two stakeholder surveys (one for dam owners and another for other stakeholders) to understand the costs of dam safety investments and potential improvements in the regulatory framework.

Assessment framework for this review

As part of this review, KPMG used the BRO's better regulation principles and the experience of regulation in other sectors to assess the existing form of regulation and to identify a best-practice framework for dam safety regulation. The analysis and recommendations in this report are based on assessments with respect to this framework.

Key elements of a regulatory framework that were considered include the:



The review found significant differences between the current regulatory framework and what would be considered best practice.

Key findings

Introduction

A list of recommendations is set out at the end of the Executive Summary, with further supporting rationale contained in the body of the report. The recommendations seek to align the existing form of regulation with best practice and thereby reduce the scope for over-investment.

Government intervention that encompasses the broadest consideration of the most efficient ways to manage the public safety risk associated with stored waters has the greatest potential to reduce the scope for over-investment in dam infrastructure. KPMG's consultations with stakeholders and research suggest that over the full life-cycle of a dam, the level of investment

in dam safety is driven by the safety standards that the standard setting authority requires dam owners to meet.

Evidence considered as part of this review indicated that the existing regulatory framework is resulting in levels of investment greater than would be considered optimal. The key issues with the current regulatory framework that contribute to this outcome are that:

- in the absence of the Act having clear objectives, the DSC has developed a strong focus on engineering solutions in order to minimise the risk of dam infrastructure failure, rather than on a broader range of possible risk reduction strategies. However, the risk to public safety arising from a dam depends on a number of factors other than the structural integrity of the dam, such as dam operations, changes in downstream development and emergency management procedures. As an illustrative example of their current focus, while the DSC requires extreme, high and significant consequence dams to have an Operations and Maintenance Manual, their regulatory activity in this regard is, in practice, limited only to confirming the existence of the manual and not to assessing how the strategies in the manual contribute to public safety;
- there is a lack of transparency for dam owners with regard to DSC decisions that require capital expenditure to reduce the risk of dam failure to "as low as reasonably practical";
- there is a limited focus on applying benefit cost analysis to identify the most efficient risk reduction options; and
- the composition of the DSC consists in part of the same dam owners that are being regulated.

An increased focus on considering the full range of alternate risk reduction strategies beyond engineering solutions, complemented by rigorous benefit cost analysis of those options, would significantly reduce the scope for over-investment in engineering options to improve public safety.

The need for government intervention and setting of safety standards

Australian jurisdictions vary considerably in the dam safety regulatory frameworks applied, varying from a highly prescriptive approach in NSW to no specific regulation in Western Australia.

Evidence from New Zealand and feedback from stakeholder consultations raised concerns that, in the absence of government regulation, there may be under-investment in public safety measures, particularly for smaller dams. On the other hand, there was evidence that owners of large dams would be less inclined to under-invest in dam safety, which is likely to relate to the substantial legal liability faced in the event of dam failure.

The review found evidence of over-investment in engineering measures to achieve improvements in public safety by large dam owners in NSW, suggesting that alternate regulatory arrangements may be warranted.

A regulatory approach similar to that used in Victoria would be more appropriate, where the regulator has less of a "hands-on" approach to determining compliance strategies for dam owners, and dam owners are made clearly responsible for ensuring and demonstrating

compliance with standards. This would reduce compliance costs and bring greater clarity to the respective roles and responsibilities of dam owners and government.

Under this approach, the regulator would enforce a consistent regulatory regime for all dams in NSW. This would involve the regulator setting the dam safety standards and guidelines, providing dam owners with relevant information in regard to these standards and guidelines, being responsible for monitoring compliance and, where necessary, taking appropriate enforcement action. However, the regulator would not determine the individual investment strategies that dam owners undertake to achieve the required standards.

The level of monitoring and enforcement of dam safety standards and guidelines for each dam would be determined by the regulator and be based on a risk approach where the regulator would assess the risk of non-compliance with the standards and guidelines. This regulatory framework provides the best prospects for levels of dam safety investment that appropriately balances safety requirements with the costs of dam safety investment.

The form of regulation and nature of the dam safety regulator

To ensure that the structure and composition of the regulator of dam safety aligns with best practice, it is recommended that the regulator be independent of the businesses it regulates. Its membership should include representatives of relevant government agencies, as well as independent expertise in dam engineering, public safety risk management and benefit cost analysis. This composition will ensure integration, complementarity and efficiency in risk reduction strategy development.

Membership of the regulator should not include representatives of dam owners, as is currently the case. This would avoid real or perceived conflicts of interest generated by a regulator that are comprised in part by the industries it regulates.

The funding arrangements for the dam safety regulator, which currently involve an annual contribution of around \$1.3 million by the NSW Government and in-kind contributions from the dam owner representatives on the DSC, should also be reformed. It would be more efficient if the costs of regulation and the operations of the regulator were fully funded by the relevant public safety risk creators, which in this case are all owners of prescribed dams.

Transparency of regulation

Transparency of regulation and the regulatory decision making process are an important part of a best-practice regulatory framework. Increased transparency reduces the risk of confusion among stakeholders, thereby enhancing regulatory efficiency and providing scope for more effective stakeholder input to the regulatory process. Where the regulator proposes changes to dam safety regulation, these changes should be subject to consultation with dam owners and other interested stakeholders and should undergo benefit cost analysis. Transparency in decision making allows stakeholders to respond efficiently to decisions and understand key issues considered to be important to the regulator.

Planning

The existing dam safety regulatory framework interacts with the planning framework in two ways:

- developments downstream of dams can change the consequences of any potential dam failure and are considered in decisions of whether individual dams require safety upgrades; and
- the DSC has input to the approvals process for mines in areas near prescribed dams through the *Mining Act 1992*.

This review has found that, where the dam safety regulator shares responsibility for industry regulation, such as with the Department of Planning and Infrastructure in regard to developments and with IPART in regard to water pricing, there is some confusion in relation to the roles of each regulator, and information is not shared in a way that allows effective and timely decision making.

At present, dam owners are not systematically advised of pending developments which could alter the consequence category of their dams, until after the development is completed. Given that a change in consequence category can impact the costs of complying with public safety standards, providing dam owners with information earlier in the process would allow them to more effectively and positively engage in the development approval process. The development approval process would in turn provide more efficient development solutions with more timely and adequate consideration of the cost of dam safety upgrades.

It is, therefore, recommended that a systematic approach be implemented to inform dam owners of developments downstream from their dams and allow dam owners' concerns to be considered as part of the planning process. This would be expected to reduce the cost of dam safety investment due to the reclassification of dam consequence categories and could be incorporated in the planning approval process or through another process as considered appropriate by the NSW Government.

List of recommendations

Recommendation 1: The Act should be amended to provide clarity in relation to the objectives of the legislation and the role and powers of the dam safety regulator. The objective should be to achieve socially acceptable levels of public safety risk in relation to stored waters in NSW and the regulatory framework should enable risk management to be achieved in the most efficient manner possible (i.e., consideration being required to be given to the broadest range of relevant operational strategies and thereby avoiding a singular focus on dam engineering solutions).

Recommendation 2: The dam safety regulator should be responsible for monitoring the compliance of dams with standards and guidelines. The regulator should determine the level of monitoring necessary for each dam based on the likelihood of non-compliance.

Dam owners should be responsible for compliance with standards and guidelines. The regulator should not be involved in the development of compliance strategies or in identifying particular dam safety upgrade strategies. Dam owners should report to the regulator annually on the level of compliance being achieved by their maintenance and upgrade programs.

If dam owners do not comply with standards, the regulator should have clear powers to compel dam owners to implement changes necessary to meet required standards and guidelines.

Recommendation 3: The government should change the composition of the dam safety regulator so that it:

- is independent of the businesses it regulates;
- is composed of representatives of relevant government agencies to ensure integration, complementarity and efficiency in risk reduction strategy development (for example, NSW Treasury, Department of Planning and Infrastructure, Department of Trade and Investment Resources and Energy and the NSW State Emergency Service (SES)); and
- has relevant independent expertise, including dam engineering, public safety risk management and benefit cost analysis.

Recommendation 4: It is recommended that the dam safety regulator be funded by relevant risk creators, which in this case are all the owners of prescribed dams in NSW.

Recommendation 5: The regulator should be required to achieve high levels of public transparency with respect to the basis of its regulatory standards and the respective roles of dam owners versus government. This transparency will make clear the legal liability of dam owners and in so doing encourage levels of private investment in dam safety that align, as far as possible, with the risk preferences of the broader community.

Recommendation 6: Where the dam safety regulator proposes changes to dam safety regulation, these changes should be subject to consultation with dam owners. Best practice principles suggest a consultation phase of at least 28 days.

Recommendation 7: The dam safety regulator should consider the views of industry and other stakeholders when making final decisions to implement changes to dam safety regulation.

When reaching its decision, the regulator should release a report explaining its decision-making process and the information it considered in making its decision.

Recommendation 8: The NSW Government should seek comment from the community on its willingness to accept the risk of dam failure and the appropriate level of dam safety investment. Community feedback should be considered when the regulator sets safety standards for dams. This should be reviewed periodically to ensure that safety standards continue to be consistent with community expectations. This outcome could also be achieved through high levels of transparency with respect to benefit cost analyses undertaken to identify efficient risk reduction strategies, with community input encouraged to that process.

Recommendation 9: Consideration by a dam owner of whether a potential dam safety investment is appropriate should explicitly include assessment of the benefits and costs of the proposed investment and alternate options to reduce the public safety risk associated with stored waters.

Recommendation 10: A systematic and proactive approach should be implemented to inform dam owners of potential developments downstream from their dams that could influence the consequence category of their dams and the cost of complying with public safety requirements. The approach should be incorporated into the planning approval process or through an alternate process considered appropriate by the NSW Government.

Recommendation 11: The NSW Government should consider options to address dam safety considerations much earlier in the planning approval process, particularly for state significant developments and state significant infrastructure.

Recommendation 12: The NSW Government should seek public comment on:

- whether the regulator's role in the approval of mining near prescribed dams is clearly defined; and
- whether the dam safety regulator should consider the economic impacts of water loss due to mining activities or whether the dam safety regulator should only be concerned with the safety of the prescribed dam.

Recommendation 13: The NSW Government should consider whether the dam safety regulator or another government agency should be required to approve Dam Safety Emergency Management Plans (DSEPs). The relevant agency should have sufficient resources to make such assessments.

Recommendation 14: The NSW Government should evaluate whether existing DSEP trigger points for alerts result in unnecessary evacuation warnings.

The implementation of these recommendations could be achieved through modification of the existing dam safety regulator (i.e. the DSC) and the regulatory framework (i.e. the *Dams Safety Act 1978* and other relevant legislation).

1. Introduction

The New South Wales (NSW) Department of Trade and Investment, Regional Infrastructure and Services (NSW Trade and Investment) engaged KPMG to undertake an independent review of the *Dams Safety Act 1978* (the Act) and the Dams Safety Committee (DSC). The focus of the review is to consider the effectiveness of the Act and DSC and, where applicable, make recommendations to improve their operation.

This is the first stage of a broader review. In the second stage, NSW Trade and Investment will report to the Minister for Primary Industries prior to undertaking broader community consultation on potential changes to the approach to dam safety management in NSW.

The NSW Department of Trade and Investment carries primary responsibility for this review and the broader review and is supported by a Steering Committee comprised of representatives of relevant NSW Government agencies.

The NSW Government has decided to review the Act and the DSC in response to concerns that the current regulatory framework leads to over-investment in dam safety. The costs of over-investment are passed on to the community, both through the costs of the goods provided by dam owners (e.g. irrigation and town water) and increased levels of taxation required to fund government expenditure on dam safety.

These concerns were raised in previous reviews conducted by the Commission of Audit (CoA) (CoA 2012) and the Independent Pricing and Regulatory Tribunal (IPART) (IPART 2010), under broader Terms of Reference than those set for this review.

The CoA Final Report on Government Expenditure noted that State Water was part way through a major capital program of dam safety upgrades, driven by DSC requirements, with a total cost of around \$400 million. The CoA stated:

'To meet the Act's requirements, very small reductions in risk are being achieved at a disproportionate cost that is not consistent with safety cost/benefit trade-offs in other industries.' (CoA, 2012, p 233)

The Final Report recommended that:

"...an independent review be conducted of the standards set by the Dam Safety Committee following a thorough risk and cost benefit assessment." (CoA 2012, p 233)

As part of its review, IPART examined the productivity performance of State Water. It noted that expenditure on safety upgrades would not expand State Water's output, and would therefore result in a reduction of State Water's productivity.

IPART noted that from FY2007-FY2010, State Water's expenditure on dam safety constituted more than 60 per cent of its total capital expenditure. Over the 2010 determination period (FY2011-FY2014), expenditure on dam safety was expected to remain at over 60 per cent of total capital expenditure, although it was expected to reduce after FY2013 (IPART 2010b).

These reviews noted that state owned corporations, such as State Water, spend a large amount on dam safety investment and questioned whether this level of expenditure is efficient, given the small reduction in risk achieved.

There is some evidence that the existing regulatory framework may be resulting in levels of investment greater than would be considered optimal, however, it is unclear whether over-investment may be due to a failure of dam owners, the regulator or the regulatory framework.

NSW Trade and Investment requested this version of the report to be issued excluding data and information provided on a commercial-in-confidence basis. This evidence cannot be included in this report due to the commercial-in-confidence nature of the data and information.

1.1 Terms of reference

The Terms of Reference (ToR) for this review are set out in Box 1 below.

Box 1 Terms of Reference for this review

- a) Clarify the objectives of the *Dams Safety Act 1978* and the 'market failures' being addressed.
- b) Consider alternative means for achieving the objectives of the legislation and identify if and where these objectives can only be achieved by regulatory intervention.
- c) Consider the most effective methods of ensuring public safety at large (prescribed) dams while retaining as much functionality as practical.
- d) Consider the Risk Management Policy Framework for Dam Safety 2006 and whether amendment of this policy is warranted.
- e) Assess and balance the costs and benefits to the community and government, including risk implications of proposed retained or new interventions.
- f) Make recommendations to the Minister on possible amendments to the Act and Committee constitution and role.
- g) Consider how advice from the Dams Safety Committee can be better integrated with the development assessment process, particularly for state significant development.

In undertaking this analysis, the review will:

- a) Consider the role and performance of equivalent statutory arrangements in other jurisdictions.
- b) Consider the safety cost/benefit trade-offs that are made in other industries.
- c) Report on the potential impact of extractive (mining) activities on dam safety.
- d) Consult with the Dams Safety Committee, dam managers (including State Water Corporation, Sydney Catchment Authority, Sydney Water and Hunter Water) and other relevant water managers in NSW.
- e) Consult with the Department of Finance and Services, the State Emergency Service,

WorkCover, NSW Trade and Investment (Resources and Energy), NSW Department of Primary Industries (Fisheries) and any other NSW Government agency relevant to dam safety.

The Act and the DSC have been in operation since 1978 but have not previously been the subject of an independent review. The DSC has previously reviewed its form of regulation and periodically refines its regulatory framework (DSC 2007).¹

1.2 Structure of the report

The remainder of this report is structured as follows:

- Section 2 provides a background to dam safety regulation in NSW and the market failures that dam safety regulation seeks to address;
- Section 2 outlines the approach and limitations of this review and the development of a framework for assessing the form of regulation;
- Section 2 considers the regulatory framework for dam safety regulation;
- Section 5 considers the risk of dam failure and the setting of safety standards;
- Section 6 discusses planning, developments and mining; and
- Section 7 discusses emergency planning for dams in NSW.

¹ The review conducted by the DSC examined the form of regulation and resulted in a move from prescriptive regulation to a mix of prescriptive and risk-based approaches. This review is discussed in further detail elsewhere in this report.

2. Dam safety regulation in New South Wales

This section considers the need for dam safety regulation, with a particular focus on dam safety arrangements in NSW.

In general, government intervention and regulation aims to address market failures in an economically efficient manner. In the case of dam safety, this involves ensuring that owners invest sufficiently in dam safety to reduce the risks of dam failure to a tolerable level.

For the provision of dams, this report considers two important market failures:

- external costs placed on downstream populations caused by dam failure (whether actual or expected; and
- imperfect information provided to dam owners and to downstream populations regarding the risk of dam failures and community preferences for minimising that risk.

Sections 2.1 and 2.2 outline the market failures considered as part of this review. The subsequent sections provide a summary of dam safety regulation in NSW.

2.1 External costs of dams

Externalities occur when a transaction generates costs (negative externalities) or benefits (positive externalities) to individuals not party to the transaction.

Dam failures, and the impact of dam failures on downstream communities, are examples of the existence of these external costs. When a dam fails, damage to property and the loss of life downstream is a realisation of these costs. A dam does not need to fail for external costs to exist. The expected cost of a dam failure is in itself an external cost as it is placed on a party other than the dam owner.

In general, people who obtain benefits from dams supplying water outnumber the people who bear the costs of potential dam failure (those living downstream). In the case of dam failure, while the costs to the broader community may be low on a per capita basis, the external cost to individual community members may be very large. The disproportionate impact per person of these external costs compared with the external benefits is an additional reason for regulating investment in dam safety.

Regulation which encourages investment in dam safety aims to shift these costs to dam owners, recognising that dam owners are responsible for external costs. In addition, if external costs were not shifted to dam owners, there would be an incentive to over-invest in dams. The owners would receive all the benefits of the dam (such as revenue for supplying water), without realising all the costs of the dam. An over-investment in dams, without appropriate investment in dam safety, would increase the impact of this market failure to the community as a whole.

Other factors, such as legal liability and requirements to provide compensation to parties impacted by dam failures, do not fully remove the costs of dam failure to third parties. However, they do internalise some of these costs by providing some incentive for dam owners to invest in dam safety.

The costs imposed on dam owners by dam safety regulation are passed through to consumers by dam owners. For example, businesses providing drinking water to Sydney can request that the pricing regulator include the costs of capital expenditure spent on dam safety in retail prices for water. The CoA report noted that nine per cent of retail water prices represent the costs of dams. As an input into the costs of dams, increased investment in dam safety would be expected to have a flow on effect on retail water prices (CoA 2012).

This presents a price signal to the broader community of the costs of dam safety. However, where the costs of dam safety are borne by the government, the price signal is muted. This may be due to:

- grants to dam owners for dam safety upgrades; or
- a pricing regulator not allowing all costs to be passed through to consumers.

For example, in rural areas of NSW, IPART does not allow State Water to pass through the full cost of dam safety upgrades to the consumer. The reason given in 2006 for this approach was that safety standards are a community requirement set by the NSW Government (IPART 2006). Instead, the NSW Government, as the owner of State Water, is required to fund some of the cost of dam safety upgrades.

The broader community bears these costs through taxation, however, is unlikely to be able to calculate the dam safety component of taxation, meaning that the price signal is muted. Likewise, if the focus of dam safety investment shifted from prevention to increased emergency management, the costs of dam safety would be met by the community through government funding to emergency services such as the State Emergency Service (SES). KPMG notes that the approach taken by IPART in relation to the pass through of dam safety upgrades is not applied in all other industries. For example, in previous reviews of public transport fares in NSW, IPART examined the efficient costs of providing rail and bus services assuming that service standards and safety requirements remained in line with policy settings. For instance, in the 2009 review of CityRail fares, IPART noted that:

"...while rail safety is a vital, non-negotiable aspect of service, IPART did not review rail safety regulation. This regulation is the responsibility of ITSRR, and RailCorp is legally obliged to meet safety requirements under the Rail Safety Act 2002. However, in making its fare determination, IPART determined CityRail's revenue requirements for the next four years based on CityRail operating its rail network safely and at the levels determined by the safety regulations."

KPMG notes that under best practice regulation, where regulators share responsibility for regulation of an industry, clear processes for regulation and cooperation between regulators is important in order to ensure effective regulatory outcomes.

2.2 Imperfect information

Imperfect information and information asymmetries may occur where one party has more or better information than other parties involved in the transaction. Where this occurs, parties involved may be unable to make efficient economic decisions. In the provision of dam safety, there are two key instances of imperfect information:

- downstream populations typically have limited information on the safety standards of the dam and the consequences of failure; and
- dam owners may have limited information about the:
 - technical requirements necessary to ensure that the dam achieves a certain level of safety; and
 - level of safety reflective of the risk preferences of the downstream population and community more broadly.

Downstream populations and the broader community may under or over-estimate the risk of dam failure, impacting the demand for dam safety from the broader community. With greater information, the community may be better able to provide input on the appropriate level of investment in dam safety required by dam owners.

As this review did not involve consultation with the broader community, it cannot confirm whether this example of imperfect information currently exists. However, given the technical nature of measuring the risks and consequences of dam failure, it is unlikely that the broader community is sufficiently informed to provide this input.

Similarly, dam owners may under or over-estimate the level of investment in dam safety required to be consistent with community expectations of tolerable risk. Without this information, a dam owner attempting to invest in dam safety in accordance with the risk appetite of the broader community would need to estimate the appropriate level of risk. This may increase the costs to the owner if they over-estimate the level of investment, or increase the risk of dam failure if they under-estimate the required level of investment.

Identifying the appropriate level of dam safety investment would likely require significant costs to gather information on the community's appetite for risk, as well as obtaining expert advice on the consequences of dam failure on downstream populations. This would need to be undertaken separately for each dam, regardless of its consequence category.

Where a regulator or the government is able to research and provide this information, it avoids duplication of effort. A regulator that specifies guidelines for the appropriate level of investment in dam safety may decrease these costs for dam owners to individually obtain this information. This would reduce the overall cost of dam safety investment in NSW and the provision of advisory material.

In addition, if a regulator provided this information, it may ensure a consistent minimum level of knowledge across all dam owners, and subsequently result in a consistent approach to addressing the safety of dams throughout NSW.

2.3 Existing approach to dam safety regulation in NSW

Dam safety regulation in NSW is the responsibility of the DSC as specified by the Act. The Act is the legislative instrument that dictates the NSW Government's approach to regulating dam safety in NSW. The DSC is responsible for regulating safety of the 376 prescribed dams in the state,² which are those dams for which failure would "threaten lives or have significant economic impacts or cause serious environmental damage" (DSC 2012).

The Act defines the DSC's constitution, functions and powers. The sections below provide an overview of the role of the DSC and its current approach to regulating dam safety and mining activities in close proximity to dams.

The Act establishes the powers of the DSC to allow it to "formulate measures to ensure the safety of dams.". It does not, however, define "safety" or specify how "safety" should be achieved. Rather, the DSC defines how it will achieve its objectives and refines this process over time as its understanding of risks to dam safety develops.

The DSC has inferred its objectives from the Act and defines its role as to:

- "protect the safety, welfare and interests of the community from dam failure by ensuring that risks from prescribed dams are tolerable;
- ensure that the DSC safety requirements are met, the risks are properly managed, are regularly reviewed, and are further reduced if reasonably practicable; and
- protect the security of dams and their stored waters from the effects of mining and other activities." (DSC 2012).

2.3.1 Role of the DSC

The DSC describes its primary role as:

"...to develop and implement policies and procedures for effective dam safety management to protect life, property and the environment from dam failures." (DSC 2013)

The DSC also regulates the operation of mines within the areas surrounding dams, under the *Mining Act 1992* (the Mining Act).

² The number of prescribed dams changes based on the size of the dam and consequences of dam failures. New investments can result in new or existing dams being newly prescribed, and downstream developments can increase the consequences of dam failure.

In carrying out these regulatory functions, the operations of the DSC can be broadly placed into four categories:



The DSC also provides information to dam owners through guidance notes and other publications, and conducts training courses, for example on *Dam Safety Surveillance* and *Dam Safety Management for Ash, Tailings and Mining Dams*.³ Appendix B provides more information on the functions of the DSC as defined by the Act.

2.3.1.1 Prescription of dams

The DSC prescribes dams based on a consequence category, which measures the level of hazard associated with a dam failure. The DSC reviews the prescribed dams list based on new information, such as proposals for new dams, inspections of existing dams and information provided by dam owners. In FY2012, 10 new dams were prescribed and six dams were removed from the prescribed dam list (DSC 2012).

2.3.1.2 Safety standards

Safety standards for prescribed dams are set by the DSC. The DSC draws heavily on Australian National Committee on Large Dams (ANCOLD) guidelines in implementing standards for dams where risks are assessed as being unacceptably high.

The DSC is also tasked with interpreting when a risk-based approach is preferable to a standards-based approach for dams requiring remedial work to lower risk. The DSC allows a risk-based approach where risks are lower than its level of tolerability and higher than its negligible level of risk.

A standards-based approach requires dam owners to meet the specified levels of dam safety. A risk-based approach allows dam owners greater flexibility to determine the appropriate level of safety required, based on considerations such as risk and cost effectiveness of investments.

A more detailed discussion on interpretation of risk and the level of safety standards is contained in Section 5.

2.3.1.3 Dam surveillance

To undertake its functions under the Act, the DSC obtains basic information on individual dams from dam owners during the development of a dam. The DSC aims to ensure that new dams are designed and constructed according to appropriate engineering standards and safety criteria. Accordingly, the DSC requires information to be provided early in the planning stages of new dams and also throughout the lifespan of the dam.

³ The DSC currently has 22 guidance sheets published on its website. These are separated into general guidance sheets (11), dam guidance sheets (7) and mining guidance sheets (4).

Owners of prescribed dams are required to undertake the following once the dam is in operation:

- using qualified personnel to operate and maintain the dam;
- conducting regular dam surveillance;
- developing emergency plans for dams which may cause loss of life in the event of dam failure;
- ongoing assessment of dams based on regular dam surveillance;
- compliance reviews with respect to DSC guidelines;
- using experienced personnel to review all dam assessments; and
- performing appropriate actions based on dam assessments to ensure dams are in a safe condition.

The DSC is empowered to request the owner of a dam to keep relevant records. If the owner does not comply, the DSC has the power to conduct the record keeping and charge the cost to the owner.

For dams with risks that are deemed 'intolerable' by the DSC, dam owners are required to reduce that risk as soon as is reasonable. For dams with risks below this level, dam owners are able to propose a level of investment they consider appropriate in order for the risk to be As Low As Reasonably Practicable (ALARP). For a risk to be ALARP, the cost of reduction in risk must be grossly disproportionate to the benefits associated with the risk reduction achieved.

Prescribed dams are monitored by the DSC through Inspection Reports and Surveillance Reports. These reports are drafted by dam owners and submitted to the DSC. Dam owners are responsible for developing plans for dam investments, including engaging engineering expertise where necessary. The DSC then evaluates the information provided to it by dam owners (DSC 2010).

In general, where proposed dam safety measures do not meet DSC requirements, the DSC seeks evidence that the risks are considered tolerable. As part of its consideration of the evidence provided by dam owners, the DSC considers the advice provided by the dam owner's professional advisors.

If the DSC considers that a prescribed dam is unsafe or may become unsafe, it may give notice under Section 18 of the Act requiring the dam owner to take actions necessary to ensure the dam's safety.

The DSC is also empowered to issue written notices to dam owners or other individuals who propose to take actions that may result in the dam becoming unsafe. However, this requires ministerial approval. The approval of the Premier is needed when the activity relates to a mine, as defined by either the Mining Act or the *Coal Mine Health and Safety Act*.

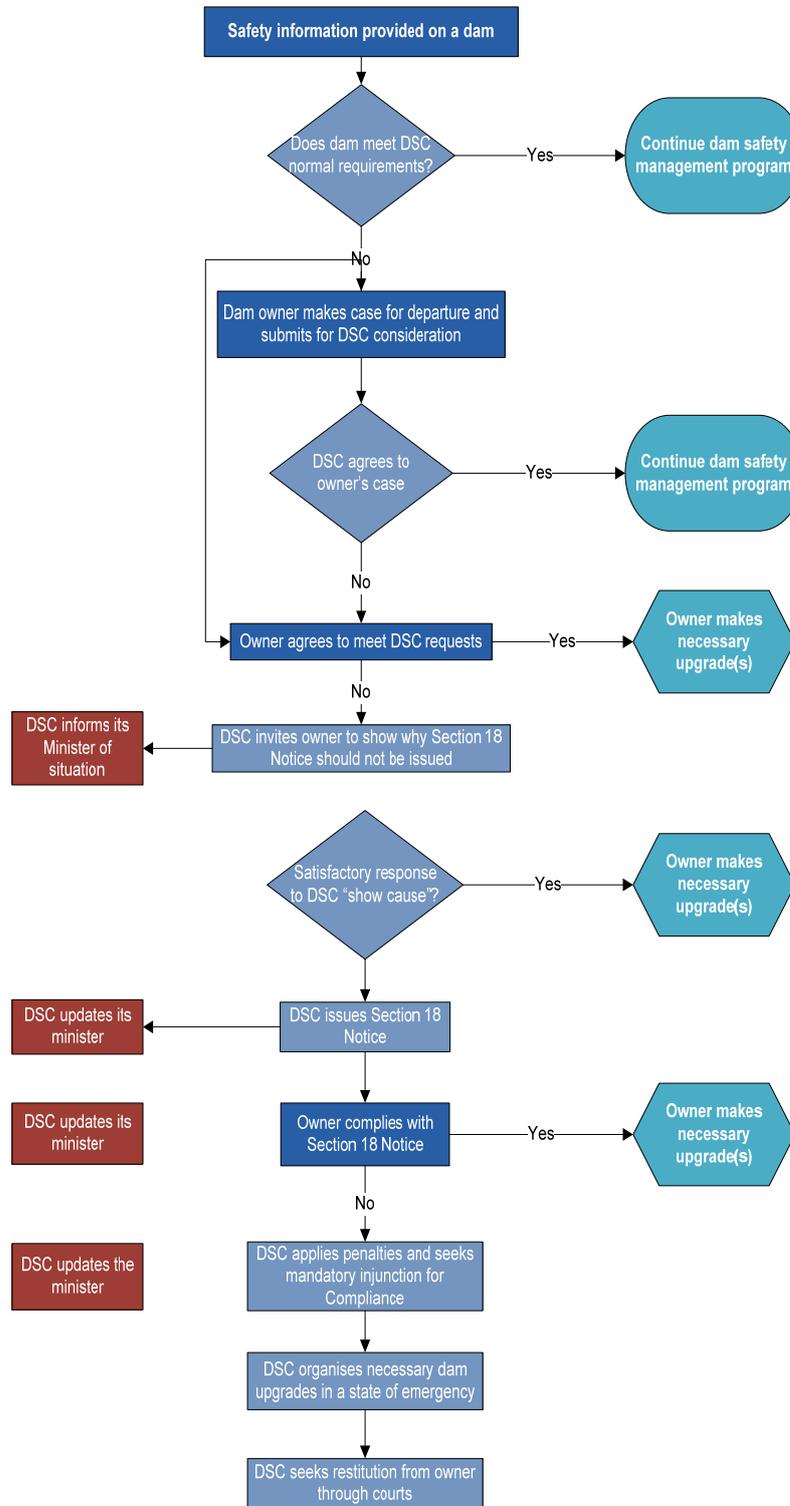
The Act also allows the DSC, in the event that the dam owner does not respond to the Section 18 notice, to enforce the notice by either imposing a penalty for violations or – under a state of emergency – undertaking remedial work on behalf of the dam owner.

The penalties the DSC may impose are currently limited to a maximum fine of \$1,100 for violations. Given the typical cost of undertaking prescribed works, this penalty is unlikely to provide sufficient financial incentive to dam owners. For instance, State Water is currently undertaking a major capital program of dam safety upgrades, with a total cost of around \$400 million (CoA 2012).

It is difficult to fully gauge the effectiveness or otherwise of penalties. Where fines have been issued, dam owners have generally addressed the DSC's safety concerns. However, the DSC has in practice issued relatively few Section 18 notices (three notices were issued in 2011-12, and one of these has been followed by legal proceedings).

Figure 1 below summarises the approach to surveillance undertaken by the DSC.

Figure 1: DSC Approach to Dam Safety Compliance



Source: Dams Safety Committee Guidance Note DSC1A

2.3.2 Responsibility of dam owners

As illustrated by Figure 1, the DSC is highly involved throughout the safety assessment process. In general, a hands-on approach to regulation can increase costs for government. However, the DSC utilises the work of dam owners and their expert advisors. Dam owners are required to design and develop investment plans for dam safety which are then considered by the DSC. The DSC does not develop plans for specific investments in dam safety. Particularly where the risks are deemed tolerable and a risk-based approach is allowed, owners have the flexibility to determine the preferred method for reducing risks in the dam so that they are ALARP. The DSC may however disagree that the risk imposed by a dam is ALARP, and require the dam owner to undertake further risk-reducing investment.

In addition, dam owners are responsible for conducting community consultation and communication as part of their proposal to the DSC. The DSC's guidance note, *Community Consultation and Communication*, outlines the dam owner's responsibilities for using community consultation as part of the risk assessment process and particular to understand societal concerns (DSC 2010b).

The DSC notes that community consultation and communication is a:

"Critical element in community safety risk management, for input to determining tolerable risk, for establishing 'do nothing' position and for identifying need for disclosure of risk reduction measures and residual risk – important to realise nothing is risk free" (DSC 2010b).

As well as providing greater flexibility to dam owners, this approach reduces the costs of regulation faced by the government.

Where an owner manages a number of prescribed dams, the owner is able to prioritise its investments to ensure that the overall risk of its portfolio is reduced as efficiently as possible. The 'whole of portfolio' approach allows dam owners to prioritise investments which provide the largest reduction in risk. For example, a dam owner may prioritise investments in dams with large downstream populations, where an investment in dam safety may provide a large reduction in the expected consequences of dam failure (DSC 2010c).

As is the case in developing plans for individual dams, a dam owner with a portfolio of dams is required to justify the prioritisation of specific investments across its portfolio.

2.3.3 Mining

The DSC has a role in the approvals process for mining projects within the areas surrounding prescribed dams. Under Section 80 of the Mining Act, the DSC is able to:

"...recommend to the Minister that a mining lease (being a mining lease over land within a notification area) be amended, by the variation of the conditions of the lease or by the inclusion of additional considerations in the lease, so as to prevent or mitigate any damage to a prescribed dam."

The Mining Act also enables the DSC to consider the safety of prescribed dams when formulating its recommendations on mining applications. If the Minister does not accept the

DSC's objections, the matter must be dealt with in consultation with the Minister responsible for the Act.

If the DSC does not make a proposal on a mining application and does not inform the Minister of this, the matter must be dealt with in consultation with the Minister responsible for the Act.

The DSC has stated in its guidance note on mining administrative procedures that its role with respect to mining is to ensure the safety of the dam and its stored waters. This includes the loss of stored waters through the reservoir floor. The DSC states that its approach to the loss of stored waters is to balance the positive economic impacts of additional mining against the negative impact of a loss of stored water (DSC 2010d).

The DSC makes recommendations to the Minister prior to the granting of a mining lease. As with dam surveillance, the DSC considers evidence provided by the mining company and its expert advisors when considering whether to make a recommendation to the Minister.

2.3.4 Composition of the DSC

The DSC is comprised of nine members appointed by the Minister, including representatives of large dam owners. DSC members are not paid for their work on the DSC and their contribution is in-kind (i.e. their time is paid for by their employing organisations). The DSC meets eight times a year (approximately every six weeks).

The DSC includes persons nominated by:

- Snowy Hydro Limited;
- the portfolio Minister under the *State Owned Corporations Act 1989* for the electricity generators;
- Sydney Catchment Authority;
- State Water Corporation;
- Hunter Water Corporation;
- the Minister administering the *Public Works Act 1912*;
- the Federal Council of the Institution of Engineers Australia (two persons); and
- the Minister administering the Mining Act.

When the DSC was founded in 1978, its membership was intended to provide sufficient expertise. In particular, the government at the time considered that the engineering services provided by the State authorities provided the necessary expertise in dam engineering (Hansard 1978).

Given the fact that the DSC includes representatives of dam owners, there is a risk that conflicts of interest may arise given that the business being regulated are represented in the regulator. While there are a number of industries with some form of self regulation, such as media and advertising, the DSC is a government regulator reporting to the Minister for Primary Industries and the Minister for Regional Infrastructure and Services. In addition, changes to the form of regulation have previously been approved by Cabinet. For example, the DSC's 2006

review of risk management procedures recommended changes to the form of regulation used by the DSC.

The DSC is supported by an Executive, which acts for the DSC between meetings and meets regularly with the Minister as well as the following five sub-committees:

Policy Sub-committee	An ad-hoc sub-committee which advises on policy development
Surveillance Sub-committee	A standing sub-committee that maintains a surveillance of dams and recommends relevant policies and actions
Mining Sub-committee	A standing sub-committee that oversees mining near dams and recommends relevant policies and actions
Hydrology Sub-committee	An ad-hoc sub-committee that advises on hydrological matters and recommends relevant policies and actions
Emergency Management Sub-committee	An ad-hoc sub-committee that advises on emergency matters relating to dams and recommends relevant policies and actions

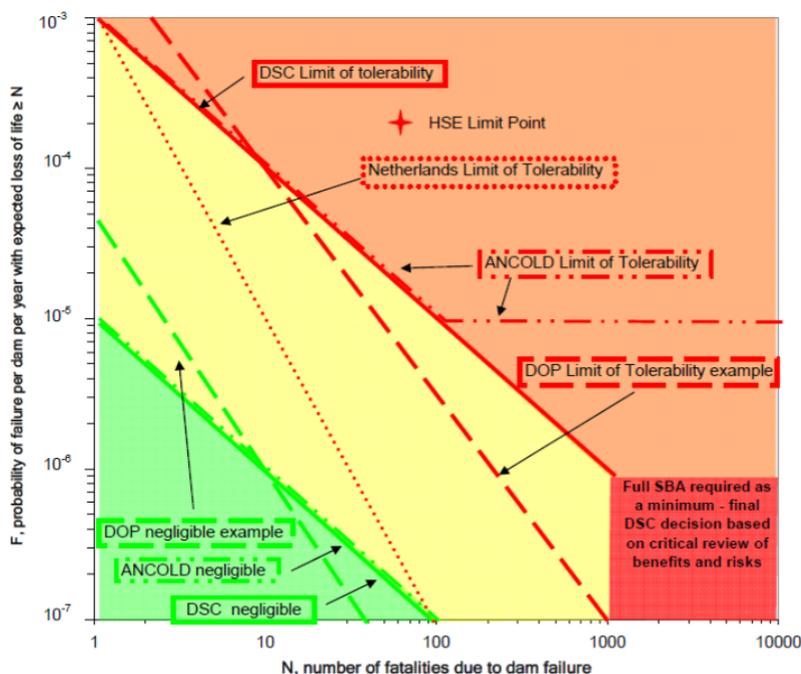
The DSC is also supported by 11 staff, including four engineers and two mining specialists who are seconded from, or employed by, the NSW Office of Water. The DSC also hires temporary contract staff as required.

2.3.5 Dam safety standards

The DSC maintains a combination of prescriptive and guidance based safety standards with which dam owners should comply to meet the DSC's expected levels of investment in dam safety. However, ultimate responsibility for dam safety and liability for any failure rests with the dam owner (DSC 2010e). The consultation undertaken in this review suggested that not all dam owners understand and acknowledge this liability, despite information being available on this subject in guidance notes published by the DSC.

The DSC determines the level of risk – and required remedial action for prescribed dams – based on an interpretation of the ANCOLD guidelines that also acknowledges the stricter conditions imposed by the DoPI (see Figure 2).

Figure 2: Societal risk requirements: Existing dams – Comparison with other industries



Note: DoPI in this figure is labelled DOP.

Source: DSC 2010c.

The DSC uses a two-pronged approach to reducing risk. For dams where risks are considered above the limit of tolerability, prescriptive standards are applied which are based largely on the safety standards specified in the ANCOLD guidelines. Owners of these dams are required to develop a suitable investment strategy to reduce the level of risk below the limit of tolerability.

For those dams in the ALARP risk region, a combination of prescriptive and risk-based standards may be applied, which are implemented through the *Risk Management Policy Framework for Dam Safety*. This framework was developed as part of the review of the form of regulation conducted in 2006. The risk-based framework allows dam owners some flexibility in the timing of, and means of achieving, a level of dam safety consistent with a risk of dam failure deemed tolerable by the community (DSC 2007).

Risk-based standards allow dam owners to temporarily offer a potentially higher risk position than would be set under prescriptive regulation, however, still ensures that safety remains at a level that is ALARP, given economic, financial and other reasonable constraints. If risk-based standards are used, dam owners must demonstrate that both the societal risk and the risk to individuals associated with dam failure are consistent with the DSC’s risk criteria.

For smaller dam owners, however, the use of a risk-based approach may involve greater costs than adopting standards prescribed by the DSC. Stakeholder consultation suggested that smaller dam owners tend to follow the prescriptive requirements.

The standards that are applied to each prescribed dam depend on factors such as whether the dam is new or existing, and the consequences that would result from the dam’s failure.

From a public policy perspective, the dam safety standards should reflect the community's attitudes to risk and the balance between the costs of investments in dam safety and the risks of dam failure. Further discussion of dam safety standards is provided in Section 5 of this report.

2.3.6 Prescribed dams

The DSC has a number of responsibilities, including:

- reporting regularly to the Minister on dam safety issues in NSW;
- contributing to or undertaking inquiries if instructed to do so by the Minister; and
- maintaining a register of dams in NSW.
- Table 1 provides a summary of prescribed dams in NSW as at December 2012 and the ownership of those dams.

Table 1: Prescribed dams in NSW by ownership type

Category of dam owners	Number of prescribed dams
Councils ¹	136
Mining companies	95
Water corporations ²	81
Energy companies	26
Other companies	19
Other state authorities	10
Non-government authorities and other non-state authorities	5
Individuals	4
Total	376

1. There are 61 different councils in NSW that own a prescribed dam and the median number of dams owned by each council is two. Councils owning more than five dams are: Coffs Harbour City Council, Gosford City Council and the Hills Shire Council (six dams each); and Liverpool City Council and Wollongong City Council (11 dams each).

2. This group is dominated by Sydney Catchment Authority (21 dams), State Water Corporation (19 dams), Sydney Water Corporation (16 dams) and Snowy Hydro (15 dams).

Source: DSC 2012.

At present, 19 prescribed dams in NSW are estimated to be in the DSC's 'intolerable' risk region, nine of which are owned by local councils. The DSC expects this number to be reduced by five by the end of 2013.

The regulatory regime in NSW applies over the entire lifecycle of a dam and includes investigation, design, construction, commissioning, operation, modifications and decommissioning. The dam safety processes developed by the DSC apply to prescribed dams. Prescribed dams are those dams that have a significant impact on community interests in the event of a failure (DSC 2010). All dams higher than 15 metres are prescribed. For smaller dams, the DSC determines whether prescription is necessary on the basis of the consequence of dam failure occurring in the:

- event of a natural flood – 'Flood Consequence Category'; and
- absence of a natural flood – 'Sunny Day Consequence' (DSC 2010f).

Dams are categorised in terms of the severity and magnitude in the event of failure of:

- loss of life; and
- damage and loss to property and the environment.

The consequence category is assigned independently of any consideration of the probability of dam failure, as it only relates to the impact of a failure. Consequence categories for a dam can vary over time, for example, if there is new housing development downstream of a dam (which increases the population at risk) or if there are modifications to the dam.

There are seven consequence categories (Extreme, High A, High B, High C, Significant, Low, and Very Low). Table 2 shows how dams are classified into a consequence category. Note that probable loss of life (PLL) is the DSC’s preferred method of classifying dams, whereas population at risk (PAR) and PLL is used by ANCOLD. While both measures consider the potential consequence of a dam failure, PAR is a worst case proxy for loss of life (DSC 2010f).

The DSC states that owners can use PAR when PLL information is not available. The DSC has stated its preference for PLL because it is concerned that PAR may either:

- under-estimate the Flood Consequence Category (FCC) for dams; or
- result in costly safety improvements, particularly in cases where the PAR reside a significant distance downstream from the dam.

The assessment of damage and loss is undertaken in line with ANCOLD guidelines.⁴

Table 2: Consequence categories based on probable loss of life

Probable loss of life	Population at risk	Severity of damage and loss			
		Minor	Medium	Major	Catastrophic
< 0.1	< 1	Very low	Low	Significant	High C
0.1 to < 1	1 to < 10	Significant	Significant	High C	High B
1 to < 5	10 to < 100	Note	High C	High B	High A
5 to < 50	100 to < 1,000		High A	High A	Extreme
50	1,000		Note 1	Extreme	Extreme

Note: The severity of damage and loss would not be minor if the PLL is 1, and it would not be medium if the PLL is ≥50.

Source: DSC 2010f.

⁴ ANCOLD is a non-government organisation dedicated to sharing professional information and knowledge of the design, construction, maintenance, and impact of large dams. It publishes guidelines relating to dam safety management processes and standards. ANCOLD is affiliated with the international organisation, the International Committee on Large Dams (ICOLD).

3. Approach

The NSW Government has decided to review the Act and the DSC in response to concerns that the current regulatory framework leads to an over-investment in dam safety.

To undertake the review, KPMG:

- received specialist technical advice on dam safety and risk standards from GHD engineers; and
- obtained information on dam safety expenditure across jurisdictions within Australia to compare the outcomes in terms of the costs of each regulatory framework.

To develop recommendations for changes to the existing regulatory framework, KPMG:

- benchmarked the form of dam safety regulation across jurisdictions; and
- employed an assessment framework to consider both:
 - better regulation principles developed by the Better Regulation Office (BRO); and
 - options provided by generally accepted models of good regulatory practice.

To inform both questions, KPMG also:

- consulted with industry and government stakeholders at three workshops to understand the issues with the existing regulatory framework and whether the existing framework is responsible for the over-investment in dam safety; and
- developed and distributed two stakeholder surveys (one for dam owners and another for other stakeholders) to understand the costs of dam safety investments and potential improvements in the regulatory framework.

3.1 Limitations of the review

This review is subject to a series of limitations.

- The scope of the consultations was limited to industry and government stakeholders by the ToR. As part of the broader review, further consultation will be undertaken by NSW Trade and Investment to illicit the views of the general community.
- The availability of data for this review was limited due to information not being readily available and at times, information being commercially sensitive. While KPMG has sought and obtained some information from other jurisdictions and larger dam owners in NSW, this information has been insufficient to conduct a complete benefit cost analysis or draw conclusions.

3.2 Assessment framework for this review

In undertaking this review, KPMG developed an assessment framework which is based on the:

- BRO's better regulation principles; and

- experience of regulation in other sectors to assess the existing form of regulation and identify a best practice framework for dam safety regulation.

Specifically, the assessment framework considered the following key elements:



The analysis and recommendations included in this report are based on the application of the assessment framework.

Table 3 outlines the performance of the existing form of regulation against the BRO's better regulation principles. While the existing form of regulation is broadly consistent with the better regulation principles, there are some differences.

Table 3: Consistency of the existing form of regulation with the better regulation principles

Better regulation principle	Existing form of regulation	Consistent with better regulation principles?
<ul style="list-style-type: none"> Principle 1: The need for government action should be established. 	<ul style="list-style-type: none"> The source, scale and nature of the problem and its impacts are well understood through the use of risk assessments for each dam. There is some evidence that the problem would not be addressed by the private market in the absence of government action. 	Yes
<ul style="list-style-type: none"> Principle 2: The objective of government action should be clear. 	<ul style="list-style-type: none"> The government aims to ensure the safety of dams. While this goal is clear, stakeholders are unclear as to the objectives of government action. It is also unclear whether the government's current objectives remain consistent with these actions. 	Partial
<ul style="list-style-type: none"> Principle 3: The impact of government action should be understood by considering costs and benefits of alternatives, including non-regulatory options. 	<ul style="list-style-type: none"> As part of the implementation of the Act, the government of the time considered the costs of dam failures based on examples from other jurisdictions. Given the findings of the CoA and IPART reviews, it is not clear that the current approach to dam safety regulation adequately considers the costs of regulation and potential alternate approaches to addressing this issue. 	No
<ul style="list-style-type: none"> Principle 4: Government action should be effective and proportional. 	<ul style="list-style-type: none"> NSW has a good safety record for dams since the commencement of the Act in 1978. The DSC has been effective in directing investments in dam safety. This may be considered proportional as the regulatory approach is largely driven by dam owners rather than the DSC. However, the perceived over-investment in dam safety suggests that the impact of government actions may be disproportional. 	Maybe

Better regulation principle	Existing form of regulation	Consistent with better regulation principles?
<ul style="list-style-type: none"> Principle 5: Consultation with business and the community should inform regulatory development. 	<ul style="list-style-type: none"> Stakeholders have criticised the DSC for its approach to consultation. Recent changes to the method of prescribing dams were implemented without consideration of the impact on regulated businesses and without sufficient consultation. 	No
<ul style="list-style-type: none"> Principle 6: The simplification, repeal, reform or consolidation of existing regulation should be considered. 	<ul style="list-style-type: none"> The DSC periodically reviews its approach to regulating dam safety. Changes to DSC safety standards in 2007 provided greater flexibility to dam owners in determining the appropriate level of dam safety investment, however, the introduction of the risk-based approach to dam safety standards increased the complexity of dam safety regulation. The broad review of dam safety regulation is considering the appropriate form of regulation of dam safety in NSW including simplification, repeal, reform or consolidation. 	Mostly
<ul style="list-style-type: none"> Principle 7: Regulation should be periodically reviewed, and if necessary reformed to ensure its continued efficiency and effectiveness. 	<ul style="list-style-type: none"> The broad review of dam safety regulation is considering the appropriate form of regulation of dam safety in NSW including simplification, repeal, reform or consolidation. Prior to this review the Act and the DSC had not been reviewed since their inception in 1978. 	Mostly

Source: BRO 2009, KPMG Analysis

The following table outlines the elements of regulation considered throughout this review and compares the existing dam safety regulation framework of addressing these elements with the better regulation principles and approaches used by other selected safety and economic regulators in Australia.

Table 4: Regulatory approach for regulators in different sectors

Element of the regulatory framework	Department of Sustainability and Environment (DSE)	Rural water corporations	Australian Building Codes Board (ABCB)	Australian Energy Regulator (AER)	IPART	DSC	Assessment of best practice for dam safety regulation
Function	Regulator of water corporation dams in Victoria.	Regulators of private dams in Victoria.	Responsible for the National Construction Code (NCC).	Pricing regulator for electricity and gas transmission and distribution.	Pricing regulator for retail water and energy prices, bulk water and public transport in NSW.	Regulator of dam safety in NSW.	The functions of the regulator should be clearly stated and should be understood by stakeholders.
Structure	The DSE is a State Government Department. The DSE administers the relevant legislation on behalf of the Minister for Water and is supported by an advisory committee.	The rural water corporations are state owned water businesses.	The ABCB includes the Federal and State Government Ministers responsible for building regulatory matters. The board consists of sixteen members and the ABCB office which is responsible for managing implementation of the ABCB's decisions.	The AER is an independent board of three members who are statutory appointments. The AER shares staff, resources and facilities with the Australian Competition and Consumer Commission (ACCC).	IPART is an independent tribunal of three members appointed by the Premier of NSW. IPART is supported by a permanent secretariat.	The DSC consists of nine members supported by staff seconded from the NSW Office of Water.	The regulator should be independent of the government and of business. This could be through an independent board, commission or tribunal. The regulator should have access to sufficient staff support and expertise to fulfil its function.
Composition	The regulator is a government department. The Dam Safety Advisory Committee (DSAC) provides advice to the DSE and is composed of experts with water industry backgrounds.	The regulator is the rural water corporation which has been delegated licensing responsibilities. Staff of the regulator are employees of the rural water corporation.	Consists of 16 members, including: <ul style="list-style-type: none"> • a chair; • up to five industry representatives; • a local government representative; and • the head of each Commonwealth, State and Territory Administration responsible for building matters. The ABCB also has two primary technical advisory committees, including the Building Codes Committee and the Plumbing Code Committee.	Consists of three members who are statutory appointments of which one must be a commissioner of the ACCC. The Commonwealth appoints one member and the States and Territories appoint the remaining two.	Consists of three members appointed by the Premier of NSW. In general, this consists of a Chair, a full-time member and a part-time member.	Consists of nine members appointed by the Minister administering the Act on the nomination of stakeholders. Consists of: <ul style="list-style-type: none"> • six members nominated by public dam owners; • two members representing the Federal Council of the Institution of Engineers Australia; and • a nominee of the Minister administering the Mining Act. 	Membership size should balance the competing needs of obtaining sufficient expertise to make robust decisions and encouraging an efficient decision making process. Appointments should be made by the government according to specific criteria.

Element of the regulatory framework	Department of Sustainability and Environment (DSE)	Rural water corporations	Australian Building Codes Board (ABCB)	Australian Energy Regulator (AER)	IPART	DSC	Assessment of best practice for dam safety regulation
Expertise	The DSAC consists of members appointed based on their expertise in dam safety, risk management, economics and business management and water industry experience.	As water corporations own dams regulated by the DSE, the regulator has water industry expertise.	The Board consists of members with industry experience as well as regulatory experience from all levels of government. The advisory committees consist of various regulatory authorities and industry representatives with relevant expertise in building regulation and the construction industry.	Board members are appointed based on their experience in regulation.	Members are appointed for five years on the basis of knowledge and understanding of economics, the interests of consumers and the interests of suppliers of services (including the interests of the government as a supplier of services).	Eight members are required to have dam engineering expertise. One member is required to have mining engineering expertise.	Expertise should be diverse enough to enable consideration of all aspects of dam safety regulation. This may include expertise in engineering, planning, mining, risk assessment, corporate finance or economics.
Powers	The DSE maintains regulatory oversight of dams owned by water corporations with an ANCOLD Consequence Category of "significant" or above. Water corporations provide annual status reports of the management of these dams to the DSE.	The water corporations issue works licences for works on dams and monitor compliance against licence conditions and safety requirements over the lifecycle of the dam.	The ABCB's responsibility is to prepare and publish the NCC on behalf of the three levels of government. Compliance is generally the responsibility of individual states and territories.	Determines access prices for energy distribution and transmission networks.	Among other roles, IPART determines prices for retail and bulk water in NSW.	Sets safety standards and monitors compliance of dams with published standards (for more detail see Section 5)	The powers of the regulator should be sufficient for the regulator to fulfil its function and address market failures. Regulators should not have powers that extend beyond the demonstrated need for regulatory intervention.
Coordination with other regulators	Shares responsibility for dam safety regulation with the rural water corporations. Pricing of water supplied by water corporation is conducted by the Essential Services Commission. This can impact investments in dam safety.	Shares responsibility for dam safety regulation with the DSE.	A large number of regulatory authorities are members of the Board or the technical advisory committees.	Coordinates with retail price regulators such as IPART. Shares resources, staff and facilities with the ACCC. Rules for energy markets which are in part administered by the AER are developed by the Australian Energy Markets Commission (AEMC).	Coordinates with the AER who determines network access prices. Considers safety information provided by safety regulators such as the Independent Transport Safety and Reliability Regulator (ITSRR).	Impacted by DoPI decisions in development approvals. Shares responsibility for approval of mining approvals near prescribed dams under the Mining Act. Shares responsibility for approving DSEPs with State Emergency Services (SES).	Where regulators share responsibility for an industry, the roles and responsibilities of each regulator should be clearly defined. Regulators should coordinate to ensure that their decisions result in effective regulatory outcomes which address the need for government intervention.

Source: ABCB, AER, DSC, DSE, IPART, KPMG analysis

4. The regulatory framework

This section considers the existing regulatory framework and its consistency with the better regulation principles and other forms of regulation. In particular, this section considers the:



4.1 Level of government intervention

The level of government intervention in dam safety should be determined by the approach required to address the market failures. In general, a lighter approach is preferred if it leads to the level of dam safety investment deemed optimal by society.

For this review, an options analysis was undertaken to examine alternate regulatory models for the Act and the DSC that the NSW Government could consider. This is consistent with Principle 3 of the better regulation principles, which requires that costs and benefits of alternate regulatory and non-regulatory options be assessed when determining the appropriate form of regulation.

Four options considered in this section are:

- **Self regulation, consistent with the approach used in Western Australia.** This would involve removing the Act and the regulator in its current form, with responsibility for dam safety standards reverting to individual dam owners. Under self regulation, dam owners would be responsible for determining the levels of investments in dam safety and the approaches to achieving these levels of safety.
- **Increased regulation, consistent with the approach used in California.** This would involve endowing the dam safety regulator with the powers to determine, oversee and approve all aspects of dam safety. This may include greater ability to amend investment plans and enforce decisions and power to require that dam owners undertake investment that the regulator considers necessary.
- **Moderate regulation, based on the existing approach used in NSW,** with some amendments to the regulatory framework to improve, for example, the transparency and accountability of the dams safety regulator.
- **Moderate regulation, based on the approach used in Victoria.** The regulator would retain its responsibility for the setting of safety standards for all dams. The regulator would

maintain a compliance and monitoring role. The extent of monitoring would be determined through a risk based approach on the basis of the risk of non-compliance.

4.1.1 The need for government intervention

The better regulation principles state that the need for government intervention in a market should be established before regulatory options are considered. Where regulation is found to be necessary, a light handed approach is preferable if the outcomes are similar to a heavy handed approach given the higher costs for government and regulated entities of heavy handed regulation (BRO 2009). Those with smaller, low consequence dams may be more likely to under-invest in dam safety where they may have restricted resources (e.g. farm dams and dams owned by councils). This could be the case where the expected consequences are restricted to damage to property, the environment, assets, and amenity rather than loss of life.

Although this under-investment may reflect willingness by dam owners to accept the legal consequences of dam failure (e.g. liability to pay compensation), it may not reflect the preference of society. For example, society may prefer prevention to compensation, particularly where compensation paid does not adequately reflect the costs to downstream populations, property and the environment.

A recent paper by Dr John Pisaniello of the University of South Australia noted the high number of farm dam failures and argued that reliance on the Common Law responsibility for landholders to maintain dams does not achieve an acceptable level of dam safety (Pisaniello 2010). While farm dams may not always be classified as low consequence, the failure of small dams upstream from a prescribed dam may increase the risk of failure of these prescribed dams.

4.1.2 Balanced approach to government intervention

Less regulation is generally preferred where safety outcomes are likely to be unchanged, however, the section above suggests that:

- significantly less intervention would not be expected to result in improved dam safety outcomes; and
- self-regulation may result in the deterioration of dam safety, particularly for small dams whose operators and owners may be less informed and less resourced.

Importantly, industry stakeholders, including dam owners, did not show a preference for self-regulation.

The dam safety record in NSW (see Appendix C.1) suggests that an increased level of government intervention is unlikely to provide material improvements in outcomes. This suggests that a balanced approach to government intervention is appropriate to deliver acceptable dam safety outcomes. The table below compares the characteristics of the four options outlined above to criteria based on the assessment framework (see Section 3.2).

Table 5: Characteristics of regulation under different models

Criteria	Self regulation	Increased intervention	Moderate intervention – NSW approach	Moderate intervention – Victorian approach
Equity	Potentially. Legal liability provides incentives for owners to reduce risks to the community.	Yes. Government determines a mix of regulator and ANCOLD guidelines and ALARP principles.	Yes. Owners comply with a mix of regulator and ANCOLD guidelines and ALARP principles.	Yes. Owners comply with a mix of ANCOLD guidelines and ALARP principles.
Efficiency (cost) Resources and expenditure on dam safety are in balance with the level of risk being managed.	No. Lower investment may result in negative externalities to the community.	No. Risk-based principles not used, which may lead to over-investment in dam safety.	Partial. Large dams may not be least cost without a benefit cost analysis. Small dams meet ANCOLD guidelines.	Yes. Large dams conduct a benefit cost analysis for investment. Small dams are likely to meet ANCOLD guidelines.
Transparency Regulators and managers of dam portfolios provide clear and balanced information to the community about dam safety.	Potentially. Regulatory monitoring can increase transparency for large dams.	Potentially. Public process for decision making through the regulator is transparent.	Potentially. Public process for decision making through the regulator is transparent.	Potentially. Information released by the regulator can increase transparency for all dams.
Consistency Dams with similar risk levels or consequences are subject to comparable safety requirements without regard for dam ownership or use.	N/A No safety requirements are outlined. However the presence of legal liability suggest that the ANCOLD guideline are likely to be met.	Yes. Dam safety investments are prescribed by the regulator.	Yes. Dams are categorised according to consequence of dam failure. Consistent approach to all dams within categories.	Yes. Dams are categorised according to the risk of non-compliance. Consistent approach to all dams of similar risk of non-compliance.

Criteria	Self regulation	Increased intervention	Moderate intervention – NSW approach	Moderate intervention – Victorian approach
Tort liability Legal responsibility is placed on dam owners in the event of dam failure.	Yes.	Yes.	Yes.	Yes.
Level of cooperation The regulator maintains a cooperative regulatory culture. Including providing guidance to dam owners and fostering partnerships with industry and other regulators.	No.	No. The regulator takes a leading role in developing service standards and dictating investment requirements.	Yes. Regulators provide guidance to owners for required dam safety improvements.	Yes. Regulators provide guidance to owners for required dam safety improvements.
Level of regulation The extent to which the government intervenes in the provision of dam safety.	Minimal. Administrator role.	Heavy. All actions directed.	Moderate. Assess and approve.	Moderate. Monitoring and compliance role. Extent of intervention based on a risk based approach to regulation.
Responsibility of dam owners	Heavy. Dam owners are responsible for determining safety levels, the approach to meeting these safety levels, and undertaking dam safety investments.	Minimal. Dam owners are responsible for the cost and implementation of dam safety investments.	Moderate. Dam owners are responsible for determining the approach to meeting safety standards (subject to approval) and undertaking dam safety investments.	Moderate. Dam owners are responsible for determining the approach to meeting safety standards and undertaking dam safety investments.

Criteria	Self regulation	Increased intervention	Moderate intervention – NSW approach	Moderate intervention – Victorian approach
Responsibility of government	Minimal/None. No responsibility for setting dam safety standards. Potential supervisory information provider role.	High. Responsibility for setting dam safety standards, and dictating the design and planning of dam safety investments.	Moderate. Government is responsible for outlining safety standards. Government is responsible for monitoring compliance with safety standards and approves investment plans set by dam owners.	Moderate. Government is responsible for outlining safety standards. Government is responsible for monitoring compliance with safety standards.

Source: KPMG analysis.

The findings of this review suggest that a balanced approach to government intervention is appropriate for dam safety regulation. There appears to be greater evidence to support intervention for dams with a high risk of non-compliance, and the experience of New Zealand and South Australia suggests that this often applies to smaller dams. Victoria has adopted an approach where large dam owners are responsible for ensuring compliance with published standards. A similar approach would be appropriate for NSW. There is also greater scope for investment decisions to be based on benefit cost analysis, which can help to reduce costs to dam owners, and in turn, consumers.

Under an approach similar to that of Victoria, the regulator would:

- develop and publish safety standards and guidelines for dams in NSW;
- provide information necessary for dam owners to achieve the expected level of safety and to comply with dam safety guidelines;
- monitor compliance with the safety standards and guidelines; and
- take remedial action where dam owners are found to be non-compliant and are not expected to become compliant without regulatory intervention.

All dams would be subject to a single regulatory framework. Broadly, dams with a high risk of non-compliance would be subject to more monitoring compared to dams with a lesser risk of non-compliance. This would balance the need to ensure that dams comply with safety guidelines with the need to reduce the regulatory burden for dam owners.

Dam owners would be responsible for developing their own strategies to comply with the dam safety guidelines, with a focus placed on the evaluation of investments in dam safety within a benefit cost analysis framework. Dam owners would report on their enforcement measures to the regulator on an annual basis.

Where dam owners are non-compliant, the regulator would compel the dam owner to develop a compliance implementation plan to undertake an appropriate investment to improve compliance.

Incorporating benefit cost analyses into the determination of the appropriate level of dam safety investment would ensure that the economic impact of available options has been considered. It is also a useful tool in identifying the ALARP level of risk.

4.2 Objectives of the Act

Prior to the introduction of the Act, the government's ability to control safety outcomes and to intervene during emergencies was limited, particularly for privately operated dams. When the Act was first introduced to Parliament, the government's objectives of ensuring dam safety were motivated by global concerns. As part of the second reading of the Bill on 8 March 1978, the Minister for Public Works referenced the failure of the Teton Dam in Idaho in 1976, which caused the loss of 11 lives and a private dam failure in Toccoa, Georgia in 1977, which resulted in 34 fatalities (Hansard 1978).

The government of the time stated the following purposes of the Act:

- to ensure the safety of dams against the possible loss of life or property associated with a dam failure; and
- to assume an even more positive role by making legislative provision for all dams, whether they be public or private, to be subject to independent expert surveillance on the safety of the dams, including the design, construction and operational procedures associated with the dams.

The objectives of the Act were to introduce a role for government in protecting the community from the costs of dam failure and to ensure a level of investment in dam safety consistent with society's expectations (Hansard 1978).

The Act constitutes the DSC and outlines the DSC's functions relating to the safety of certain dams. In its current form, the Act does not specify the objectives of the DSC with regard to dam safety, but describes the constitution and functions of the DSC. Over time, the DSC itself has defined its role and objectives.

As part of the online survey conducted by this review, stakeholders were asked what they considered to be the most important objective of dam safety regulation. The most common responses were:

- 'to maintain dam safety standards to protect populations that live downstream' (41 per cent of respondents); and
- to 'manage risks around dam safety to a level consistent with community risk preferences' (30 per cent).

These responses suggest stakeholders' perceived objectives of the Act are similar to the original objectives of the Act.

4.2.1 Stakeholder consultation on the objectives of the Act

Stakeholder suggestions for improvements to the objectives focused on two main areas:

- providing greater clarity of the objectives of dam safety regulation in the Act, including defining the objectives of the DSC; and
- including additional objectives for the DSC in the Act.

Government workshop participants also considered these matters to be particularly important.

The online survey questioned the importance of including objectives within the Act. Responses were mixed, with:

- 53 per cent of responses suggesting that the Act should be changed to include objectives; and
- 40 per cent stating that the Act is appropriate in its current form.

In addition, stakeholders were asked whether it was most important to:

- include the DSC's objectives in the Act;
- include specific regulations in the Act;
- introduce new powers for the regulator; or
- introduce community consultation requirements.

The inclusion of objectives was ranked by the respondents as the most important of these alternatives.

Specific items nominated for inclusion in the Act included:

- requirements imposed on owners by the DSC, in particular rules around the use of risk-based approaches and when risk-based approaches are appropriate;
- definition of the ALARP principle in the Act to provide greater clarity to dam owners; and
- regulatory requirements and details of the regulatory framework.

The DSC has issued a number of publications on all aspects of its operations, including detailed guidance notes, annual reports, and its interpretation of its objectives. Many stakeholders appear unaware of the availability of this information. While this review has found that the Act should be amended to provide greater clarity to stakeholders, these issues could be addressed by improved communication between the regulator and dam owners. In addition to the changes to the Act discussed above, stakeholders requested that the objectives of the regulator include other matters for the regulator to consider in its decisions, including:

- water security and the safety of drinking water;⁵

⁵ This was raised in workshops and in surveys, particularly in relation to the impact of mining activities on the water stored in dams. However, another stakeholder did not support a role for the dams safety regulator in regulating water quality.

- a need for transparency of the costs and benefits of dam safety; and
- the safety and environmental concerns of communities in close proximity to dams.

Providing more clarity in the Act regarding the appropriate use of benefit cost analysis would be consistent with the recommendations made in Section 5. This approach may reduce the scope for over-investment in dam safety.

4.2.2 Recommended changes to the Act

The findings of this review support stakeholders' requests that the objectives for dam safety, and the preferred method of achieving safety levels, should be clearly articulated in the Act. The provision of clear public policy objectives is important to signal the government's expectations and the expected outcomes of regulation. It is also a key component of the better regulation principles and the assessment framework for this review.

Clear objectives may assist in ensuring the regulatory approach is consistent with the intent of the regulation and the issues it aims to address as well as any relevant government policies. In addition, providing greater clarity in the Act would reduce risks of confusion for stakeholders.

Consistent with these principles and views expressed by stakeholders and to clarify the objectives of dam safety regulation, the government should consider the following amendments to the Act:

- **Amendment 1:** clarify objectives of focussing on achieving socially acceptable levels of risk reduction in relation to stored waters in NSW, and for risk reduction to be achieved in the most efficient manner possible (i.e. avoiding a singular focus on dam engineering solutions).
- **Amendment 2:** specify the regulatory body or bodies that are responsible for:
 - setting dam safety standards;
 - evaluating proposals for dam upgrades; and
 - ensuring compliance with these standards.
- **Amendment 3:** clearly specify the level of authority given to the regulatory body or bodies mentioned above, including enforcement measures and the consistency of these measures with responsibilities assigned to regulators.

The first amendment would require the costs of dam safety investments be considered where the risk is tolerable to the community.

The second amendment is consistent with transparent regulation, which is an important component of the assessment framework for this review. Feedback from stakeholders suggested some confusion about the role of the DSC. Some stakeholders saw the DSC as a supervisory body with oversight functions whereas others assumed that meeting regulatory requirements would remove their legal liability for dam failure. This suggests that some believe that the regulator has a more interventionist role with greater powers, than the Act infers.

The third amendment aims to ensure that a regulator has access to enforcement powers consistent with its role.⁶

The government should also give consideration to the appropriate method of implementing these changes, including whether the changes:

- are made in the Act or in accompanying regulations; and
- may be incorporated in other acts (e.g. the Mining Act) or whether these changes could be consolidated into a single act.

4.3 Governance framework

As discussed in Section 2.3.1, the Act sets out a high-level framework for the management of dam safety in NSW by establishing the legal basis for the DSC as a statutory body representing the Crown.

Currently, the DSC is the NSW regulator for dam safety and determines which dams are to be prescribed (currently 376 dams). Prescribed dams are those for which failure would “*threaten lives or have significant economic impacts or cause serious environmental damage*” (DSC 2012).

Section 4.1 above established the need for continued regulation of dam safety. This section considers a best practice approach to regulation and regulatory governance for dam safety in NSW. KPMG has considered a number of options for the structure of the regulator. Analysis of these options has been informed by the assessment framework and precedents set out in Section 3.2. The regulator of dam safety in NSW could be structured as:

- a single regulator supported by staff;
- a committee which could have many members or fewer, such as a tribunal or commission, supported by a secretariat (i.e. the current model);
- a government department; or
- a regulator supported by an advisory committee.

The DSC is currently supported by staff of the NSW Office of Water. Examples of other regulators include:

- IPART, which regulates prices of many utilities and other services in NSW, is a tribunal supported by a secretariat;
- DoPI, which is a government department responsible for implementing government policies regarding planning and developments in NSW; and

⁶ The maximum penalty the DSC can levy (currently \$1,100) is small relative to the cost of dam safety upgrades. However, it is consistent with the potential penalties in Victoria, where the penalty for failing to comply with a direction under Section 80 of the *Water Act 1989*, is currently over \$2,800.

- the DSE in Victoria, which regulates dam safety and is supported in an advisory role by the Dam Safety Advisory Committee (DSAC), which consists of members with water industry expertise.

Further examples of governance arrangements for dam safety regulation in other jurisdictions are outlined in Appendix C.

The sections below consider the composition, expertise, funding and powers of the regulator and develop recommendations that meet objectives of a regulator that:

- is independent of business;
- makes its decisions independently of government; and
- has the required expertise to provide high quality regulatory decisions.

Table 6 below provides examples of precedents by summarising the levels of expertise and industry representation for regulators of dam safety in NSW and Victoria as well as the regulation of building codes in Australia.

Table 6: Composition and expertise of dam and building safety regulators in Australia

	DSC (NSW)	DSAC (Victoria)	Australian Building Codes Board (Australia)
Number of members	Nine	Four	16
Composition	<ul style="list-style-type: none"> • Six members appointed to represent public enterprise which own dams, including electricity generators, water businesses and local councils. • Two members appointed to represent the Federal Council of the Institution of Engineers Australia. • One member appointed to represent the Minister administering the Mining Act. 	<ul style="list-style-type: none"> • Three members with water industry experience not currently associated with dam owners in Victoria. • One member associated with Southern Rural Water. 	<ul style="list-style-type: none"> • Chairperson. • Up to five industry representatives. • The head of each Commonwealth, State and Territory Administration responsible for building matters. • A representative of the Australian Local Government Association.

	DSC (NSW)	DSAC (Victoria)	Australian Building Codes Board (Australia)
Expertise	<ul style="list-style-type: none"> • Eight members with dam engineering expertise. 	<ul style="list-style-type: none"> • Members appointed based on their expertise in dam safety, risk management, economics and business management and water industry experience. 	<ul style="list-style-type: none"> • Members are supported by two technical advisory bodies, the Building Codes Committee and the Plumbing Code Committee which includes regulators and industry.

4.3.1 Composition and structure of the DSC

Best practice suggests that a regulator should be independent of both regulated entities and government. A regulator that is independent of regulated entities is less likely to be subject to real or perceived conflicts of interest. The DSC is not currently independent of business, given that a number of its members represent large dam owners.

A regulator that makes decisions independently of government is less likely to be subject to real or perceived political influence. An independent regulator may also have greater ability to consider long term matters of public interest when making decisions. This may be particularly important in the regulation of dam safety, where the assets being regulated have very long lives and investments are often made once per generation.

Regulators are generally reliant on legislation enacted by government for their powers. The structure of the regulator can assist independence. For example, IPART is a NSW Government agency within the Department of Premier and Cabinet, but is constituted to act independently of government. Alternative structures may be used if appropriate measures are established to ensure independence of decision making.

Safety regulation for large dams in Victoria is conducted by DSAC, which has a light handed monitoring role. Regulators with more determinative powers (e.g. the AER and IPART) are constituted to act independently of government.

Where a government department is the regulator, enhanced accountability might be achieved through establishment of an independent advisory group to inform the regulator's decisions.

To ensure that the composition and structure of the regulator aligns with the better regulation principles and best practice, the regulator should:

- be independent from the businesses it regulates;
- be composed of representatives of relevant government agencies to ensure complementarity and efficiency in risk reduction strategy development; and
- have access to independent expertise beyond engineering, such as public infrastructure including risk management strategy and expertise in benefit cost analysis.

A dam safety regulator that incorporates an advisory panel and the other attributes described above would address concerns identified during stakeholder consultations, including insufficient representation from:

- the mining sector;
- local government - in light of the number of dams owned by councils and because NSW Public Works no longer represents the interest of councils, as was intended when the DSC was formed; and
- risk experts.

4.3.2 Broader expertise for the dams safety regulator

The required expertise of the regulator and how this is to be sourced should be considered when determining the appropriate form of regulation. Currently, the Act requires that one member of the DSC has expertise in mine engineering, while all other members have dam engineering expertise.

An alternate approach, as outlined above and used by the DSE and the ABCB, would be for the regulator to be advised by a committee that comprises a wider range of expertise.

A move to risk based assessments and benefit cost analysis suggests that the regulator would benefit from access to broader skill sets and perspectives (e.g. economics and risk experts). This would enable the regulator to consider factors beyond the probability of dam failure. For example, including economic expertise would enable consideration of the efficient costs of dam safety investment.

4.3.3 Funding of the DSC

The funding of the DSC should be considered in conjunction with the composition of the DSC. Under the current arrangements, large dam owners who nominate members to the DSC fund the costs of their respective representatives. This poses risks to independence and to a fair apportionment of the costs of regulation between regulated bodies. If large dam owners were not providing this in-kind contribution, costs to the government would increase. A stakeholder suggested that a different model may be appropriate, such as a system where licensing revenue from dams funds the DSC.

In addition to the contribution of industry representatives, the remaining cost of the DSC in FY2012 was met as follows:

- \$1.3 million in funding from the NSW Government; and
- \$356,000 in revenues from other sources (including interest).

The structure of the revenue framework could be more efficient if it were to derive revenue from dam owners in proportion to the costs of regulation that they generate. In other sectors, funding is typically structured such that government guarantees funding which it in turn recovers from regulated bodies. This manages risks to the regulator's independence which would arise if the regulator were exposed to risks of non-payment of funding by the bodies it regulates.

A more detailed study of any revised funding approach would need to be conducted to determine how any revised regulatory cost burden could be fairly apportioned to regulated dam owners.

As part of the next phase of consultation, the government should consider seeking community and stakeholder feedback on the appropriate funding method for the dam safety regulator.

4.3.4 Powers of the DSC

The DSC argued that it is currently limited in its ability to enforce decisions. Consequently, its ability to regulate is hampered by the lack of significant penalties. Further, the DSC's emergency powers do not provide a proactive regulatory tool. The DSC would prefer to have the ability to impose more effective penalties. Support for this was mixed:

- almost three-quarters of dam owners who responded to the online survey indicated that the DSC's current powers should be maintained at existing levels; while
- a majority of other respondents thought that the regulator should have an oversight role and rely on assessments provided by the owner rather than have a more interventionist role. One stakeholder's opinion was that the DSC was intended to be an *"industry watchdog and not a decision maker"*.

Dam owners and non-dam owners responded differently to the question regarding whether the regulator should have extended powers to enforce safety measures. Seventy-four per cent of dam owners who responded believed that, if the DSC were to remain as regulator, its powers should not change. Only 29 per cent of non-dam owners believed that this should be the case, with 64 per cent supporting an increase in the DSC's powers.

The current maximum penalty that the DSC can levy is small relative to the cost of investments in dam safety. The better regulation principles suggest that regulation should be proportional and effective. This is consistent with the assessment framework, which suggests that regulators' powers should be limited to the level necessary to address the market failures that regulation intends to address. Where regulation is limited in this way, the costs of regulation to the government and businesses is reduced and there may be less scope for over investment.

There is little evidence to suggest that dam owners do not comply with DSC guidelines. The available evidence suggests that the existing penalties are sufficient to encourage dam owners to invest in dam safety according to the regulator's requirements. This review has therefore not recommended an increase in the powers of the dam safety regulator.

4.4 The provision of information

As discussed in Section 2.3.1, the DSC provides information to stakeholders as part of its responsibilities for the regulation of dam safety. This includes:

- information on whether dams are prescribed and the consequence category of each prescribed dam;
- guidance sheets on aspects of dam safety regulation, including the current DSC process and requirements and responsibilities of dam owners, miners and other stakeholders; and
- responses to proposed dam safety upgrade plans submitted by dam owners.

The ability of the DSC to provide, keep and furnish information is specified in Section 15 of the Act, however, there is a lack of clarity regarding requirements for the DSC to provide the information listed above.

The provision of information by the dam safety regulator is important to reducing the impact of information asymmetries identified in Section 2.2. and to providing transparent and consistent decision making.

Feedback from the workshops suggested there are issues surrounding the provision of information between the DSC, its stakeholders, and in particular dam owners. The communication gap appears throughout the regulatory process, including when dam owners present applications and after decisions have been made.

The main issues raised by stakeholders were:

- a lack of clarity around where a risk-based approach based on ALARP can be used and where ANCOLD standards must be met;
- the DSC could better explain ALARP to dam owners who struggle to apply the principles for dams. Some large dam owners use risk assessments, but it was suggested that these are not of an appropriate standard;
- greater consultation is required with dam owners during the decision making process;
- there should be greater transparency of the DSC's decisions and reasoning after decisions have been made;
- the DSC should refrain from using emotive language, such as "deficient dams", in its recommendations; and
- the DSC should improve the communication between itself and other parts of the government.

4.4.1 Stakeholder understanding of the regulatory framework

A number of the issues and suggested improvements raised by stakeholders regarding the process of providing information between the dam safety regulator and stakeholders are already in place. In particular, the DSC's guidance notes provide information on the regulatory framework, including technical information on the approach dam owners should take in the design and implementation of safety related dam upgrades.

The reported disconnect between dam owners and the DSC suggests that it is important to emphasise existing forms of information provided by the DSC to dam owners. The dam safety regulator could implement programs to improve industry awareness of the risk-based approach to dam safety. In particular, the dam safety regulator should identify:

- where the risk-based approach is more appropriate than prescriptive standards;
- the information required by the regulator to review proposed dam safety upgrades; and
- how to use the ALARP principle in the design of dam construction and upgrades.

An option for the regulator to improve the level of information is to distribute copies of the guidelines to all dam owners in NSW, as has been done in Victoria and the United States.

4.4.2 Increasing the scope for consultation

In addition to the above, stakeholders raised concern about the level of consultation during the review process and the clarity of the DSC's decision making process. The better regulation principles emphasise the importance of clarity and transparency of decision making processes.

The regulator should improve the current approach to providing information to stakeholders by:

- being proactive in requesting information necessary for its decision making process. This may be through the use of information requests, publishing review checklists or other approaches considered necessary by the regulator;
- publishing its statement of reasons for each review. The statement should clearly outline the regulator's review process, the issues it considered and any other relevant information required to explain its decision to approve or deny a proposed dam safety investment; and
- publishing a draft statement of reasons for each review. The draft statement of reasons should include the regulator's draft decision, which would include any information expected to be added in the final statement of reasons. The regulator should request that the dam owner and other stakeholders provide a response to the draft statement of reasons. These submissions should be considered by the regulator in making its final decision.

Given that these options may reduce the timeliness of the regulator's reviews and potential resource constraints, it would be reasonable for these options to be implemented for high priority reviews only (i.e. for dams with higher consequence categories).

4.4.3 Changing dam safety guidelines

Feedback provided by stakeholders suggests that the DSC's current approach to releasing information has not always resulted in timely information provision. For instance, one stakeholder noted that the process of determining the consequence categories for dams was changed in November 2012, but the new guidelines were not published on the DSC website until recently. In addition, the stakeholder noted that the guidelines were changed without notice or consultation.

There were also concerns about changes to guidelines with little consultation and consideration of the impacts on regulated businesses. The changes were based on changes to the ANCOLD guidelines which were adopted by the DSC. It is not clear to what extent NSW-specific factors were considered by the DSC when determining whether to adopt these guidelines. This is not consistent with Principles 3 and 5 of the better regulation principles.

Where the regulator or the government proposes changes to regulation, it is good practice for these to be subject to consultation with dam owners and other interested stakeholders. In addition, understanding the impact of regulatory change in terms of costs and benefits of alternate options, including non-regulatory options, is considered best practice.

The better regulation principles suggest that at least 28 days should be allowed for industry consultation, which should seek stakeholder views on:

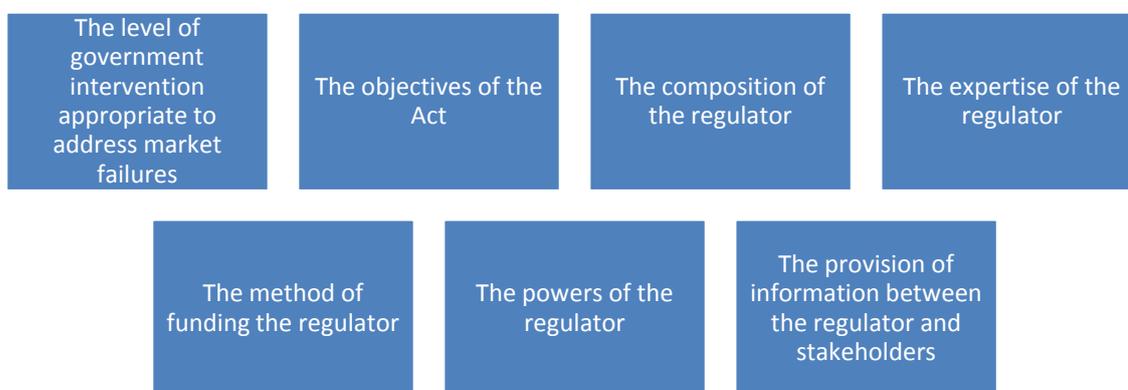
- whether proposed changes would impose unreasonably high costs on dam owners; and
- the approach, with regard to seeking stakeholder views and forming decisions, taken in implementing the change in guidelines.

The regulator should also consider the views of industry and other stakeholders when making its final decision to implement changes to dam safety regulation. When reaching its decision, the regulator should release a report explaining its decision making process and the information it considered in making its decision. In addition, the report should specify:

- the expected impacts of the change on dam owners; and
- any changes to the procedures for obtaining approval for proposed dam safety investments.

4.5 Summary of recommendations

The list below provides a summary of the recommendations outlined in this section. These recommendations refer to the following aspects of dam safety regulation:



These recommendations have been developed based on the assessment framework outlined in Section 3.2. KPMG has considered the better regulation principles and the approach to structuring regulators in other jurisdictions and sectors in its analysis.

Recommendation 1: *The Act should be amended to provide clarity in relation to the objectives of the legislation and the role and powers of the dam safety regulator. The objective should be to achieve socially acceptable levels of public safety risk in relation to stored waters in NSW and the regulatory framework should enable risk management to be achieved in the most efficient manner possible (i.e., consideration being required to be given to the broadest range of relevant operational strategies and thereby avoiding a singular focus on dam engineering solutions).*

Recommendation 2: *The dam safety regulator should be responsible for monitoring the compliance of dams with standards and guidelines. The regulator should determine the level of monitoring necessary for each dam based on the likelihood of non-compliance.*

Dam owners should be responsible for compliance with standards and guidelines. The regulator should not be involved in the development of compliance strategies or in identifying particular dam safety upgrade strategies. Dam owners should report to the regulator annually on the level of compliance being achieved by their maintenance and upgrade programs.

If dam owners do not comply with standards, the regulator should have clear powers to compel dam owners to implement changes necessary to meet required standards and guidelines.

Recommendation 3: *The government should change the composition of the dam safety regulator so that it:*

- *is independent of the businesses it regulates;*
- *is composed of representatives of relevant government agencies to ensure integration, complementarity and efficiency in risk reduction strategy development (for example, NSW Treasury, Department of Planning and Infrastructure, Department of Trade and Investment Resources and Energy and the NSW State Emergency Service (SES)); and*
- *has relevant independent expertise, including dam engineering, public safety risk management and benefit cost analysis.*

Recommendation 4: *It is recommended that the dam safety regulator be funded by relevant risk creators, which in this case are all the owners of prescribed dams in NSW.*

Recommendation 5: *The regulator should be required to achieve high levels of public transparency with respect to the basis of its regulatory standards and the respective roles of dam owners versus government. This transparency will make clear the legal liability of dam owners and in so doing encourage levels of private investment in dam safety that align, as far as possible, with the risk preferences of the broader community.*

Recommendation 6: *Where the dam safety regulator proposes changes to dam safety regulation, these changes should be subject to consultation with dam owners. Best practice principles suggest a consultation phase of at least 28 days.*

Recommendation 7: *The dam safety regulator should consider the views of industry and other stakeholders when making final decisions to implement changes to dam safety regulation. When reaching its decision, the regulator should release a report explaining its decision-making process and the information it considered in making its decision.*

5. Safety standards

All else being equal, higher safety standards will require greater investment than lower standards. The appropriate level of government intervention is also informed by the level of safety standards, as government intervention is justified by the market's failure to meet the community's preferred levels of safety.

As outlined in the approach and illustrated below, key consideration of this review is the appropriate level of safety standards for prescribed dams regulated by the DSC. Failures of prescribed dams are considered to have serious consequences, thereby requiring higher levels of dam safety and monitoring.



The appropriate safety standards would be those consistent with the level of risk deemed tolerable by the community, as has been discussed earlier in this report. At this level, there is a balance between the costs of dam safety investments to the community and the risks to the community of a dam failure.

This section briefly outlines the appropriate level of safety standards for dams and is based on a report drafted by GHD for this review, *Dams Safety Committee – Review of Risk Management Framework*. The full version of this report is attached at Appendix D.

The sections below discuss:

- why it is necessary to measure risk;
- how risk is measured in dams regulation;
- the current approach to risk taken by the DSC;
- the differences between DSC standards and standards elsewhere in Australia; and
- the impact of these differences on dam safety investment in NSW, Victoria and Queensland.

5.1 Measuring the risk and consequences of dam failure

Safety standards for dams are set by regulators to ensure that dam owners invest in protecting downstream communities and ecosystems from the risk of dam failure. Safety standards are set as a function of the risk, which is the product of:

- the annual probability of dam failure for all events; and

- the consequence of dam failure for each event in terms of:
 - potential loss of life;
 - loss or damage to property;
 - environmental damage;
 - health and social impacts; and
 - economic losses.

Measuring risk allows the development of a framework for the regulation of dam safety investments so that the costs of dam safety reflect the risk of dam failure. There are two types of risk considered as part of dam safety regulation:



Both forms of risk are considered in the existing ANCOLD guidelines on risk assessment and the DSC Risk Policy.

5.1.1 Individual risk

Individual risk is the risk experienced by an individual in a given time period. It reflects the time spent at risk for the individual and the severity of the consequences faced by the individual. As mentioned in the GHD report, there are three ways to measure individual risk:

- location-specific individual risk, which is the risk for a hypothetical individual who is positioned in a particular location 24 hours a day, 365 days per year;
- individual-specific individual risk, which takes into account variable locations for the hypothetical individual; and
- average individual risk, which calculates the number of fatalities compared with the total number of people at risk.

5.1.2 Societal risk

Societal risk is the risk experienced by a population that will be affected by failure of the dam. Societal risk is the relationship between the cumulative annual probability of dam failure and the number of fatalities realised as a result of a dam failure.

Societal risk can be measured by annual fatality rates or FN curves, which plot the relationship between the cumulative annual probability of dam failure and the number of lives at risk. Given its focus on the number of lives at risk, FN curves do not consider property damage with respect to either:

- damage to the asset; or
- loss of benefits provided by the asset.

5.2 Safety standards set by the DSC

The DSC in NSW has defined risk criteria for public safety in the form of individual risk and societal risk (DSC, 2006). Both criteria follow the pattern of the UK HSE tolerability framework (UK HSE, 1992).

The DSC approach to dam safety regulation is a mixture of prescriptive regulation and risk based assessments. The approach for an individual dam is based on where that dam lies on the DSC's preferred FN curve outlined in the figures below.

These figures outline DSC requirements for dam safety investments through the use of FN curves. The requirements are greater for new dams and major augmentations. It is generally cheaper and easier to meet these targets in a new dam, where safety requirements can be incorporated into the design of the dam or augmentation more readily than in an older dam.

Figure 3: Tolerable risks for existing dams in NSW

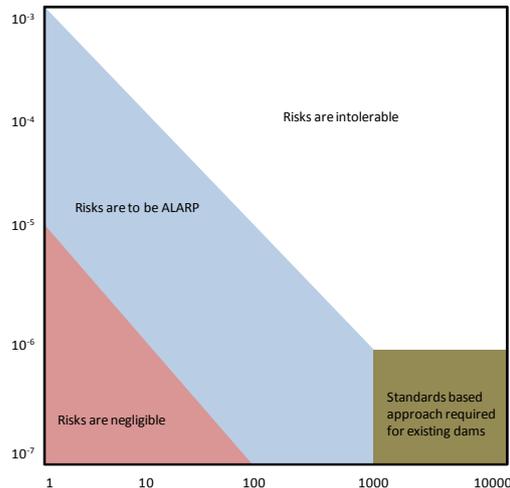
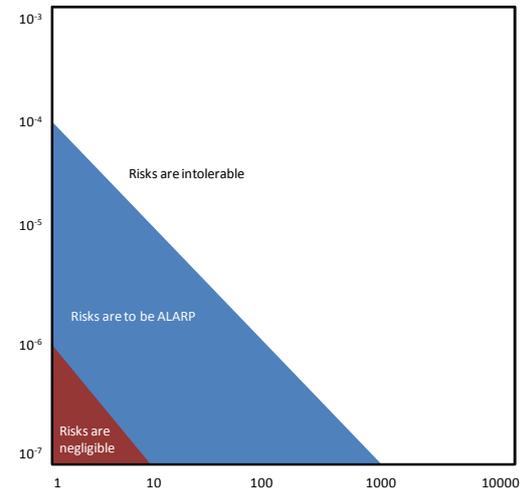


Figure 4: Tolerable risks for new dams or major augmentations in NSW



Source: DSC Guidance Note (DSC1B) – Background to DSC Risk Policy Context

Prior to the approval of the *Risk Management Policy Framework for Dam Safety* framework in 2006, the DSC only used prescriptive regulation. The framework also formalised the *tolerable risk* concept, and this mirrored the introduction of risk-based assessments by ANCOLD in 2003.

If the risks related to a dam failure fall in the upper right “*intolerable*” region of the chart (unshaded), the risks are deemed unacceptable and investments in dam safety are necessary to reduce risk. If the dam risk falls in the lower left “*negligible*” region of the chart (shaded red), the risks are deemed low enough such that no additional investments are required.

In the middle region (shaded blue), further risk reduction is desired, however, additional investments are made according to the ALARP principle.

5.2.1 Criticism of the DSC's approach to setting safety standards

A criticism of the approach used by regulators such as the DSC, ANCOLD and the HSE is that the tolerable risk level is subjective and differs across regulators. A suggested alternate approach has been to solely rely on a benefit cost analysis to determine the level of dam safety investment consistent with an appropriate level of risk.

The benefit cost analysis approach would place more emphasis on the total costs of dam failure and not just the expected number of fatalities. This would involve considering additional costs such as property damage, environmental damage and other economic costs. KPMG notes that dams with higher expected fatalities would generally also have higher expected costs associated with property and environmental damage.

Taking a broader view of costs may increase or decrease the total cost of dam safety depending on where the safety standards are set with respect to the FN curve. If overall risk is allowed to increase, the cost of dam safety across the state would fall under either approach. Conversely, a more conservative approach to risk would increase the costs of dam safety.

It should be noted that benefit cost analysis is a useful tool to estimate whether a dam's risk of failure is ALARP, however, regulators prefer to exclude the use of risk-based assessments beyond the tolerable level of risk.

This review has found that best practice regulation of dam safety should consider all aspects of dam safety investment when making regulatory decisions. This review has recommended that broader expertise be appointed to the regulator to improve the regulator's consideration of issues other than engineering issues (e.g. costs and benefits of dam safety investments).

5.2.2 The ALARP principle

Under the ALARP principle, investments should occur if costs to improve dam safety are reasonable. A dam only satisfies the ALARP criteria if the quantum of further improvement in dam safety is not reasonable given the resources required to achieve this improvement, as outlined in detail in Box 2.

Box 2: The ALARP principle

The ALARP principle refers to the risk based assessment approach used by both DSC and ANCOLD to provide flexibility to dam owners in determining the appropriate level of risk of dam failure. When risk is below the level deemed tolerable by the regulator, the dam owner can justify higher levels of risk on the basis of the costs of obtaining further reductions in the risk of a dam failure.

For dams not in the intolerable zone, owners are required to demonstrate that risks to the individual and societal risks are ALARP. Owners must establish their case to support their risk position within the region of tolerability using three key principles:

- **Prevention:** Practicable measures have been taken to prevent dam failures (engineering solutions).
- **Control:** Measures to control floods in the case of dam failures. However, it should be noted that often in the case of dam failure, there is limited scope for control once a dam begins to fail.
- **Mitigation:** Measures that would help to reduce the impact of dam failures, including effective flood warning and communications systems, protocols for interaction with the emergency authorities, and effective evacuation and welfare plans to protect those at risk (DSC 2010d).

The DSC will review the case on the basis of:

- “The disproportion between the *sacrifice* (money, time, trouble and effort) in making the safety improvement and the risk reduction that is achieved;
- the level of risk in relation to the *limit of tolerability* and the *negligible* risk level;
- the *cost-effectiveness* of safety improvement options;
- any relevant *recognised good practice*; and
- *societal concerns* as revealed by the owner’s or proponent’s consultation with the community and other stakeholder (DSC 2010c).”

The DSC has stipulated that it will not accept a case based on cost to save a statistical life as a demonstration that risks are ALARP, and it requires that the dam owner consult with the affected community and other stakeholders before it will accept risks within the region of tolerability as being tolerable (DSC 2010d).

In addition, the DSC requires that dam owners engage the community as part of their investment proposal. In guidance note DSC2I, the DSC states that consultation is undertaken because, amongst other reasons:

- stakeholders, especially the public who bear the cost of dam failure risks, need to have had the chance to participate in an effective manner, be given early opportunity to understand risks, to openly accept risks as tolerable, or endorse proposed risk mitigation measures, or lobby for greater risk reduction, or move property and family elsewhere etc; and
- it is a critical element in community safety risk management for input to determining tolerable risk (DSC 2010b).

It is difficult to evaluate ALARP, and the DSC does not have specific tests in place to measure if further risk reductions are justifiable. This was raised as a concern by some dam owners, as some investments they would consider as unnecessary under the ALARP principle have been considered necessary by the DSC.

It is noted that there is a key difference between the approaches in NSW and Victoria with respect to application of the ALARP principle. In Victoria, dam owners self report their ALARP decisions to the regulator based on ANCOLD standards and benefit cost analyses that consider broader factors associated with risks to public safety. In NSW, the DSC is directly involved in determining whether investments are ALARP, however:

- there is a greater focus on structural characteristics of dams, unlike Victoria, in which analysis considers broader factors which affect risk; and
- there is poor transparency in decision making, driven by lack of clarity on compliance requirements and the overarching regulatory objective.

This is inconsistent with the assessment framework of this review and the better regulation principles which stress the importance of transparency in generating robust regulatory outcomes. An objective approach to determining whether the risks of dam failure are ALARP would be consistent with the best practice regulatory framework for dam safety.

A measure used by the UK HSE is a gross disproportion test, which identifies the gross disproportion between the cost of an additional risk reduction measure and the estimated benefit of that risk reduction. The HSE uses a disproportionality ratio, which is a cost benefit

ratio that includes both economic and life safety benefits.⁷ More detail on the HSE's approach is included in Appendix D.

The ANCOLD guidelines use this ratio to derive an ALARP justification rating based on range of costs per statistical life saved. The DSC suggests that dam owners use disproportionality as a basis for their investment plans, however, it does not recommend the use of specific ratios.

5.3 Difference between the DSC and ANCOLD guidelines

The ANCOLD approach is similar to, and is the basis for, the DSC approach. The DSE and rural water corporations in Victoria have established the ANCOLD guidelines as the basis for dam safety regulation in Victoria.

Key differences between the two approaches occur for dams with greater consequences of failure for loss of life, whereas the DSC approach requires greater investment in dam safety.

In addition, the ANCOLD guidelines include greater clarity around the use of disproportionality to determine whether the risks of dam failure are ALARP. A summary of the approaches used to set safety standards in different jurisdictions is included in Appendix E.

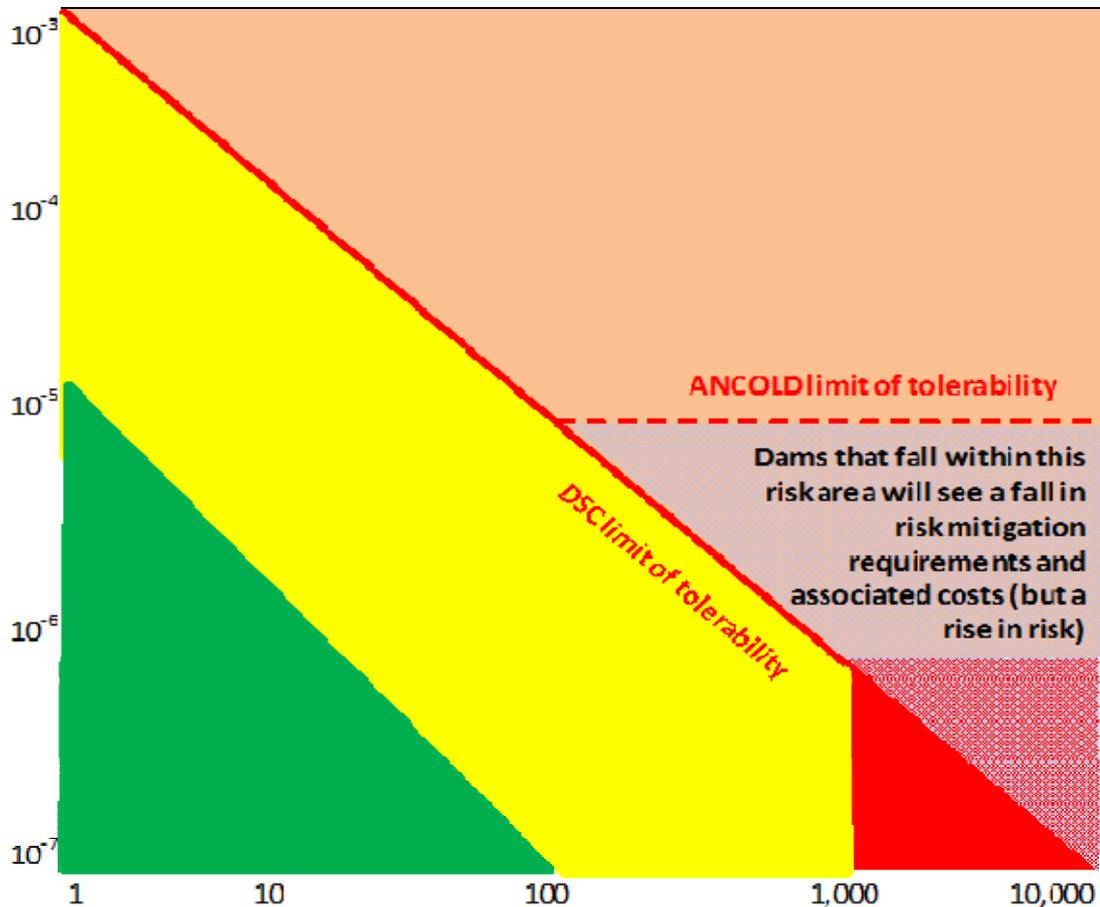
5.3.1 Treatment of high consequence dams

The DSC framework above differs from the ANCOLD standard for dams where the expected loss of life is at least 100. As shown in the figure below, the ANCOLD guidelines do not increase the safety requirement beyond this point, reflecting the difficulty in accurately measuring the risks of dam failure beyond this level.

This difference means that for dams with large consequences in terms of the potential for loss of life, the DSC standard requires greater investments in risk standards than the ANCOLD requirements. Most dams, however, do not fall in this region. Research and consultation suggested that a limited number of dams in NSW fall in or near the trapezium outlined above. For these dams, use of the ANCOLD guidelines rather than the DSC guidelines would be expected to reduce the cost of dam safety investments if all else was equal.

⁷ Bowles, D.S, Tolerable Risk for Dams: How Safe is Safe Enough? US Society on Dams Annual Conference, March 2007

Figure 5: Difference between the DSC and ANCOLD risk guidelines



Source: GHD analysis

Note: y-axis represents the probability that a dam failure results in a loss of life equal to the number shown in the x-axis.

The grey area represents the area where dams are within the ANCOLD tolerability limit and outside the DSC tolerability limit.

5.3.2 Differences in the approach to ALARP

The DSC in NSW and the DSE in Victoria both use the ALARP approach to determine whether a dam with risks within the limit of tolerability should have further safety upgrades. However, there are differences in the approach that each regulator uses to determine whether a dam's risk of failure is ALARP.

The DSC requirement is that dam owners demonstrate that both individual risk and societal risk are ALARP. Even in cases where numerical risk criteria are already being met, there is a further principle of avoiding avoidable risks which needs to be followed.

In NSW and Victoria, the same broad issues must be considered when determining whether the risk of dam failure is ALARP. These are:

- the disproportion between the sacrifice (money, time, trouble and effort) in making the safety improvement and the risk reduction that is achieved;

- the level of risk in relation to the limit of tolerability and the negligible risk level;
- the cost-effectiveness of safety improvement options;
- any relevant recognised good practice; and
- societal concerns as revealed by the owner's or proponent's consultation with the community and other stakeholders (DSC 2010c).

In addition, the DSC notes that dam owners should consider the disproportion between the sacrifice (in terms of money, time, trouble and effort) in making the safety improvement and the risk reduction that is achieved.

While both states require similar issues to be considered when determining whether a dam's risk of failure is ALARP, the Victorian guidance is clearer in its advice to dam owners. For instance, the DSE provides guidance as to the characteristics of 'good' practice while the DSC does not.

The DSE also notes that once a dam's risk of failure is within the tolerable risk zone, it is unlikely that any investment would be considered cost effective according to Cost to Save a Statistical Life (CSSL) measures. Given that Victoria has a lower limit of tolerability, based on ANCOLD guidelines this suggests that the costs of dam safety investments in NSW are likely to be greater than in Victoria for large consequence dams (where the expected loss of life is greater than 100).

5.4 Evidence of over-investment in dam safety

Previous reviews have suggested that there is over-investment in dam safety in NSW. As discussed in Section 2.1 the costs of over-investment in dam safety may be passed on to the community through the cost of outputs of dams and through the government's ownership of dams.

Over-investment in dam safety suggests that the existing form of regulation is not proportional to the market failures that the regulation intends to address. This is inconsistent with the better regulation principles and with the assessment framework for this review. **Information provided on a commercial-in-confidence basis has indicated that there is evidence of some larger dams over-investing in dam safety. This evidence cannot be included in this report due to the commercial-in-confidence nature of the information.**

5.5 Assessment of safety standards

All else equal, higher safety standards will require greater investment than lower standards. According to the assessment framework set out in Section 3.2, the appropriate level of safety standards is the minimum level that adequately addresses the market failure with regard to dam safety (i.e. the level that balances the community's preference for avoiding risk with the cost of investing in dam safety).

5.5.1 Level of safety standards

Over-investment in dam safety suggests that the existing form of regulation is not proportional to the market failures that the regulation intends to address and that the level of government

intervention is higher than necessary to address market failures. This is not consistent with regulatory best practice.

The government should therefore consider whether the existing safety standards are in line with community standards. The government should seek comment from the community on its willingness to accept the risk of dam failure and the appropriate level of dam safety investment. Community feedback should be considered when the government or the regulator sets safety standards for dams. This should be reviewed periodically to ensure that safety standards continue to reflect community standards.

Obtaining community feedback ensures that the costs of dam safety reflect community willingness to tolerate the risks of dam failures. This is particularly important given that price signals for the outputs of dams are often muted by IPART pricing decisions or through the indirect link between dam safety investments by State Owned Corporations (SOCs) and the community through taxation.

However, KPMG notes that the technical nature of dam safety investment may make consultation with the community difficult. In order to address this, consideration should be given to the appropriate consultation framework to gather community feedback. For instance, this may be obtained through willingness to pay studies rather than through submissions to a discussion paper.

The better regulation principles suggest that regulations should be reviewed regularly to ensure that they remain appropriate. Similarly, the tolerable level of risk should also be reviewed regularly to ensure that it remains consistent with community attitudes. This is consistent with other regulators such as IPART and the AER, which periodically review the form of price regulation and the AEMC which review the National Electricity Rules.

Reviewing community attitudes to risk regularly is an additional cost of dam safety regulation. Given that community preferences are likely to remain relatively stable over time, relatively infrequent reviews should be sufficient to identify structural changes in the community's level of tolerable risk.

The effect of this change would be to improve the correlation between community preferences and prevailing safety standards by addressing the issue of information asymmetries in the market for dam safety investment.

Both online surveys indicated that the majority of respondents believe that the current dam safety measures are effective, with over 94 per cent of respondents stating that the current use of prescriptive and risk based standards are either somewhat, very, or extremely, effective in achieving an appropriate level of public safety. A combination of prescriptive and risk-based standards was further justified, with 89 per cent of survey respondents stating it as the best approach to regulating dam safety.

The current approach has required a significant investment in dam safety in some cases with a high Cost to Save a Statistical Life. Specific feedback included:

- a large dam owner suggested that the money spent by the dam owners (in some cases funded by the NSW Government) could be better spent elsewhere in line with community expectations.
- another stakeholder argued that the risk-based standards are still too prescriptive;

- one stakeholder noted that a lack of a formal benefit cost analysis of investments in dam safety has led to a decline in productivity for relevant state owned corporations (SOCs); and
- a dam owner argued that the risk-based approach should be the long term target, otherwise expenditure would only be deferred rather than avoided completely.

Given the criticisms of the DSC's approach to setting safety standards outlined in Section 5.2.1, as well as stakeholder feedback that greater use of benefit cost analysis is necessary, the existing approach to reviewing investments should be amended to include consideration of the economic costs and benefits of investments.

The ALARP principle aims to balance the costs and benefits of dam safety investments with broader considerations, such as good practice dam safety management practices and the principle of avoiding avoidable risks. Benefit cost analysis is an important tool for determining whether risks are ALARP, however this is not included in the current approach.

The use of benefit cost analysis should be specifically included in the regulatory framework. The regulator's guidelines should be clear and specific as to how benefit cost analysis will be used in investment decision making and could provide guidance on benchmarks consistent with efficient levels of investment in dam safety.

A potential approach to incorporating benefit cost analysis more formally in the regulatory framework could be to require dam owners to develop a business case for major dam upgrades. Business cases generally include an analysis of the costs and benefits of investment options and alternatives, as well as some contextual discussion of broader issues, to help determine the most cost effective option.

Many dam owners already develop business cases for proposed dam safety upgrades part of the financing process. For instance public dam owners, such as SCA and State Water are required to develop a business case to access funds from Treasury.

There are some impediments to a broader adoption of benefit cost analysis in the dam safety process, such as:

- the potentially significant cost of conducting a benefit cost analysis or developing a business case; and
- the availability and accuracy of data including the difficulty in estimating the level of risk.

As the cost of developing a business case may be large relative to the cost of smaller dam upgrades, a formal approach to incorporating benefit cost analysis in the regulatory framework may need to consider the requirements for smaller dam owners.

When conducting a benefit cost analysis, the availability of information to enable a robust analysis (i.e. estimations of risk) is an important factor that needs to be taken into account. For example, pre upgrade analyses of the upgrades of dams owned by State Water resulted in benefit estimates that were much smaller than the benefits realised after the upgrades were completed. In addition, State Water advised that alternate approaches to estimating risk may give different estimates of the benefits of dam safety upgrades and therefore different values for CSSL.

To ensure consistency across NSW and to assist dam owners to develop cost effective approaches to benefit cost analyses, the government may wish to consider appropriate benefit cost analysis guidelines for assessing planned investments in dam safety.

5.5.2 Costs of complying with DSC standards

The survey asked dam owners about the costs of meeting DSC standards. Over half the respondents stated it was difficult to meet the safety standards required by the DSC, with 73 per cent advising that the cost of compliance was the most difficult aspect. It is noted that this refers to the total cost to achieve compliance and not the marginal cost in achieving DSC compliance over meeting the ANCOLD guidelines.

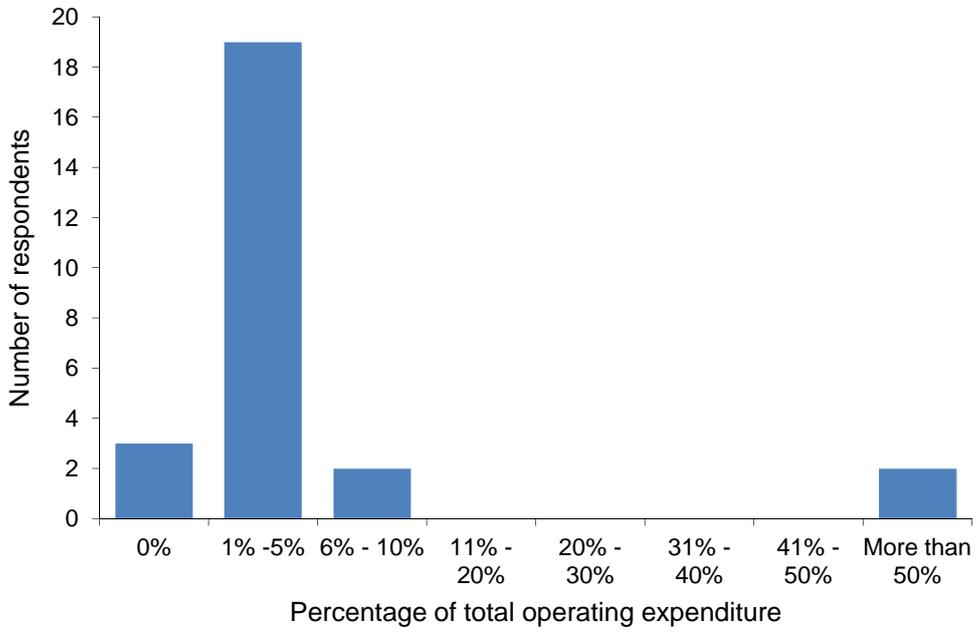
The survey also suggested that for most dam owners, investments in dam safety would likely be no different under a self regulation framework. This may be because most dam owners are likely to default to meeting the ANCOLD guidelines in the absence of the DSC to reduce their liability in the case of dam failures. Notwithstanding this, the cost of meeting the DSC's requirements remains high for owners of large dams.

Almost 90 per cent of respondents indicated that the current approach to regulating dam safety is somewhat, very, or extremely, useful in allowing them to manage their dams in the most cost effective way.

As a proportion of total operating and capital costs, the costs of dam safety were not large for most dam owners. The figures below outline the operating and capital costs spent on dam safety as a proportion of total costs for owners of a single dam. While there are some outliers who face large costs of dam safety, a large majority of dam owners spend less than 10 per cent of operational and capital expenditure on dam safety.

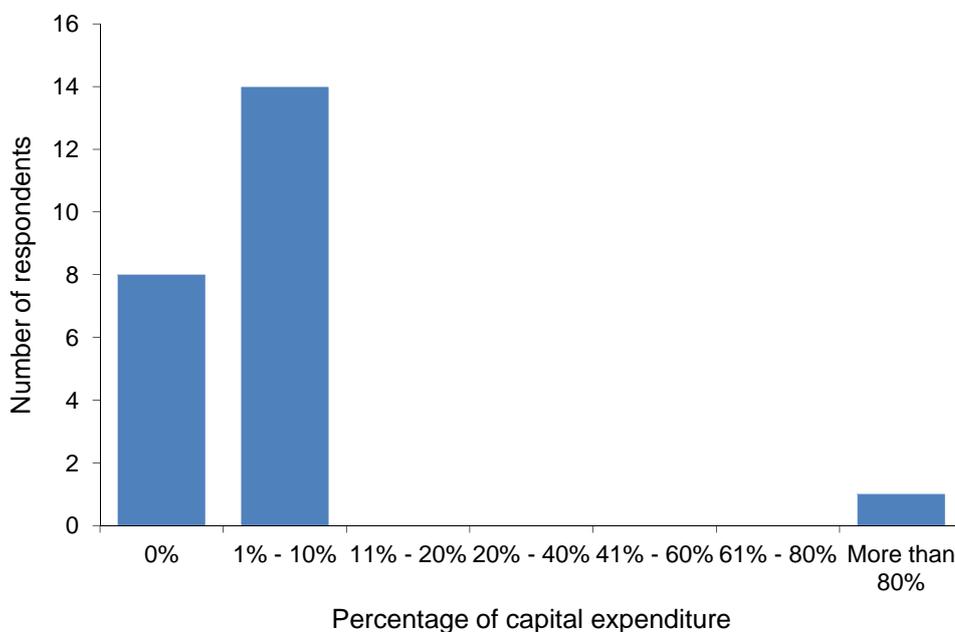
The existence of outliers may reflect dams with high consequences of failure, such as those located in areas with large downstream populations, or companies where the storage of water is an important part of their business. Appendix F of this report provides further details for owners of more than one dam and for specific ownership types.

Figure 6: Average annual cost of undertaking regular dam safety maintenance as a percentage of total operations and maintenance budget – owners of one dam



Source: Online survey responses

Figure 7: Capital expenditure on dam safety upgrades as a percentage of total capital expenditure over the last five years – owners of one dam



Source: Online survey responses.

5.6 Summary of recommendations

The aim of dam safety regulation is to address the market failures associated with the provision of dams, in particular the external costs imposed on downstream populations through:

- exposure to the risk of dam failure; and
- information asymmetries between the public and dam owners regarding the acceptable level of risk.

The level of safety standards is the key lever available to the government for addressing these market failures. All else equal, higher safety standards will require greater levels of investment in dam safety upgrades, thereby shifting the costs of dam failures to dam owners. Shifting these costs to dam owners strengthens the incentives to achieve socially efficient levels of private investment in dams and dam safety

The recommendations of this review seek to ensure that the level of safety standards set by the regulator is proportional and effective in addressing the market failures associated with dam safety. In addition they seek to address evidence of over-investment in dam safety for larger dams in NSW.

Recommendation 8: *The NSW Government should seek comment from the community on its willingness to accept the risk of dam failure and the appropriate level of dam safety investment. Community feedback should be considered when the regulator sets safety standards for dams. This should be reviewed periodically to ensure that safety standards continue to be consistent with community expectations. This outcome could also be achieved through high levels of transparency with respect to benefit cost analyses undertaken to identify efficient risk reduction strategies, with community input encouraged to that process.*

Recommendation 9: *Consideration by a dam owner of whether a potential dam safety investment is appropriate should explicitly include assessment of the benefits and costs of the proposed investment and alternative options to reduce the public safety risk associated with stored waters.*

6. Planning, development proposals and mining

This section considers dam safety regulation and its relationship with the NSW planning system, including state significant developments such as coal mining projects. In particular, it is concerned with the integration of the DSC's decisions and the planning process.



The best practice regulatory framework emphasises the importance of ensuring that where multiple regulators share responsibility for industry, such as in the case of planning, dam safety and mining, there should be clear processes which outline the responsibilities of each regulator. The analysis in this section considers the shared responsibility associated with planning developments downstream of dams and mining developments near dams.

The NSW planning system is currently under review, and changes to legislation are being proposed. As part of this review, the NSW Government released a Green Paper, *New Planning System for NSW: Green Paper*, which makes a number of recommendations including better integration of government agencies in both strategic planning and development approval processes (DoPI 2012). These changes are intended to help reduce duplication in the planning process, streamline development approval processes to make them faster and less complicated, and better link the delivery of infrastructure to strategic planning for growth.

The government has since released a White Paper for public consultation, *A New Planning System for NSW – White Paper*. The White Paper aims to ensure sustainable growth in business and housing development in NSW but does not specifically address dam safety issues in the planning process. In this context, an important issue is how to better integrate advice from the DSC with the development approval process in a timely manner.

There are a number of ways in which the state's planning system and development assessment processes may interact with dam safety:

- increased development, particularly urban development, downstream of a dam may increase the number of persons and property at risk from a potential dam failure;
- new developments can impact on the safety of existing dams or the quality and quantity of stored waters. A common example is underground coal mining near dam walls or stored waters; and
- new development proposals can also include the construction of new dams that later become prescribed, such as tailings or contaminated water dams near coal preparation plants or mineral processing plants at mines. The risks associated with construction and

operation of these dams then needs to be monitored by the DSC. These new developments are often state significant development or state significant infrastructure proposals.

Issues associated with these various scenarios are considered in the sections below.

6.1 Downstream development proposals

Where increased development downstream of a dam increases the number of persons and property at risk from potential dam failure, the consequence category of a dam may need to be reassessed. Currently, the DSC provides information on the consequence category of dams periodically to dam owners, in response to information provided by dam owners. However, dam owners are not informed in a systematic manner of developments which may impact on their responsibilities under the Act.

It is also not clear that strategic planning decisions (i.e. development of planning instruments and strategies and zoning decisions) downstream of prescribed dams always take into account potential impacts on consequence categories for the dam.

6.1.1 Improving the provision of information to the DSC and dam owners

Stakeholders at the workshops commented on the provision of information to the DSC and dam owners regarding downstream development proposals. The DSC advised that, typically, it does not learn about new development proposals until after they have commenced. In addition, there does not appear to be a systematic approach to informing dam owners about downstream development proposals unless the development is in the same local government area as the council that owns the affected dam.

One response from dam owners to the online survey suggested that dam owners are usually informed after the fact by the DSC advising that their dam is now prescribed. Other dam owners also suggested that they must rely on informal channels (such as discussion with local farmers) or their own investigations, to confirm whether downstream development proposals have changed the expected consequences of dam failures and increased the consequence category of the dam.

43 per cent of respondents to the dam owners' survey confirmed that they receive notifications from local councils about any new development downstream. However, more importantly, around one-third of dam owners stated they do not receive any notification from either the developer, local council or the DSC of downstream development proposals.

The DSC noted that, if development proposals were required to include information on whether the development is downstream of a dam, information could then be relayed to the DSC and to the dam owners in a timely manner. Dam owners responding to the survey considered this approach appropriate, but noted that developers may not know if their project is downstream from a dam.

6.1.2 Impact of downstream developments on safety requirements

The second issue raised by stakeholders was that downstream developments may increase the consequences of dam failure and consequently increase the amount of investment required by the dam owner to meet the DSC's standards.

This represents an external cost faced by dam owners following investment decisions made by developers downstream. This may occur because the downstream population increases, or because the potential loss of property occurring from a dam failure has increased. Where a previously unprescribed dam becomes prescribed as a result of increased downstream development, or a dam moves from a lower consequence category to a higher one, the potential financial or risk impacts on dam owners may be large.

Stakeholders suggested that dam owners should be consulted during the development approval process or that the DSC should be involved in the planning process. One stakeholder stated that this approach may reduce complaints from dam owners affected by downstream developments. 65 per cent of survey respondents indicated that dam safety considerations could be more effectively integrated into the planning system by requiring all development applications to include a question about whether the proposed development is downstream of a dam and sending this information to the DSC and relevant dam owner.

The concerns of stakeholders suggest that it would be appropriate for government and industry stakeholders to engage with the DoPI review to raise any concerns they may have about the impacts of planning on dams and dam safety requirements. In particular, there is some support for a systematic approach to informing dam owners of potential developments downstream from their dam which could impact the cost of complying with DSC requirements. This may be done by having requirements for inclusion in the Environmental Impact Statement (EIS) for state significant development proposals of information regarding the location of prescribed dams in the vicinity of, or upstream of, the proposed development. Given these stakeholder concerns, there would be scope to include representatives of the DoPI and other relevant government agencies on the DSC to provide specific guidance and insight.

A systematic approach to informing dam owners of proposed developments which could impact the consequence category of their dams would allow them to engage in the broader planning process.

The government may also consider whether a systematic approach to including dam owners and the DSC in the planning process may be beneficial. This could involve consultation with the DSC and affected dam owners over strategic planning decisions (i.e. development of planning instruments and strategies and zoning decisions) and major development proposals in the vicinity of, or downstream of, prescribed dams.

6.2 Mining

Through provisions of the *Mining Act 1992* (the Mining Act), the DSC manages and monitors mining activity (commonly underground and open cut coal mining activity) around prescribed dams. The DSC defines areas (called Notification Areas) around any prescribed dam which it considers may be affected by mining. Mining leases are granted within Notification Areas on the basis that the leaseholder must apply for an additional approval from the Minister for

Mineral Resources to conduct any mining within the Notification Area. The Minister then seeks the DSC's recommendations before granting any such approval.

The DSC recommendations are then usually applied in the Minister's approval for mining operations permitted in the Notification Area. This may include restrictions on areal extent and type of mining, and requirements for related monitoring and reporting.

The extent and frequency of monitoring are influenced by the type of mining and the nature and importance of the potentially affected features (i.e. the dam wall or stored waters).

Conditions governing mining in the vicinity of a dam wall are generally more stringent than for mining near stored waters.

The DSC has sometimes recommended adjustments to mining leases, following consultation with dam owners, to protect stored waters from pressure-induced leakages associated with nearby mining. The imposition of these conditions has an economic cost in terms of the reduced scope for mining, although it avoids costs associated with the loss of stored water quantities.

Respondents to the survey advised that DSC decisions have not prevented them from engaging in any mining projects. However, mining has been restricted within Notification Areas as a consequence of DSC recommendations.

88 per cent of stakeholders believe that the DSC is generally effective in managing risks of dam safety associated with mining. However, over one-third suggested that the DSC could work more closely with mining companies in the early stages of developing a mine, including during the development consent process. Mining companies have suggested that the DSC approvals take too long due to its non-integrated assessment process. This includes iterative processes where the DSC requests additional information from companies subsequent to granting both development consent and a mining lease.

One stakeholder mentioned that interaction with the DSC and provision of data and analysis resulted in approval from the DSC to mine within what was a restricted area. The DSC noted that, as additional information is received, and the understanding in the field progresses, the DSC's decision making process is adapts to reflect this improved knowledge.

The DSC advised that its iterative process is necessary, as there is usually not enough information provided at the start of the project for the DSC to make a decision. The DSC has also advised that meetings can be convened remotely between scheduled meetings, if this is necessary.

One stakeholder also suggested that the time between DSC meetings (the DSC meets every six weeks) slows down approvals of potential mining projects. The question was raised regarding whether the DSC should be a full time body in order to speed up approvals.

In addition, a number of criticisms of the DSC's current approach to mining have been raised as part of this review. These include:

- the DSC not providing input into some applications for mining leases in Notification Areas;
- whether the DSC should be reviewing water storage losses as part of its consideration; and
- whether the DSC's approach to measuring storage losses is reasonable.

6.2.1 DSC input into the mining lease approval process

Under Section 80 of the Mining Act, the DSC is able to recommend amendments to mining leases in Notification Areas in order to prevent or mitigate any damage to a prescribed dam. The DSC has stated in its guidance notes that when assessing applications for mining leases it considers the security of water storages and the loss of water from the reservoir. In particular, it has mentioned that it considers the cost of the water loss over time relative to the benefits of additional mining.

Stakeholders are generally content with the outcomes of the DSC's reviews of mining leases. However, it was noted that the Act is not clear on the separation of the dam structure and the stored waters and that it appeared that a small water loss could be an issue in the context of a large scale mining project.

The DSC notes that the loss of water is generally permanent, and that it balances the economic benefit of a short term investment in mining with a longer term loss in water storage. The DoPI raised concern with this approach. Given that water loss does not relate to dam or mine safety, DoPI was concerned that the DSC is acting beyond its powers under the Act and the Mining Act.

The scope of this review has not considered the context of the Mining Act and whether legislation grants the DSC the ability to consider the economic costs of lost water storage in drafting its recommendations to the Minister. If the DSC is acting outside its powers, impacted mining companies would be expected to challenge the DSC's authority to make these recommendations.

Under Section 91 of the Mining Act, if the DSC does not make a proposal regarding conditions for a mining lease, and does not inform the Minister that it does not intend to make a proposal, the Minister must consult with the Minister responsible for administering the Act. This procedure is also required if the Minister does not agree with the DSC's recommended amendments to the lease.

A single stakeholder mentioned that in some cases the DSC has not provided input into this process. Where this is not communicated to the Minister responsible for approving the mining lease, the approval process is slowed by the requirement for the Minister responsible for the Act to be consulted in the approval process.

Where stakeholders are concerned over the approval process for mining leases, an option for consultation would be to amend the Mining Act, so that in the event of the DSC not making a recommendation to the Minister, the response is treated as if the DSC accepted the mining lease without amendment.

If this approach were taken, any mining lease that the DSC considers appropriate would not require comment from the DSC, reducing the resources devoted to responding to each mining lease.

In cases where the DSC has not issued a recommendation to the Minister, this approach would streamline the mining lease approval process by removing the requirement of consultation with the Minister responsible for the Act. This would reduce the cost of the process, in terms of time and resources, to government and to the mining company seeking the lease.

6.2.2 Measuring storage losses

The DoPI also raised concerns that recent DSC approvals for underground coal mining near stored waters were unjustifiably strict. As well as the concern that this is beyond the DSC's role, DoPI was concerned that the difficulties in accurately measuring water seepage preclude the DSC from setting standards for water seepage at the current levels.

In particular, DoPI has raised the following concerns:

- the DSC's limits on storage loss do not appear to be based on scientific evidence, resource valuation or broader public policy;
- the DSC's probability requirements are so high that they cannot be reliably measured by groundwater models;
- the difficulty in measuring permeability factors suggests that Monte Carlo analysis is not appropriate as it will tend to find a small number of simulations outside the tolerability limits; and
- because of the time limits involved, actual losses may not be possible to measure while the mine is in use.

The DoPI has noted that by the DSC including a probability limit, and requiring its establishment through multiple executions of a Monte Carlo analysis, a 'simple' prediction of loss based on measured permeability is not sufficient. The Monte Carlo approach uses repeated sampling to obtain estimates of actual outcomes.

The DSC's approach is aimed at providing a decision process based on probability rather than providing a single, definitive limit. This acknowledges that, based on the modelling of a very large geological footprint with all the inherent geological unknowns, there will be a range of potential values of water loss with varying levels of probability of occurrence.

The process is consistent with the DSC's overall approach using risk based standards. However, the Monte Carlo approach should be used with caution as it could be unreliable or misleading since it includes scope for variation of input parameters but potentially ignores greater variability in the assumed hydrogeological models.

The more normal approach of carrying out a sensitivity analysis may well have more meaning. It is recommended that the DSC reviews the requirement for a Monte Carlo analysis recognising the potential limitations of the method in this context.

The DoPI contends that it is not possible to monitor actual losses of stored waters to mine workings within the timeframe that those workings are open. This is because of the time it takes for water to travel to the mine itself, which may be some distance away from the water storage.

If water loss is to occur however, the seepage paths from the reservoir to the future mine workings will already be saturated. Flow should occur and be measurable immediately. However the source of the flow may not become apparent for many years. Establishment of the post-mining drainage situation within the rock mass may also take some time to reach equilibrium. Identifying and measuring the seepage flows against the numerous other water movements within the mine system is also difficult. The situation may also revert back to original conditions when mining ceases should the mine be totally and completely sealed at its

entrances to preclude drainage of the rock mass. For these reasons concerns over long term water losses may be overstated.

The DSC has suggested that, while it acknowledges the difficulty in determining the appropriate balance between mining projects and dam safety, it has continued to refine its process as progress in the field occurs.

If the remainder of this review and the broader consultation process determine that the DSC is able to continue to consider water losses as part of its recommendations on mining leases, these technical queries should be reviewed and subjected to stakeholder consultation. If it is found that the DSC is not able to consider water losses in its recommendations, consideration of the technical components of these decisions would be unnecessary.

6.2.3 State significant developments

There has been some concern that the DSC is not sufficiently integrated with the rest of the planning system and that the DSC has not shown a willingness to engage with the broader planning process, specifically for state significant developments.

Under provisions of the *Environmental Planning & Assessment Act 1979*, a significant number of statutory approvals cannot be refused if they are required for carrying out of state significant development. In addition, these approvals must be “substantially consistent with” the development consent. These approvals include mining leases, environment protection licences, licences under the *Pipelines Act 1967* and approvals under the *Mine Subsidence Compensation Act 1961*.

If the DSC’s recommendations are not “substantially consistent with” the development consent, it may be difficult (if not impossible) to ensure that the relevant mining lease remains substantially consistent with the development consent, as required under the planning legislation. This suggests that there would be some benefit in ensuring that the DSC is involved in the process at an early stage.

One stakeholder suggested that it has been the DSC’s practice to refrain from providing comment to the DoPI on any risks to dams and stored waters posed by state significant development proposals, particularly underground coal mining. Instead, the DSC has sought to manage the potential impacts of such developments on dams through its powers under the Mining Act. Under this approach, changes suggested by the DSC may alter the lease such that it is no longer “substantially consistent with” the development consent.

The DoPI has suggested that the assessment of dam safety risks (for both mining and other development proposals) should be carried out during, rather than separately to, the development assessment process. It suggested that the DSC should provide the Department with advice during this process (as do other affected government agencies) to ensure that suitable standards or performance measures are incorporated in any resulting development consent, to reduce safety risks (either for dam walls or to the quality or quantity of stored waters) to acceptable levels. Including representatives from the DoPI and other relevant government agencies directly on the DSC would also assist in improving its integration with the broader state planning system.

The DSC contends that its decision making process requires more detailed information that is not typically available in the initial planning stages. Addressing this issue may allow the DSC to consider state significant developments earlier in the development approval process.

The DoPI also suggested that advice should be provided regarding development proposals that may impact on either the physical integrity (i.e. risk) or the consequence category of existing dams, and on appropriate construction, management and monitoring standards for new dams contained within development proposals (e.g. tailings dams).

As part of the next phase of the review, the government should seek input from stakeholders on the best approach to reconcile this information gap so that the DSC can be involved earlier in the process. This may be through changes to the information required from mining companies early in the planning process or through directing the DSC to provide input earlier in the planning process, recognising that due to information requirements this may lengthen the time spent gaining initial approval.

6.3 Summary of recommendations

The existing dam safety regulatory framework interacts with planning frameworks in two ways:

- developments downstream of dams can change the consequences of any potential dam failure and is incorporated in the decision of whether individual dams require safety upgrades; and
- the DSC has input in the approvals process for mines in areas near prescribed dams through the Mining Act.

KPMG has made recommendations to improve communication to dam owners of downstream developments which may impact their responsibility to invest in dam safety upgrades. KPMG has also outlined issues with regard to mining that should be considered by the government. Any proposed changes which may impact the DSC's activities under the Mining Act should be subject to consultation with stakeholders of the Mining Act.

Recommendations in this section refer to the integration of DSC decisions with the broader planning process, in particular for mining within dam safety notification areas. KPMG notes that inclusion of relevant government agencies as members of the dam safety regulator may assist in addressing these issues.

Recommendation 10: *A systematic and proactive approach should be implemented to inform dam owners of potential developments downstream from their dams that could influence the consequence category of their dams and the cost of complying with public safety requirements. The approach should be incorporated into the planning approval process or through an alternative process considered appropriate by the NSW Government.*

Recommendation 11: *The NSW Government should consider options to address dam safety considerations much earlier in the planning approval process, particularly for state significant developments and state significant infrastructure.*

Recommendation 12: *The NSW Government should seek public comment on:*

- *whether the regulator's role in the approval of mining near prescribed dams is clearly defined; and*
- *whether the dam safety regulator should consider the economic impacts of water loss due to mining activities or whether the dam safety regulator should only be concerned with the safety of the prescribed dam.*

7. Extreme weather events and seismic activity

This section considers the performance of dam safety regulation in minimising the risks of extreme weather events and seismic activity on the safety of dams.

7.1 Extreme weather events

For prescribed dams where persons may be at risk downstream if the dam fails, the dam owner is required to have in place an appropriate dam safety emergency plan (DSEP). A DSEP outlines the actions that a dam owner is required to take in response to a range of emergency situations including extreme weather events. It is focused on actions relating to:

- notifying emergency services including the NSW Police and NSW State Emergency Service (NSW SES), dam owner management, the DSC and the Minister; and
- securing the dam structure with the intent of ensuring public safety.

A DSEP must include background information on the dam, notification protocols in case of an emergency, the anticipated consequences of dam failure, flood plan information (maps, flood depths, velocities and arrival times, affected dwellings, businesses and other infrastructure) and emergency procedures to secure the dam (DSC 2010d).

The dam owner develops the DSEP. As part of the preparation of the draft and final DSEPs, the dam owner is required to consult the SES State Headquarters. The DSC provides comment on the draft DSEP and notes the final DSEP, but does not approve the final DSEP as set out by dam owners. DSEPs are updated annually and tested once every five years. This testing includes appropriate SES involvement.

There are three alert levels included in the DSEPs, in increasing order of severity they are white, amber and red. Alerts are raised based on rainfall, the detection of defects, forecast weather patterns, earthquakes and other similar events. An amber alert warns the public of the potential for evacuation and a red alert requires evacuation of the affected area.

Dam owners have raised some concerns with the DSC Emergency Management Sub Committee that alerts, and subsequent evacuations, are triggered too early. Emergency services are required to consider the safety of the broader public when carrying out evacuations. The current approach allows for DSEPs to be updated with later trigger points if the DSC and the SES agree with this approach.

The SES has advised that it does not have the resources to examine every DSEP and instead it focuses on the very highest risk dams. This may result in DSEPs that are not the result of an outcome negotiated between dam owners and the SES and could result in DSEPs that are not appropriate given the characteristics and risks of the individual dam.

7.2 Balance of emergency response and dam safety

To some limited extent, additional expenditure on emergency management can be a substitute for expenditure on investments in dam safety. Emergency management can potentially reduce the negative impacts of dam failures on the downstream population, although damage to property and environment is unlikely to be mitigated. For example, increased investment in the State Emergency Service (SES) may in some instances lead to improved emergency response times and evacuation procedures, resulting in a lower number of fatalities if a dam were to fail as a result of reduced investment in safety standards.

7.3 Seismic activity

The DSC also manages risks to dam safety from seismic activity. The DSC's approach to managing these risks takes into account the fact that Australia is subject to relatively low levels of seismic activity and that there are very few instances internationally of dam failures resulting from earthquakes. It is significant to note that, in the USA, the National Performance of Dams Program quotes that of the causes of dam failures from 1975 to 2001, nearly 70 per cent were due to overtopping and 12 per cent due to piping with the remaining 18 per cent being spread across 10 categories, including 6 per cent not known. No failures due to seismic activity are recorded. (They could be included in the 'Other' category but this is less than 2 per cent of all recorded failures.)

In light of these considerations, the DSC has set minimum requirements for dams in relation to risks associated with seismic activity.

7.4 Industry stakeholder consultation

In the online survey, stakeholders were asked for their views on how effective the current dam safety framework is in managing risks of extreme weather events and how clear the current dam safety framework is in outlining the requirements of different parties in the case of dam failure in an extreme weather event. They were also asked about the responsibilities of the SES in relation to dam failure and level of guidance they receive from the SES.

In general, responses to this section were positive. Over 90 per cent of respondents believe that the DSC requirements for managing risks around extreme weather events are effective and 83 per cent believe the current framework outlines clear requirements for different parties in the event of a dam failure in an extreme weather event. Over half of the stakeholders stated that the current balance of responsibilities between dam owners and the SES in the event of a dam failure in an extreme weather event is "about right".

According to the online survey, almost all respondents advised that they are required to have a DSEP. One stakeholder raised concerns that the DSC only notes DSEPs, rather than reviewing and endorsing them. It was suggested that the DSC role should be expanded to include a review capacity.

Stakeholders were asked whether the current policy mix of emergency response and prevention through dam safety was appropriate. While stakeholders did not provide a large amount of comment on this issue, it was noted by a stakeholder that a greater emphasis on

emergency response may be difficult given existing funding levels. Also, it may not be an efficient use of resources given that any investment in the community's ability to respond to an emergency caused by a dam failure would be used infrequently.

There was little focus on the impact of seismic activity on safety requirements in the workshops. In the surveys, almost all dam owners and other stakeholders considered that the DSC's requirements with regard to seismic activity are "about right".

Given the stakeholder response to the current form of regulation, there is little evidence to suggest that the current approach needs amendment. There may be benefit from consulting with the community on the mix of emphasis on emergency response and prevention and whether the resources invested in dam safety would be more efficiently used elsewhere.

While stakeholders raised some concern that alerts are triggered too early, leading to unnecessary evacuation warnings, the current approach should allow for flexibility if the dam owner is able to provide evidence of more appropriate trigger points. However, this would need to be agreed with the DSC and the SES.

The government may wish to consider whether the DSC should be required to approve DSEPs, however it may not provide significant benefits, given that the existing approach requires the DSC and the SES to provide input throughout the development of the DSEP.

7.5 Potential increased investment in emergency response

Prior to considering a potential increased reliance on the SES in the event of dam failure, the government should undertake a full benefit cost analysis, in conjunction with the NSW SES, to understand the full impacts of a change in the balance of investment in emergency management and prevention. Consideration should be given to:

- the reduction in any costs (benefits) associated with reduced safety standards, and the level of PAR;
- the ability of the SES to evacuate in a safe and timely fashion (i.e. availability of sufficient access routes) in the event of failure;
- the cost of an augmented SES capable of responding to dam failures, noting that additional resources are unlikely to be used frequently; and
- the cost of environmental damage including on-going loss of economic activity and production capacity and bio-diversity as a result of flooding due to dam failure.

7.6 Summary of recommendations

Emergency plans detail the responsibilities of dam owners and emergency services where there is a likelihood of dam failure; this may include public alerts and evacuation orders. DSEPs are drafted by the dam owner in consultation with emergency services and the DSC. KPMG's recommendations with DSEPs consider the criticism of the existing process by dam owners and the SES.

Under the current form of regulation, dams that would place lives at risk in the event of a dam failure are required to have a DSEP in place. The DSEP is developed by dam owners with the input from the SES and the DSC.

While there is broad support for the current approach amongst stakeholders, some suggestions for improvement were raised by dam owners and are addressed in the options listed below. Because of the support for the existing arrangements, these options should be subject to community feedback before determining whether amendments to the existing approach should be made.

Recommendation 13: *The NSW Government should consider whether the dam safety regulator or another government agency should be required to approve Dam Safety Emergency Management Plans (DSEPs). The relevant agency should have sufficient resources to make such assessments.*

Recommendation 14: *The NSW Government should evaluate whether existing DSEP trigger points for alerts result in unnecessary evacuation warnings.*

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Appendix A: Stakeholder Consultations

Stakeholder consultation was undertaken as part of this review, and was designed to collect views on the strengths and weaknesses of the existing Act and regulatory framework. Consultation took the form of:

- workshops with:
 - the DSC;
 - large dam owners; and
 - selected government agencies;
- an interview DSC members unable to attend the initial workshop; and
- online survey, which was provided to all prescribed dam owners in NSW, selected government agencies, and other parties.

Detailed information on the consultations undertaken is outlined in Table A - 1.

A summary of the responses to the online survey are discussed in the following sections.

Table A - 1: Stakeholder consultation

Stakeholder group	Stakeholders	Consultation details
Regulator	Dams Safety Committee members: <ul style="list-style-type: none"> • Brian Cooper, nominee of Engineers Australia and Chairman of the committee • Ian Anderson, nominee of the Minister for Mineral Resources • Giovanni de Cataldo, nominee of State Water Corporation • Ian Forster, nominee for the state-owned electricity generators • Jeffery Gleeson, nominee for Hunter Water and Deputy Chairman of the committee • Dene Jamieson, nominee of the Minister responsible for administering the <i>Public Works Act 1912</i> • Steve Knight, Executive Engineer and Chairman for DSC Meetings 	Workshop – 3 hours Facilitated by: <ul style="list-style-type: none"> • Nicki Hutley (KPMG); • Steven Casey (KPMG) • Ingrid Emery (KPMG); • Richard Frost (GHD); • Malcolm Barker (GHD); and • Michael Scotland (NSW Trade and Investment). Date: 4 February 2013
Regulator	Dam Safety Committee members unable to attend the workshop: <ul style="list-style-type: none"> • Ian Landon-Jones, nominee of Sydney Catchment Authority and Chairman of ANCOLD • Norman Himsley, nominee of Institution of Engineers Australia • Steve Knight, Executive Engineer and Chairman for DSC Meetings 	Interview – 2 hours Attended by: <ul style="list-style-type: none"> • Nicki Hutley (KPMG); • Ingrid Linsley (KPMG); • Richard Frost (GHD); and • Michael Scotland (NSW Trade and Investment). Date: 11 February 2013

Stakeholder group	Stakeholders	Consultation details
Large dam owners	<ul style="list-style-type: none"> • Sydney Catchment Authority, represented by Ian Tanner and Graham Begg • Sydney Water, represented by John Murray and Luke Mortimer • Hunter Water, represented by John Peel and Phil Townsend • State Water, represented by Amit Chanan and Stephen Farrelly • Snowy Hydro, represented by Ken Lister and Brian Mayhew • Water Directorate, represented by Wayne Franklin and Gary Mitchell • Local Government and Shires Association, represented by Sascha Moege • NSW Minerals Council, represented by Richard Walsh (BHP Billiton Illawarra Coal) and Greg Tarrant (Peabody Energy) • IPART, represented by Amanda Chadwick 	<p>Workshop – 3 hours Facilitated by:</p> <ul style="list-style-type: none"> • Steven Casey (KPMG); • Ingrid Emery (KPMG); • Richard Frost (GHD); • Malcolm Barker (GHD); and • Michael Scotland (NSW Trade and Investment). <p>Date: 4 February 2013</p>
Government agencies	<ul style="list-style-type: none"> • Department of Finance and Services, represented by Daniella McKenzie, Gavin Priestley (Public Works), Rick Still (Public Works) and John Dixon (Public Works) • DoPI, represented by David Kitto (Mining and Industry Projects) and Felicity Greenway (Infrastructure Projects) • NSW SES, represented by Steve Opper and Belinda Davies • NSW Trade and Investment, represented by Carolyn Murphy (Resources and Energy) and Matthew Gordos (Fisheries) 	<p>Workshop – 3 hours Facilitated by:</p> <ul style="list-style-type: none"> • Nicki Hutley (KPMG); • Ingrid Emery (KPMG); • Richard Frost (GHD); • Michael Scotland (NSW Trade and Investment). <p>Date: 12 February 2013</p>

Stakeholder group	Stakeholders	Consultation details
	<ul style="list-style-type: none"> • NSW Department of Primary Industries, represented by Guy Russell (Catchments and Lands), Guy Van Owen (Catchments and Lands), David Stokes (NSW Office of Water) and Stephen Palmer (NSW Office of Water) • NSW Department of Premier and Cabinet, represented by Cassandra Gercken • Division of Local Government, represented by Daniela Heubusch 	
All stakeholders	<p>Prescribed dam owners Government agencies that attended the workshops DSC Institution of Engineers Australia</p>	<p>The online survey was developed to provide an opportunity to all dam owners to participate in the review, and to allow workshop participants an opportunity to provide more detailed responses to the issues addressed in the workshops.</p> <p>KPMG prepared the survey and managed all aspects of the data gathering and analysis. NSW Trade and Investment sent out the survey, via email, to all participants.</p> <p>Dates: 8-22 March 2013</p>

A.1 Results of the online survey

KPMG prepared an online survey that was sent to all prescribed dam owners, selected government departments, and other stakeholders to elicit their views on the current dam safety regulatory regime.

The online survey questions were developed by KPMG and GHD, and reviewed by the Steering Committee. Two surveys were developed, one for dam owners and another for non dam owners, with the questions varying slightly between the surveys. The questions covered the main topics outlined in the early stages of consultation and discussed at the workshops including:

- Respondent details;
- Objectives of the dam safety regime;
- Governance arrangements;
- Approach to regulating dam safety;
- Safety standards;
- Compliance costs;
- Dam safety and the planning system;
- Dam safety and extreme weather events;
- Dam safety and seismic activity; and
- Dam safety and mining.

The survey was sent to 178 stakeholders with 109 either partially or completely finishing the survey. Table A - 2 summarises the respondents to the online survey by stakeholder type. The key findings and trends resulting from the survey responses are discussed in further detail below with the full set of survey questions contained in Appendix G.

Table A - 2: Summary of responses to the online survey by stakeholder type

Stakeholder type	Number of responses
Dam owner survey	93
State Government Department	4
State owned corporation	8
Other water corporation	1
Local council	34
Mining company	19
Energy company	1
Other company	6
Non government organisation	6
Not identified	14 (14)
Other stakeholder survey	16

Stakeholder type	Number of responses
• Government Department	8 (2)
• DSC member or employee	4
• Mining company	3 (1)
• Other	1 (1)

Note: The numbers in parenthesis refer to partially completed surveys

A.2 Respondent details

This section of the survey aimed to gather background information about the stakeholder and the dams they own. This includes their ownership structure, the number and type of dams they own and whether the DSC prescribes their dams.

The majority of respondents were either local council (31 per cent) or mining companies (20 per cent). Twenty-two per cent of respondents were State Government Departments and State Owned Corporations (11 per cent each).

Fifty-eight per cent of stakeholders indicated they owned between 1 to 5 dams, most stakeholders (74 per cent) reported that they own between one and five dams prescribed by the DSC. Of these prescribed dams, the consequence categories were fairly evenly spread across the categories with 22 per cent classified as very low and 11 per cent classified as extreme.

A.3 Objectives of the dam safety regime

Questions were asked to determine stakeholders understanding of the *Dams Safety Act 1978* (the Act) and what they believed were the most important objectives of the Act. Stakeholders were also asked for their understanding of dam safety and what they believe the dam safety regime should attempt to achieve.

Stakeholders were divided on whether the Act should change to include specific objectives, with 53 per cent believing it should change and 40 per cent stating it is appropriate in its current form. If new legislation was introduced, respondents believed that the most important focus should be on the objectives of the Act, with maintaining dam safety standards to protect populations that live downstream (41 per cent) and managing risks around dam safety to a level consistent with community risk preferences (30 per cent) seen as the most important objectives of the Act and the DSC.

A.4 Governance arrangements

Stakeholders were asked what the best governance framework for dam safety in NSW is and if dam safety were to be managed by a regulator, what the role of the regulator should be. Views were sought as to what powers the regulator should have to enforce dam safety measures, the composition of the regulator, as well as the impact that self-regulation might have.

Most respondents supported a regulatory body in the form of a statutory authority (71 per cent).

Over half of the respondents believe that the dam safety regime should consider the cost of dam safety maintenance and capital upgrades in determining the investments needed for individual dams to meet tolerable risk levels.

In addition, over half of the respondents also believe that the regulator should perform an oversight role, relying on assessments provided by the owner, rather than a more interventionist role.

Dam owners and non-dam owners responded differently to the question on whether the DSC should have extended powers to enforce safety measures. Seventy-four per cent of dam owners believe that if the DSC were to remain as regulator their powers should be kept the same, whereas only 29 per cent of non-dam owners believe this should be the case, with 64 per cent arguing that the DSC's powers should be increased.

Stakeholders did not support self regulation, with two-thirds of stakeholders indicating that there would be an increase in the chance of dam failures if self-regulation was in place. Most stakeholders thought that the cost of managing dam safety would stay the same (49 per cent) or rise (15 per cent) under self-regulation. Only 36 per cent stated that costs would fall under self regulation.

If the composition of the DSC was to change, stakeholders believe either a risk expert (30 per cent) or a representative for the councils (35 per cent) should be included on the DSC or one of its sub-groups.

A.5 Approach to regulating dam safety

This section aimed to identify the clarity and effectiveness of dam safety measures currently implemented by the DSC including their approach to prescribing and categorising dams as well as setting safety standards. Respondents were asked to rate the current level of dam safety and their thoughts on what is the best approach to regulating dam safety in NSW.

Stakeholders appear happy with the current approach to prescribing dams, with 77 per cent of respondents stating the approach is clear and 82 per cent of respondents believe the DSC's dam categorisation is an effective way of grouping the large range of dam types and sizes in NSW.

The majority of stakeholders believe that the current dam safety measures are effective, with over 94 per cent of respondents stating that the current use of prescriptive and risk based standards are somewhat, very or extremely effective in achieving an appropriate level of public safety. The use of a combination of prescriptive and risk based standards was further justified as 89 per cent of respondents stated this is the best approach to regulating dam safety.

Additionally, almost 90 per cent of respondents indicated that the current approach to regulating dam safety is somewhat, very or extremely useful in allowing them to manage their dams in the most cost effective way.

A.6 Safety standards

These questions aimed to gain insights into how difficult it is to comply with the current safety standards required by the DSC, and what makes it difficult to comply. It also aimed to identify how the introduction of risk-based standards has impacted on the amount spent on dam safety and how clear these risk based standards are in relation to determining when they can be used. Understanding of the use of the ALARP principle, as well as the usefulness of the DSC guidance notes on ALARP were other important areas in this section.

Over half the respondents stated it was difficult to meet the safety standards required by the DSC with 73 per cent advising that the cost of compliance was the most difficult aspect. Views on the regulator were split with 40 per cent of stakeholders stating the NSW dam safety regulator should minimise risks that might lead to dam failure and 60 per cent stating the regulator should accept risks that might lead to dam failure within the tolerable level.

Eighty-four per cent of respondents believe that risk based standards are clear in whether they can be used for their dams and 93 per cent believe the DSC guidance notes describing the ALARP principle are useful in understanding how to use ALARP in justifying the current or proposed modified risk status of their dam.

A.7 Compliance costs

Stakeholders were asked to provide detail of how much it costs each year to undertake dam safety maintenance and dam safety upgrades as required by the DSC. This was reported as a dollar figure as well as a percentage of capital expenditure and operating expenditure. They were also asked to rate the current costs of complying with the DSC's requirements in terms of what they would have spent on dam maintenance and upgrades regardless of the DSC. Additionally, questions were asked to determine the benefit of the maintenance and upgrades in terms of increasing safety of the dams.

The majority of owners of single or small dams highlighted that annual dam safety maintenance costs were less than \$50,000. However for larger dam owners, costs were far greater with nearly 10 per cent over \$500,000 per annum. When taking dam safety maintenance costs as a percentage of total operations and maintenance budgets, the majority of respondents indicated they spent less than 10 per cent regardless of the size of the dam.

Almost two-thirds of dam owners outlined that the current cost of complying with the DSC requirements is about what they would spend on dam safety anyway.

Capital upgrade costs followed a similar theme to that of maintenance costs. When expressed as a percentage of total capital expenditure, the majority of dam owners indicated the cost of meeting DSC requirements was less than 10 per cent of their total capital expenditure.

Around two-thirds of respondents stated that the dam safety upgrade did not impact on the probability of a dam failure and over 90 per cent indicated that the upgrade did not impact on the population at risk of their dam.

A.8 Dam safety and the planning system

This section was focussed on how the DSC interacts with the planning process and how dam safety considerations could be more effectively integrated into the planning system.

Forty-three per cent of dam owners confirmed they receive notification from the local council about any new development downstream. Of note is that around one-third of dam owners stated they do not receive any notification from the developer, local council or the DSC of downstream developments. Sixty-five per cent of respondents indicated that dam safety considerations could be more effectively integrated into the planning system by requiring all development applications to include a question about whether the proposed development is downstream of a dam and sending this information to the DSC and the relevant dam owner.

A.9 Dam safety and extreme weather events

Stakeholders were asked their views on how effective the current dam safety framework is in managing risks around extreme weather events and how clear the current dam safety framework is in outlining the requirements of different parties in the case of dam failure in an extreme weather event. They were also asked about the responsibilities of the SES in relation to dam failure and the level of guidance they receive from the SES.

In general, responses to this section were positive. Over 90 per cent of respondents believe that the DSC requirements in managing risks around extreme weather events are effective and 83 per cent believe the current framework outlines clear requirements for different parties in the event of a dam failure in an extreme weather event. Over half of the stakeholders stated that the current balance of responsibilities between dam owners and the SES in the event of a dam failure in an extreme weather event is about right.

A.10 Dam safety and seismic activity

This section determined the importance of risks associated with seismic activity on dams and the current safety requirements relating to seismic activity.

Sixty-four per cent of survey respondents believe the risks associated with seismic activity are important for their dams. Additionally almost all respondents (95 per cent) believe that the current dam safety regulatory requirements relating to seismic activity are about right.

A.11 Dam safety and mining

This section aimed to gain views on the effectiveness of the DSC in managing risks associated with mining and how the DSC could improve their management of risks relating to mining.

Eighty-eight per cent of stakeholders believe that the DSC is effective in managing risks around dam safety that are associated with mining; however, if the DSC was to improve its approach to managing risks to dam safety associated with mining, over one-third suggested it could work more closely with mining companies in the early processes of developing a mine.

Appendix B: Functions of the DSC

This appendix provides a summary of the functions of the DSC as defined by the Act. These functions are set out in below.

The Act defines the DSC's functions as:

- a) to maintain a surveillance of prescribed dams, the environs under, over and surrounding prescribed dams and the waters or other materials impounded by prescribed dams to ensure the safety of prescribed dams;
- b) to examine and investigate the location, design, construction, reconstruction, extension, modification, operation and maintenance of prescribed dams, the environs under, over and surrounding prescribed dams and the waters or other materials impounded by prescribed dams;
- c) to obtain information and keep records on matters relating to the safety of dams;
- d) to formulate measures to ensure the safety of dams;
- e) to make such reports or recommendations to the Minister or any other person in relation to the safety of prescribed dams as the Committee considers necessary or appropriate;
- f) to make reports and recommendations with respect to the prescription of dams for the purposes of this Act;
- g) to exercise such other functions as are conferred or imposed on the Committee by or under this or any other Act or the regulations; and
- h) to do such supplemental, incidental and consequential acts as may be necessary or expedient for the exercise of its functions.

Appendix C: Government intervention in dam safety

The level of government intervention in dam safety should be determined by the approach required to address the market failures. In general, a lighter approach is preferred if it leads to the level of dam safety investment deemed optimal by society.

As discussed in Section 4.1, for this review, an options analysis was undertaken to examine alternative regulatory models for the Act and the DSC, which the NSW Government could employ in relation to dam safety. This appendix considers the impact of the level of intervention on the likelihood of dam failures and discusses the four options briefly outlined in the body of this report in more detail.

These regulatory models consider differing levels of government intervention in the market for dam safety investment. The appropriate level of government intervention will depend on the prevailing safety standards and subsequent level of investment required. The lower the level of safety standards required, the more likely it is that the market will meet society's expected level of investment without the need for government intervention. This is due to existing incentives to invest in dam safety such as:

- concerns over legal liability in the case of dam failure; and
- the need to ensure that the dam continues to provide economic benefit to the dam owner.

Better regulation principles state that the need for government intervention in a market should be established before regulatory options are considered. Where regulatory options are found to be necessary, a light handed approach is preferable to a highly regulated approach, where the outcomes of each approach are similar (BRO 2009). This is generally due to the higher costs (both to government and to the regulated entity) of higher regulation. Increased costs may include compliance costs for businesses and supervisory costs for governments.

C.1 Impact of the level of intervention on dam failures

To date in NSW and Australia, there have only been a minimal number of dam failures that have resulted in loss of life.

"Many dams have failed, and continue to fail, throughout the world, often with disastrous consequences including loss of life and property, environmental damage and loss of the purpose of the dam (e.g. town water supply). A small number of large dams have failed, or partially failed, in Australia but only one of those failures involved loss of life (i.e. 14 lives lost in the failure of Breisis Dam in Tasmania in 1929)." (DSC 2013)

Despite the good safety record nationwide, Australian jurisdictions use varied approaches to regulating dam safety, suggesting that there may be more than one approach which provides suitable outcomes. Current guidelines used in NSW and most other Australian jurisdictions draw largely on ANCOLD. For example, in Victoria, while the regulator does not ensure compliance of all dams, the required levels of safety are based on ANCOLD guidelines.

Measuring the relative success of different regulatory frameworks based on the Australian experience is difficult. While NSW's dam safety record has been without any significant issue since 1978, there are a number of factors that limit the extent to which this is a function of government intervention.

These factors include that:

- there is no single consistent data source for dam failures globally, making comparisons across jurisdictions difficult;
- failures may only be reported for regulated dams which limits information on the total number of dam failures in any one jurisdiction;
- a lack of dam failures cannot be considered evidence that one system is more effective than another. The probability of a dam failing is remote for most jurisdictions. Given this, 35 years of regulation in NSW is not a sufficient period of time to fully consider the effectiveness of the NSW regime; and
- the main driver of the risk of dam failure in NSW is the level of investment in dam safety. This is generally based on the level of safety standards. The level of safety standards is independent of the level of government intervention.

C.2 Examples of dam failure

While a lack of dam failures is not sufficient to determine that the form of government intervention is successful in increasing the level of dam safety, a large number of significant dam failures may indicate that the broader regulatory framework is not achieving appropriate dam safety outcomes.

There have been three dam failures in NSW since the inception of the Act in 1978, resulting in no loss of life. Internationally, there have been a large number of catastrophic dam failures. For example, during the nine-year period to late 1994, there were more than 400 dam failures in the United States, although there was no loss of life associated with some 98 per cent of these dams (US Homeland Security, 2011). According to the US Bureau of Reclamation (USBR), many of these dams were unregulated and either fell outside of a regulatory jurisdiction or were small in size.

Table D - 1 summarises a selection of major dam failures and the regulatory responses to these dam failures.

There is no one universal international database for dam failures that allows inferences to be drawn about the nature of dam failures and the regulatory framework prevailing in the jurisdiction in which the failure occurred. It is true that the older a dam, the more likely it is to pose some risk to downstream communities. This risk is heightened if the dam is exposed to high seismic activity and/or extreme weather events.

Table D - 1: Major dam failures and regulatory responses across jurisdictions

	NSW	QLD	UK (New legislation)	British Columbia (Canada)	California (US)
Incident Description	Three separate incidents: 1. Galambine Dam 2. Lake Mannus Dam failed in October 2010. 3. Oaky River Dam failed on the 22nd February 2013, following prolonged and very intense rainfall. The right hand side embankment section of the dam was breached and washed away.	An inflatable rubber dam device, used to raise the height of a weir to increase its capacity failed at Bedford Weir. This resulted in a release of 6,000 megalitres of water into the recreational area below.	In 1925, the failure of two dams caused a flood that swamped the village of Dolgarrog in North Wales, killing 16 people. The disaster was started by the failure of the Eigiau Dam, a small gravity dam. The water released from the reservoir flooded downstream, and overtopped the Coedy Dam, an embankment dam. This dam failed, releasing the huge volume of water that flooded Dolgarrog.	Testalinden Dam Failure - causing a debris and mud torrent that severely impacted a number of homes and an agricultural area eight kilometres south of Oliver, British Columbia	St. Francis Dam was designed and built by the City of Los Angeles in 1924-26, to contain a year's water supply for the city south of the San Andreas fault. Around midnight March 12/13, 1928 a massive landslide occurred along the dam's left abutment. A flood wave 140 ft deep swept down the canyon, Resulting in the loss of 420 lives.
No. of fatalities	0	1	16	0	420
Date of incident	1978-2013	23 November 2008	1925	13 June 2010	12 March 1928
Incident cause	1. Unknown 2. Overtopping due to heavy rain 3. Prolonged and very intense rainfall	Failure of the water storage bladder	Overtopping and burst embankment	Heavy rains in the area	Dam collapse - 13 different panels investigated the St Francis failure. Most blamed the failure on hydraulic piping along the inactive San Francisquito fault beneath the dam's right abutment.

	NSW	QLD	UK (New legislation)	British Columbia (Canada)	California (US)
Regulatory response	Regulation already in place	Inspections of all other similar structures across Queensland and a government report into the incident.	The disaster at Dolgarrog led the British parliament to pass the Reservoirs (Safety Provisions) Act in 1930 that introduced laws on the safety of reservoirs. This legislation was replaced by the Reservoirs Act, 1975.	Immediately following the Testalinden dam breach, staff from the Ministry of Environment (the Ministry) conducted a review of the Provincial Dam Safety Program and initiated a Rapid Dam Assessment (RDA) for the majority of dams in the province. This assessment was undertaken to determine if there were any other dams at risk of imminent failure and create an updated inventory of dams in the province	Following the St. Francis Dam failure in 1928, the following changes to dam safety occurred: <ul style="list-style-type: none"> • Engineering geologic input on dams became commonplace in the 1930s (it had been all but absent in the 1920s). • Review of all federal dams • Increased dam safety legislation in California • Professional engineering registration • State-mandated arbitration hearings for victims of natural disasters Impact on passage of the Boulder Canyon Project Act and the design of Hoover Dam • AIME and ASCE conferences on foundations for high dams • Increased awareness of uplift theory and effective stress • State review of San

NSW	QLD	UK (New legislation)	British Columbia (Canada)	California (US)
				Gabriel Dam at The Forks <ul style="list-style-type: none"> • Retrofit of Mulholland Dam • External Peer Review and the Proctor Compaction Test

C.3 Approaches to dam safety regulation

The current form of regulation in NSW lies slightly towards the more interventionist end of the spectrum, with the DSC making and auditing specific recommendations to dam owners, but having little ability to enforce these recommendations other than under a state of emergency. Four regulatory models that would each achieve the objective of providing dam safety, but with potentially different degrees of acceptable risk to life and property, are considered in the sections below.

The sections below provide a qualitative discussion of the costs and benefits of each option. A discussion of the quantitative costs of dam safety investment under each approach is difficult due to a lack of data and the difficulty of identifying dams with similar characteristics.

All jurisdictions in Australia except Western Australia have legislation in place relating to dam safety, with the regulatory body in charge being either a statutory authority or a government department. While objectives are outlined in legislation in Victoria and Queensland, it is common across jurisdictions internationally to have no formal objectives specified in the regulatory framework. For example, the UK, British Columbia, California, New York and the Federal Energy Regulatory Committee (FERC) do not explicitly state objectives in their legislation.

Table D - 2 below briefly outlines the governance arrangements for dam safety regulation across jurisdiction. The responsibilities of the regulators vary considerably, ranging from an administrator role where the regulator does not review any technical information but ensures that the correct processes are being undertaken, as is the case in Queensland, to an assessor and approver role where the regulator assesses dam conditions using its own resources, such as that in place in California. In the middle is the oversight role where the regulator relies on the assessment provided by the dam owner, as in the UK. In some jurisdictions, such as NSW, the regulator undertakes both administrator and oversight roles.

The regulatory bodies are mostly government funded, except for California where majority of revenue comes from collecting fees from dam owners, although they also receive a small grant from the government. The regulators vary in size with Victoria having one employee compared to 60 in California. The number of dams the regulators control also varies, with New York having 5,726 dams covered by the regulatory regime, compared to the 376 dams that NSW regulates.

Table D - 2: Governance arrangements across jurisdictions

	NSW Dams Safety Committee	Victoria Risk and Governance Group within the Office of Water	Queensland Department of Energy and Water Supply (DEWS)	UK (New legislation) Environment Agency	British Columbia (Canada) Ministry of Forests, Lands and Natural Resource Operations	California (US) Division of Safety of Dams within the Department of Water Resources	New York (US) Dam Safety Section of the Department of Environmental Conservation
Responsibilities of parties involved with dams	DSC role is to: maintain surveillance; examine dam location, design and construction. obtain information and keep records to ensure safety of prescribed dams. Owners are required to provide information and take measurements at the request of the DSC. The DSC may authorise dam inspections.	For public dams, Water Corporations must provide annual Statements of Obligations (SoO) dam safety reports. There are no specific reporting requirements for dams owned by public entities apart from Water Corporations (i.e., local government bodies, Parks Victoria). For private dams, construction and operating licenses are required. Licensing authorities are responsible for licensing/registering in accordance with guidelines, conducting on-site inspections; ensuring compliance; and developing and maintaining information on dams.	Regulator collates a register of service providers and publishes it annually, reviews and makes recommendations about the standards under the Act and monitors compliance with the Act. Service providers must have an approved strategic asset management plan that ensures continued supply	EA is a regulatory body that allows independent engineers and dam owners to undertake the majority of dam safety requirements. Where necessary they can: appoint an engineer if the owner fails to, commission essential works in the interests of safety in the event of non-compliance and act in an emergency if the owner is unable to.	Ministry of Environment comptroller appoints dam safety officers for various regions. Dam owners are required to report to the dam safety officer with submissions regarding operations, maintenance, emergency planning, alterations and reviews. They are also required to obtain a water licence.	The Division of Safety of Dams employs engineers who supervise all stages of the dam life cycle. They supervise construction, conduct inspections and can take control of the dam in emergency situations. The dam owners are required to submit information at the request of the department and pay filing and application fees.	The functions of the Department's Dam Safety Section include: safety inspection of dams; technical review of proposed dam construction or modification; monitoring of remedial work for compliance with dam safety criteria; and emergency preparedness.
Number of employees at the regulatory authority (FTEs)	11 FTEs plus 9 members of the DSC	1	16	12 (England and Wales)	12	60	12.5

	NSW Dams Safety Committee	Victoria Risk and Governance Group within the Office of Water	Queensland Department of Energy and Water Supply (DEWS)	UK (New legislation) Environment Agency	British Columbia (Canada) Ministry of Forests, Lands and Natural Resource Operations	California (US) Division of Safety of Dams within the Department of Water Resources	New York (US) Dam Safety Section of the Department of Environmental Conservation
Number of dams covered by the regulatory regime	376	300 (only includes 'significant' or higher hazard category dams, although all dams owned by Water Corporations are included in the regulations).	100	2115 (England and Wales)	1640	1254	5726
Funding arrangements	Government funded	Government funded	Government funded but regulator has the power to charge fees to owners	Government funded with ability to recover enforcement costs from dam owners and charge fees incurred in carrying out functions in connection with reservoirs.	Government funded and fees from licensing requirements.	Fees to dam owners account for over 99% of revenue, with the Federal Government providing a small grant.	Government funded with the ability to recoup costs for work it completes on behalf of the owner

Source: KPMG analysis

C.3.1 Self-regulation

Self regulation would involve removing the Act and the regulator in its current form, with responsibility for dam safety standards reverting to individual dam owners. Self regulation is the approach used in Western Australia and a number of other jurisdictions throughout the world.

Under self regulation, an Act may not be necessary. However, if a limited form of regulatory oversight was included in this framework, such as in a supervisory role, the Act would still be required to define the role and objectives of the regulator.

Under self regulation, dam owners would be responsible for determining the levels of investments in dam safety and the approaches to achieving these levels of safety.

While dam owners would not be in breach of dam safety regulations if they under-invest in dam safety, legal liability in the event of dam failure remains with dam owners. For this reason, it is likely that dam owners, particularly those with larger and higher consequence dams, would continue to seek to reduce legal liability by meeting best practice guidelines from other jurisdictions, such as the ANCOLD guidelines. However a review of dam safety in New Zealand found that under a self regulated approach, a number of large dams would need to be decommissioned due to safety concerns (PCL 2010).

Those with smaller, low consequence dams may be more likely to under invest in dam safety given restricted resources (this could be particularly true for farm dams and a large number of dams owned by councils). This could be the case where the expected consequences are restricted to damage to property, the environment and loss of the asset and the amenity it provides, as opposed to loss of life.

While this may reflect a willingness by dam owners to accept the legal consequences of dam failure, such as the requirement to pay compensation, it may not reflect the preference of society as a whole. For example, society may prefer prevention to compensation, particularly where the level of compensation paid does not adequately reflect the costs to downstream populations, property and the environment.

A recent paper by Dr John Pisaniello of the University of South Australia noted that reliance on the Common Law responsibility for landholders to maintain dams does not work in obtaining an acceptable level of dam safety. It particularly noted the high number of farm dam failures (Pisaniello 2010). While farm dams may not always be prescribed based on the low consequences of failure, the failure of small dams upstream may increase the risk of dam failure of a prescribed dam downstream.

It appears that owners of smaller dams, especially those that are more remote, are more likely to rely on a regulator such as the DSC to understand the risks posed by the dam, due to their lack of access to relevant expertise. In New Zealand, prior to the regulation of dams, a large number of small dams did not meet modern engineering standards (PCL 2010). It is not clear whether this issue was a function of an unwillingness to invest in dam safety upgrades or a lack of understanding of recent developments in the field of dam engineering. If it was the latter, increased information provision may be a more appropriate policy response than a prescriptive form of regulation.

Consultation with industry provided mixed responses. Some stakeholders suggest that in general, there would be little difference in dam safety investment in the absence of a regulator

prescribing dam safety outcomes. These stakeholders were of the view that dam owners would maintain existing investments to reduce their legal liability in the case of dam failure. Stakeholders noted that, in the absence of published safety standards, most dam owners would comply with ANCOLD guidelines.

Conversely, a number of dam owners suggested that a reduction in the level of government intervention would decrease the level of investment and increase the chance of dam failures. In addition, the review of dam safety in New Zealand indicated that an absence of safety regulation resulted in negative safety outcomes for dams (PCL 2010). This would suggest that under self regulation, there could be under-investment in dam safety relative to the socially optimal outcome.

This suggests that while the majority of large dams would achieve appropriate safety levels in the absence of regulation, some dams, in particular smaller dams, would not achieve socially desirable levels of investment. This indicates a need for government intervention for small dams is necessary in order to ensure appropriate safety outcomes.

Table D - 3: Summary of qualitative costs and benefits of a self-regulation model

Costs	Benefits
Likely reduction in safety standards for at least some dams leading to potential increase in loss of life and/or damage to property and environment.	Potential reduction in costs to dam owners through reduced capital expenditure on dam safety. (Note: This may not apply to all publicly owned dams. For some dams, the cost of capital expenditure can be passed on to end-users through fees and charges).
Legal liability likely to minimise increase in risk, at least among large dam owners. Some concern has been raised that this is not a sufficient incentive for smaller dam owners to invest in dam safety.	Reduced delays (e.g. for mining operations).
Risks increase over time as average age of dams rises. Would rely on dam owners to monitor risks over time.	Reduced administration and compliance costs through abolition of regulator (approximately \$1.5 million per annum (DSC, 2012)).
Potential loss of information to dam owners currently provided by the DSC.	
Increased costs to small dam owners in obtaining engineering information.	

C.3.2 Increased regulation

Under this approach, existing legislation would be amended to include increased regulation of dam safety by endowing the dams safety regulator with the powers to determine, oversee and approve all aspects of dam safety, similar to the approach used in California.

The dams safety regulator would have greater control of the investments undertaken by dam owners to improve dam safety. This may include greater ability to amend investment plans and enforce its decisions and power to require that dam owners undertake investment that the regulator considers necessary. To facilitate this approach the Act, or a similar instrument, would need to be amended to outline the role and responsibilities of the regulator.

Where the government’s role is expanded to include the design and construction of dam safety upgrades, the government may be considered more responsible in the event of a dam failure than under a more light handed regulatory approach.

Increasing the level of regulation provides the government with greater control over dam safety. This is particularly important where the private sector would not meet dam safety requirements without significant levels of government intervention. However, the better regulation principles state that intervention should be proportional to the problem that regulation is intended to address. The assessment framework developed in Section 3.2 suggests that intervention should be as light as possible given the need to address the market failures associated with dam safety.

Given the track record of dam safety in NSW, and the evidence that there is an over-investment in dam safety in NSW, higher levels of regulation do not appear necessary to achieve acceptable dam safety outcomes.

Table D - 4: Summary of qualitative costs and benefits of increased regulation model

Costs	Benefits
Significant increase in costs required to administer and oversee regulation.	Some increase in safety standards as all dams meet prescribed requirements.
Increased costs to dam owners and water consumers as highest level of safety standards implemented regardless of cost.	
Potential for loss of competition and increased costs of capital works for dams as all activity is at the direction of the regulator.	
Where the government is responsible for the prescription of dam safety investments, as well as the delivery of these investments, responsibility for dam safety may shift to the government from dam owners.	

C.3.3 Balanced approach to government intervention

The sections above suggest that significantly less or more intervention would not be expected to result in improved dam safety outcomes. Where safety outcomes are likely to be unchanged, less regulation is generally preferred on the grounds of regulatory efficiency. However, self-regulation may result in the deterioration of dam safety levels, particularly for small dams whose operators and owners may be less well-informed and less well-resourced. Importantly, industry stakeholders, including dam owners, did not show a preference for self-regulation.

NSW’s dam safety record suggests that an increase in the level of government intervention is unlikely to provide measurable additional benefits in outcomes. This suggests that a balanced approach to government intervention, such as the existing approach, is appropriate to deliver acceptable dam safety outcomes. The sections below consider two approaches to government intervention. The first is consistent with the existing approach to intervention in place in NSW. The second is based on the Victorian approach, where the government sets safety standards

and guidelines, but compliance in the case of large publicly owned dams is the responsibility of the dam owner.

The findings of this review suggest that an approach similar to that used in Victoria, where larger dam owners are responsible for compliance with the safety standards set by the regulator may be suitable going forward.

Under an approach similar to that of Victoria, the government regulator would be limited to a compliance and monitoring role. However the regulator would take a risk based approach to monitoring to reduce the burden of regulation on dam owners who are likely to comply with guidelines. Under this approach the regulator would:

- develop and publish safety standards and guidelines for dams in NSW;
- provide information necessary for dam owners to achieve the expected level of safety and comply with dam safety guidelines;
- monitor compliance with the safety standards and guidelines;
- take remedial action if a dam owner does not comply with the safety standards and guidelines and is not expected to meet these guidelines without further intervention.

While the regulatory framework for all dams would be consistent, the extent of the monitoring regime would vary for each dam as the regulator takes a risk based approach to determining the level of monitoring necessary. It is expected that dams with a high risk of non-compliance would be subject to greater monitoring than those with less risk of non-compliance. The appropriate level of monitoring would be a decision made by the regulator.

Dam owners would be responsible for developing their own strategies to comply with the dam safety guidelines published by the regulator with focus placed on investments in dam safety within a benefit cost analysis framework. The regulated businesses would report on their enforcement measures to the regulator on an annual basis.

Where businesses were not complying with the published guidelines, the regulator could compel the dam owner to develop an implementation plan to comply with the guidelines and undertake the necessary investments required to improve the safety of the dam.

An alternate approach would be to retain the DSC, but require that the DSC place greater emphasis on benefit cost analysis in its decision making. The DSC may also provide guidance on the approach dam owners should take in performing benefit cost analysis. Currently the DSC does not have formal guidelines in place to assess the economic impact of dam safety projects.

Whilst the NSW Treasury provides guidelines for undertaking economic appraisals, dam safety is a complex area that may benefit from the development of specific guidelines that assist in assessing the likely outcomes of dam safety upgrades. There are examples of other industries employing specific guidelines, for example the Roads and Maritime Services, which uses both the NSW Treasury guidelines as well as the RTA Economic Analysis Manual when evaluating proposed road safety projects.

The RTA Economic Analysis Manual provides guidance on the appropriate methodologies and economic parameter values to use when evaluating the costs and benefits of proposed road safety upgrades. A similar manual could be developed by the dams safety regulator to inform dam owners of the regulator's expectations when evaluating proposed investments in dam safety.

Box 3 below provides a brief summary of the government's role in dam safety regulation in Victoria and New South Wales.

Box 3: Regulatory frameworks in Victoria and New South Wales

Victoria

In Victoria, the Department of Sustainability and Environment (DSE), through the Office of Water is responsible for managing dam safety. A key aspect of the regulatory framework in Victoria is the significant difference in requirements for private and public dam owners. Public dams are regulated through a Statement of Obligation issued by the Minister and privately owned dams are regulated through licensing authorities.

These differing requirements provide greater flexibility to investments in publicly owned dams than those owned privately. In particular, the DSE and other government authorities have more responsibility for ensuring compliance with specified safety standards.

For public dams, a statement of obligations specify the obligations that dam owners have in performing their function and include clauses in relation to developing and implementing processes to identify, assess, and manage dam safety risks in the following areas:

- risk management;
- asset management;
- dam safety; and
- emergency response.

The obligations also require dam owners to:

- operate within the ANCOLD guidelines;
- prioritise the risks posed for all dam components and types of failure;
- give priority to reducing risk to life over other risks;
- determine the need for reducing risks relative to the ANCOLD tolerability limits;
- base the program for reducing risks on the concept of ALARP;
- where feasible, achieve the best results with available resources by progressively implementing risk reduction measures.

For private dams, powers are delegated to five Licensing Authorities (LAs). The LAs are responsible for:

- licensing or registering in accordance with the Ministerial Guidelines;
- making on-site inspections for licence applications;
- ensuring compliance with licence conditions and safety requirements; and,
- developing and maintaining a database of dams.

New South Wales

The DSC has a role in regulating the safety of dams as well as regulating the operation of mines within the areas surrounding dams. The DSC determines which dams are subject to regulation based on the consequence category of the dam and sets the safety standards for dams in NSW, which is similar to the ANCOLD guidelines.

For dams with risks that are deemed 'intolerable' by the DSC, dam owners are required to reduce that risk as soon as is reasonable. For dams with risks below this level, dam owners are able to propose a level of investment they consider to be ALARP. For a risk to be ALARP, the cost of reduction in risk must be grossly disproportionate to the risk reduction achieved.

Prescribed dams are monitored by the DSC through Inspection Reports and Surveillance Reports. These reports are drafted by dam owners and submitted to the DSC. In general, where proposed dam safety measures do not meet DSC norms, the DSC seeks evidence that the risks are considered tolerable. As part of its consideration of this evidence the DSC considers the advice given by the dam owner's professional advisors.

The DSC also has a role in the approvals process for mining projects within the areas surrounding prescribed dams. The DSC is able to recommend amendments to mining leases to protect prescribed dams.

The DSC makes recommendations to the Minister prior to the granting of a mining lease. As with dam surveillance, the DSC considers evidence provided by the mining company and its expert advisors when considering whether to make a recommendation to the Minister.

C.3.3.1 Existing form of intervention

The government may choose to maintain the current level of government intervention with some amendments to the regulatory framework to improve, for example, the transparency and accountability of the dams safety regulator.

Under this approach, the level of government intervention would remain at the current level, however recommendations in other sections of this report would seek to address the actions of the regulator, including the composition of the committee, decision making procedures and the dissemination of information.

This approach has proven to be successful in minimising the risk and consequences of dam failure in NSW. However, maintaining regulation in its existing form has been criticised for the level of investment required to meet its safety standards. The over-investment in dam safety can also be addressed by changing the level of safety standards (as seen in Section 5).

Investment in dam safety is largely driven by the safety standards set by regulators. Under the current approach to regulation, the DSC is responsible for setting safety standards while dam owners are responsible for determining the approach to meeting the DSC standards. Below the tolerable level of risk and consequences, dam owners are responsible for deciding whether to use the DSC's standards or to set their own safety standards and provide evidence as to why these standards are ALARP.

Under this approach, the DSC does not provide input on the appropriate level of investment unless the proposals of the dam owner are deemed insufficient. This may allow over-investment to occur if the dam owner has an incentive to over-invest in dam safety upgrades. This may be the case where a regulated business aims to increase its asset base to obtain greater regulated returns.

C.3.3.2 Increased compliance responsibility for dam owners

There may be a case for increasing the amount of flexibility in the current level of regulation, for example, establishing a new regulatory body that issues guidelines and safety standards for larger dams, but maintains a greater degree of intervention in the case of small dams.

In Victoria, a distinction is made between public and private dam ownership, with public dams typically representing the larger dams in the state. While this approach does not treat similar dams consistently, an approach where all dam owners are responsible for complying with regulatory standards could be appropriate.

Under this approach, the dams safety regulator would retain its responsibility for the setting of safety standards for all dams. The regulator would fulfil a monitoring and compliance role, with the extent of the monitoring based on the likelihood of non-compliance. The Act, or a similar instrument, would need to be amended to reflect the role of the regulator.

Dam owners would be subject to a lighter form of regulation, where dam owners are responsible for determining the appropriate approach to meeting dam safety standards, without the regulator approving proposals for dam safety upgrades. Dam owners would be required to take a risk-based approach to dam safety, including consideration of the costs and benefits of investments in dam safety. Owners of dams would be responsible for setting the level of investment in dam safety required for their own dams. Dam owners would be required to report to the regulator annually on the progress of their dam safety management programs.

In Victoria for example, the regulator establishes ANCOLD guidelines as a basis for safety investments. However, large dam owners have responsibility for ensuring the compliance of their dams. Where large dam owners do not comply with published guidelines, the relevant Minister can request that the dam owner rectify the situation.

While dam owners are free to determine the appropriate level of dam safety investment within the framework of the specified guidelines, legal liability remains with dam owners in the case of dam failure. For this reason, it is likely that dam owners would continue to seek to reduce legal liability by meeting best practice guidelines from other jurisdictions, such as the ANCOLD guidelines.

Under the approach recommended in this review, all dams are subject to the same regulatory framework. However, the extent of regulatory monitoring may differ from dam to dam based on the likelihood of non-compliance. The distinction between dams would be determined by the regulator.

Table D - 5: Summary of qualitative costs and benefits of partial regulation model

Costs	Benefits
Limited likelihood of significant reduction in safety standards for large dams due to legal liability requirements.	Potential reduction in costs to large dam owners through reduced capital expenditure on dam safety. (Note that this does not apply to dams where the cost of capital expenditure can be passed on to end-users through fees and charges).
Some potential increase in loss of life and/or damage to property and environment.	Some reduction in delays (e.g. for mining operations).
	Improved cost-benefit analysis of individual dam upgrade requirements, suggesting that the reduction in dam safety would be small relative to the reduction in costs to dam owners, and subsequently consumers of dam services.
	Reduced costs of regulation as the regulator is not required to ensure compliance of all prescribed dams.

C.4 Stakeholder views on government intervention

Stakeholder views of the role of government and the level of government intervention focussed on the role of the regulator and the power of the regulator rather than on the appropriate regulatory model. However, stakeholders did not support self regulation, with two thirds of stakeholders indicating that there would be an increase in the chance of dam failures if self-regulation was in place.

While some concern has been raised regarding the cost of the existing form of regulation, there was a mixed response as to whether self regulation would reduce the costs of dam safety. The majority of stakeholders responding to the survey thought that the cost of managing dam safety would stay the same (49 per cent) or rise (15 per cent) under self-regulation. However, 36 per cent stated that costs would fall under self regulation. The mixed response suggests that most stakeholders would not expect a large decrease in investment costs under self regulation

The majority of stakeholders believe that the current dam safety measures are effective, with over 94 per cent of respondents stating that the current use of prescriptive and risk based standards are; somewhat, very or extremely effective in achieving an appropriate level of public safety. The use of a combination of prescriptive and risk based standards was further justified as 89 per cent of respondents stated this is the best approach to regulating dam safety.

One stakeholder opined that the DSC was intended to be an “industry watchdog and not a decision maker”. This suggested a preference for a less interventionist role for government. Most respondents to the online survey supported a regulatory body in the form of a statutory authority (71 per cent). In addition, over half of the respondents also believe that the regulator should perform an oversight role, relying on assessments provided by the owner, rather than a more interventionist role.

Dam owners and non-dam owners responded differently to the question of whether the dams safety regulator should have extended powers to enforce safety measures. Seventy-four per cent of dam owners believe that, if the DSC were to remain as regulator, their powers should be kept the same, whereas only 29 per cent of non-dam owners, believed this should be the case, with 64 per cent arguing that the DSC's powers should be increased.

Appendix D: Review of Risk Management Framework

D.1 Risk Criteria Types

Risks to people can be expressed in two complementary forms:

- **Individual risk** - the risk experienced by an individual person. The frequency at which an individual may be expected to sustain a given level of harm from the realisation of specified hazards; and
- **Societal risk** - the risk experienced by the whole group of people exposed to the hazard. The relationship between the frequency and the number of people suffering from a specified level of harm in a given population from the specified hazards

Both risk types are discussed as the dam safety risk management policy framework⁸ under review presents both individual and societal risk criteria.

Individual Risk

Individual risk is the risk experienced by a single individual in a given time period. It reflects the severity of the hazards and the amount of time the individual is in proximity to each of them. The number of people present does not significantly affect it.

Individual risk is defined formally (by Institution of Chemical Engineering, UK) as the frequency at which an individual may be expected to sustain a given level of harm from the realization of specified hazards. It is usually taken to be the risk of death, and usually expressed as a risk of fatality per year.

Individual risk may be calculated in various ways, and although each is consistent with the above definition, the results may differ substantially. The three main types of individual risk:

Location-specific individual risk (LSIR)

This is used to indicate the risk at a particular location. It is the risk for a hypothetical individual who is positioned there for 24 hours per day, 365 days per year. It is a standard output from a Quantitative Risk Assessment (QRA). The geographical variation of LSIR may be represented by iso-risk contour plots and used for land-use planning.

Individual-specific individual risk (ISIR)

This estimate takes into account of people being at different hazardous locations within a facility for different lengths of time. Risk estimates from a QRA are often converted to this form before comparing with risk criteria or data.

⁸ Dams Safety Committee NSW 2006

Average individual risk (IR)

This is usually calculated from historical data

Individual risk = Number of fatalities/number of people at risk

This is the average **ISIR** over the group of people included in the data. 'Every day' average individual risk values can be found in Appendix D-2.

Although these different forms are widely used, the use of the distinguishing terms LSIR, **ISIR** and average IR is less common. This often causes confusion when comparing individual risks from different studies. Also, when comparing risk results with criteria, it is important that consistent definitions are used.

Societal Risks

Societal (or group) risk is the risk experienced in a given time period by the population local to the hazard. It reflects the severity of the hazard and the number of people in proximity to it. It is usually taken to refer to the risk of death, and usually expressed as a risk per year. Societal risk is defined (by Institution of Chemical Engineering, UK) as the relationship between the frequency and the number of people suffering a given level of harm from the realization of specified hazards.

The term 'societal risk' is sometimes taken to refer to members of the public. It can also refer to the workers. Societal risks may be expressed in the form of:

- **FN curves**, show the relationship between the cumulative frequency (F) and number of fatalities (N).

FN curves are frequency-fatality plots, showing the cumulative frequencies (F) of events involving N or more fatalities.

FN curves are graphical measures of group risk that show the relationship between frequency and size of the accident.

- **Annual fatality rates**, in which the frequency and fatality data is combined into a convenient single measure of group risk.

The annual fatality rate (AFR) is the long-term average number of fatalities per year due to a particular cause. For a particular event, it is equal to the frequency of the event (F), multiplied by the number of fatalities caused (N). The fatality rates of all relevant events may be summed to give the total AFR for the accident type or the installation as a whole.

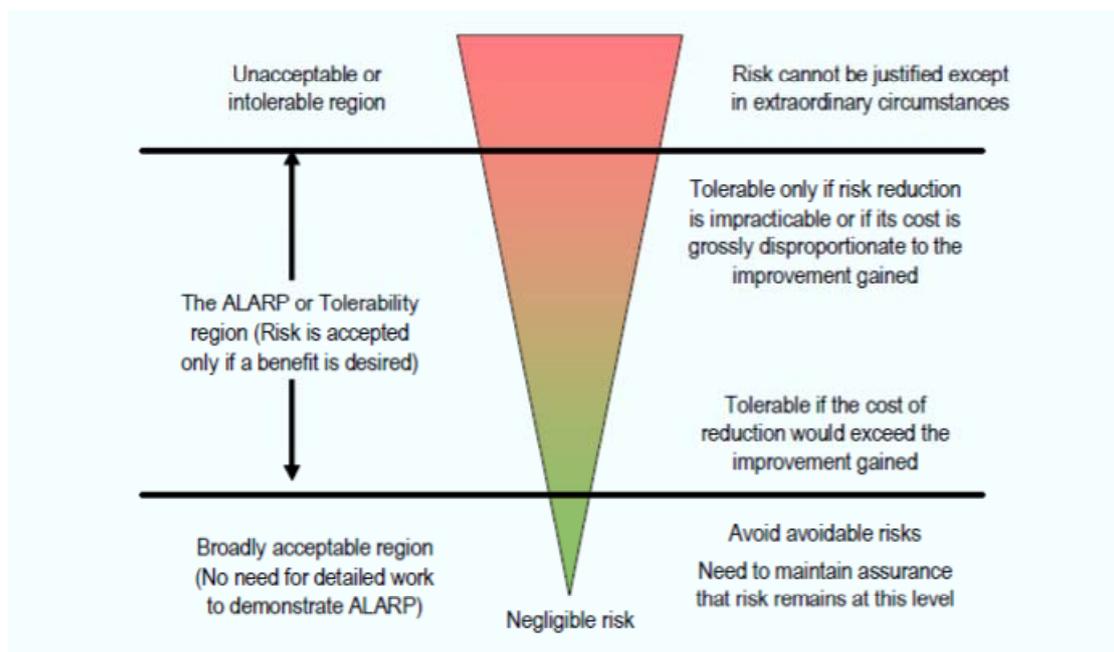
Although the AFR is a standard measure of societal risk it has a number of various names:

- Expectation value (EV) of group risk;
- Potential loss of life (PLL) per year;
- Rate of death (ROD); and
- Annual fatality rate (AFR).

D.2 DSC Risk Criteria

The Dams Safety Committee (DSC) in NSW has defined risk criteria for public safety⁹. The criteria are in the form of individual risk and societal risk. Both forms of criteria follow the pattern of the UK HSE tolerability framework¹⁰, which is graphically represented as Figure E - 1 below.

Figure E - 1: UK HSE Risk Tolerability Framework



The framework has three areas, an upper area where risks are so high as to be intolerable in nearly all circumstances, a lower area where risks are so low that further reasonable and practicable risk reductions are unlikely to be found, and a central area where risks are only tolerable if they are As Low As Reasonably Practicable (ALARP). The framework is a practical interpretation on how to meet the OHS duty in English and Australian law to “ensure safety so far as reasonably practicable”¹¹.

The DSC has effectively adopted this framework and its concepts of upper and lower limits are manifest in the DSC’s individual and societal risk criteria. One concept that does not seem to have translated into the DSC framework is the concept of gross disproportion, an aspect of the HSE framework that has precedence in UK and Australian law.

⁹ Dams Safety Committee NSW 2006

¹⁰ UKHSE, 1992

¹¹ It should be recognised that both the framework and formulations to demonstrate ALARP are only guidance (albeit published by regulators) and compliance does not necessarily mean compliance with the legal duty, which is a legal decision made by a court of law.

Individual Risk Criteria

Risk acceptability proposed in 2006 by the DSC for members of the public from dam hazards as individual risk are as follows:

For existing dams, the DSC's limit of tolerability is 1 in 10,000 per annum, which is the same as that of ANCOLD and of Health and Safety Executive, United Kingdom (HSE). For proposed dams and major augmentations, the DSC's limit of tolerability is 1 in 100,000 per annum, which is the same as that of ANCOLD.

For all dams and major augmentations, the DSC's negligible risk is 1 in 1,000,000 per annum...In line with the HSE view, the DSC regards this negligible level of risk as so low that it is not worth searching for further reduction, though any obvious inexpensive precautions would be taken.

Of note is the fact that the DSC has adopted the ANCOLD criterion, which is based on HSE ISIR criteria limits and not the LSIR criteria from commonly used for land planning (as in the UK, NSW and Victoria).

Societal Risk Criteria

Risk acceptability proposed by the DSC for members of the public from dam hazards as societal risk are presented as Figure E - 2 for existing dams and Figure E - 3 for proposed dams and major augmentations.

Figure E - 2: Societal Risk Requirements: Existing Dams – Comparison with other industries

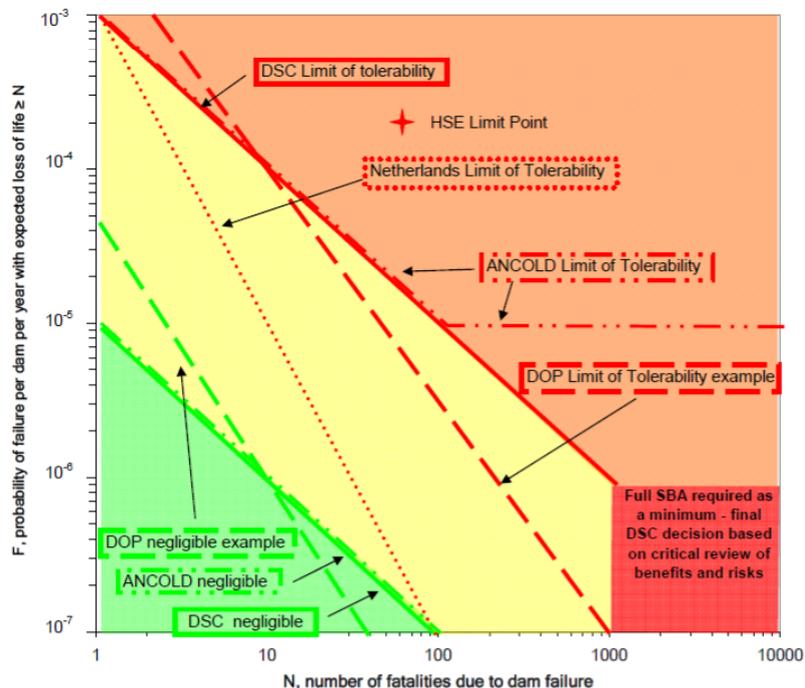
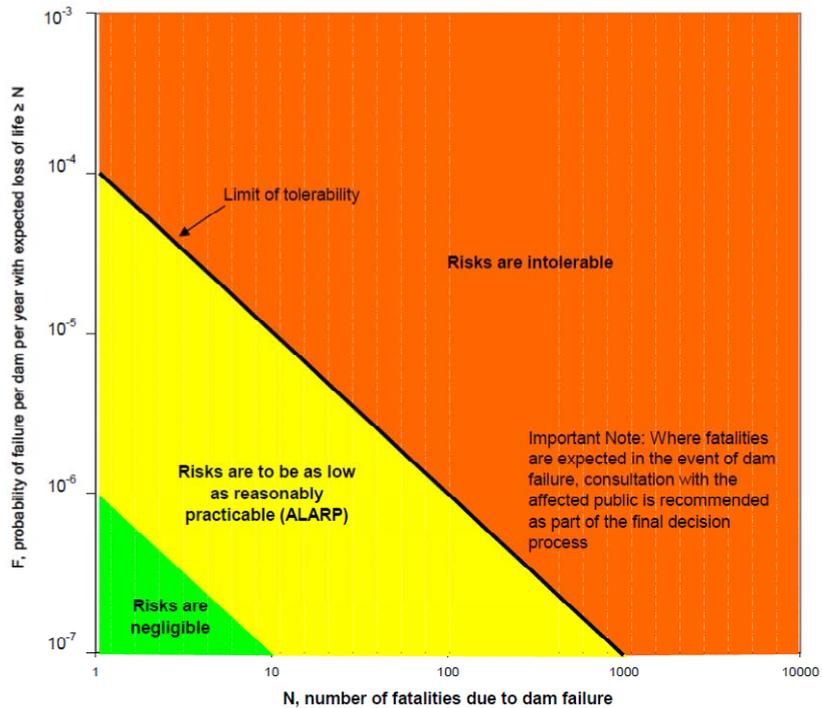


Figure E - 3: DSC Societal Risk Criteria for Proposed Dams



The NSW DOP societal risk criteria are also shown on Figure E - 3.

Published Risk Criteria

Much of the published risk criteria in standard and guidelines are based upon the UKHSE defined risk tolerability framework and management approach.

Commentary regarding UKHSE’s view of the acceptable and tolerable ranges is provided in Appendix D-3. The US has used the risk of a person of contracting cancer, averaged over a working life as a basis for defining its single-level criteria. As this is for workers and not the public the US criteria is not explored further.

Individual Risk Criteria

NSW DOP individual risk criteria

In NSW a LSIR based criteria is presented as Table E - 1. This guidance is also commonly adopted by the Queensland major hazard regulator. Note that it only defines the upper limit and varies according to land use.

Table E - 1: NSW Department of Planning individual risk criteria

Land Use	Suggested Criteria (risk in a million per year)
Hospitals, schools, child-care facilities, old age housing	0.5
Residential, hotels, motels, tourist resorts	1
Commercial developments including retail centres, offices and entertainment centres	5
Sporting complexes and active open space	10
Industrial	50

Victorian Individual Risk Criteria for major hazards

Individual risk criteria for public safety relating to hazardous industries in Victoria have been published in an “interim” form for over 20 years and are used by Worksafe in making determinations on the acceptability of new major hazards. Table E - 2 provides an overview of the LSIR based individual risk criteria that are generally applied to land use surrounding major hazards.

Table E - 2: Victorian Offsite Individual Risk Criteria

Conditions	Acceptable Risk (per year)	
	New Plant	Existing Plant
Maximum acceptable risk level in residential areas	1×10^{-7}	1×10^{-7} ¹⁾
Risk level not to be exceeded at plant boundary	1×10^{-5}	1×10^{-5} ²⁾

- 1) For risk levels between 1×10^{-5} and 1×10^{-7} per year all practicable risk reduction measures to be taken, but a restriction on residential development is applicable to new proposals. (i.e. $<10^{-7}$ per year is acceptable, with no additional controls required and $> 10^{-5}$ is unacceptable.)
- 2) When outside the plant boundary risk reduction measures must be taken.

Western Australian EPA Land Use Planning Criteria

The EPA has since 1986, required proponents of industrial projects to assess the off-site individual risks from its plant. Since that time the EPA has issued the guidance to provide the background for the setting of individual fatality risk criteria and also discussing aspects on societal risk. Current understanding of the WA criteria is as follows:

(a) A risk level in residential areas of one in a million per year or less is so small as to be acceptable to the EPA.

(b) A risk level in "sensitive developments", such as hospitals, schools, child care facilities and aged care housing developments, of one half in a million per year or less is so small as to be acceptable to the EPA. In the case of risk generators within the grounds of the "sensitive development" necessary for the amenity of the residents, the risk level can exceed the risk level of one half in a million per year up to a maximum of one in a million per year, for areas that are intermittently occupied, such as garden areas and car parks.

(c) Risk levels from industrial facilities should not exceed a target of fifty in a million per year at the site boundary for each individual industry, and the cumulative risk level imposed upon an industry should not exceed a target of one hundred in a million per year.

(d) A risk level for any non-industrial activity or active open spaces located in buffer areas between industrial facilities and residential areas of ten in a million per year or less is so small as to be acceptable to the EPA.

(e) A risk level for commercial developments, including offices, retail centres, showrooms, restaurants and entertainment centres, located in buffer areas between industrial facilities and residential areas, of five in a million per year or less, is so small as to be acceptable to the EPA.

Note how such criteria are almost identical to the NSW Department of Planning criteria presented on Table E - 1.

UK Individual Risk Criteria for Land Use Planning

Trbojevic in his paper (Trbojevic 2005) states

"It is also interesting to mention an alternative set of criteria based on the scaled risk integral or "injury criterion" has been proposed in 1989 by the HSE for land use planning (LUP), HSE 1989. The criteria are defined in terms of a dangerous dose of toxic gas, or heat, or explosion overpressure which gives the following effects a) severe distress to almost everyone, b) a substantial fraction requires medical attention, c) some people are seriously injured, requiring prolonged treatment, and d) highly susceptible people might be killed. The risk is then defined as the "risk of dangerous dose" or the risk of receiving a dangerous dose, or worse. The corresponding criteria are out of date but are summarised in Table E - 3 together with the current LUP methodology, HSE 2003. It should be noted that light shaded areas correspond to the new 2003 criteria, HSE 2003. The main difference is that in the current version there are three regions of risk zones (inner – nearest to the hazard site, middle and outer) for which HSE has not yet specified any numbers."

Table E - 3: UK Individual Risk Criteria for Land Use Planning

Category of development	Individual Risk of Dangerous Doze [Per Year] - 1989		
	> 10 ⁻⁵	Between 10 ⁻⁵ and 10 ⁻⁶	Between 10 ⁻⁶ and 0.3 x 10 ⁻⁶
Sensitivity Level - 2003	Inner Zone	Middle Zone	Outer Zone
Housing developments providing for more than 25 people (Category A)	Assessment required. Against development if > 25 people	Assessment required. Against development if > 75 people	Allow development
Level 1	DAA	DAA	DAA
Small workplaces, parking areas, etc. (Category B)	Allow development	Allow development	Allow development
Level 2	AA	DAA	DAA
Retail, community, leisure facilities, some workplaces, (Category C)	Assessment required. Against development if > 100 people	Assessment required. Against development if > 300 people	Allow development
Level 3	AA	AA	DAA
Highly vulnerable or very large facilities (Category D)	Against development	Assessment required. Against development if > 25 people	Specific assessment required
Level 4	AA	AA	AA
DAA	Don't advise against development		
AA	Advise against development		

Table E-3 above is used by the HSE for land use planning in the vicinity of existing facilities. They are not used in the assessment of risks from a proposed facility.

Comparison of Criteria

The risk levels for the boundaries between the regions are given in various government guidelines and industry standards and are shown in Table E - 4. It is stated which of the individual risk approaches defined previously are used for the basis of each criteria.

Table E - 4: Guideline / Standard / Regulator's Documented Risk Criteria - Individual

Source and Application	Risk Criteria (per annum)						
	10 ⁻²	10 ⁻³	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶	10 ⁻⁷	10 ⁻⁸
NSW DSC individual risk (also ANCOLD, Dam Safety Victoria, Queensland) (ISIR)	Orange	Orange	Yellow	Yellow	Green	Green	Green
Existing Dams	Orange	Orange	Yellow	Yellow	Green	Green	Green
New Dams	Orange	Orange	Yellow	Yellow	Green	Green	Green
Victorian "Interim" Offsite Individual Risk Criteria (public risk) (LSIR)	Orange	Orange	Yellow	Yellow	Green	Green	Green

Source and Application	Risk Criteria (per annum)						
	10 ⁻²	10 ⁻³	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶	10 ⁻⁷	10 ⁻⁸
NSW DOP criteria (public risk) (LSIR)	[Orange bar from 10 ⁻² to 10 ⁻⁶]						
residential, hotels, resorts	[Orange bar from 10 ⁻² to 10 ⁻⁶]						
sporting complexes active open space	[Orange bar from 10 ⁻² to 10 ⁻⁵]						
industrial #	[Orange bar from 10 ⁻² to 10 ⁻⁴]						
WA EPA criteria (public risk) (LSIR)	[Orange bar from 10 ⁻² to 10 ⁻⁶]						
residential	[Orange bar from 10 ⁻² to 10 ⁻⁶]						
non-industrial activity or active open spaces	[Orange bar from 10 ⁻² to 10 ⁻⁵]						
industrial #	[Orange bar from 10 ⁻² to 10 ⁻⁴]						
UK LUP "dangerous dose" (public risk) (LSIR)	[Orange bar from 10 ⁻² to 10 ⁻⁵ ; Green bar from 10 ⁻⁶ to 10 ⁻⁸]						
Housing developments >25 people #	[Orange bar from 10 ⁻² to 10 ⁻⁵ ; Green bar from 10 ⁻⁶ to 10 ⁻⁸]						
Retail; Community, leisure facilities > 100 people #	[Orange bar from 10 ⁻² to 10 ⁻⁵ ; Green bar from 10 ⁻⁶ to 10 ⁻⁸]						
Highly vulnerable or very large facilities >25 people#	[Orange bar from 10 ⁻² to 10 ⁻⁶ ; Green bar from 10 ⁻⁷ to 10 ⁻⁸]						
UK HSE, 1992 ¹²	[Orange bar from 10 ⁻² to 10 ⁻³]						
Maximum risk to workers in any industry (ISIR)	[Orange bar from 10 ⁻² to 10 ⁻³]						
Risk to average radiation worker (ISIR)	[Orange bar from 10 ⁻² to 10 ⁻⁴]						
UK HSE, 2001 ¹³ R2P2 – members of the public (ISIR)	[Orange bar from 10 ⁻² to 10 ⁻³ ; Yellow bar from 10 ⁻³ to 10 ⁻⁶ ; Green bar from 10 ⁻⁶ to 10 ⁻⁸]						
UK HSE, 2002 ¹⁴ ~(ISIR) workers	[Orange bar from 10 ⁻² to 10 ⁻³ ; Yellow bar from 10 ⁻³ to 10 ⁻⁶ ; Green bar from 10 ⁻⁶ to 10 ⁻⁸]						
UK HSE, 2009 ¹⁵ - tolerable level not stated	[Green bar from 10 ⁻⁶ to 10 ⁻⁸]						
The Netherlands (LSIR) **	[Orange bar from 10 ⁻² to 10 ⁻⁵ ; Yellow bar from 10 ⁻⁵ to 10 ⁻⁸ ; Green bar from 10 ⁻⁸ to 10 ⁻⁸]						
Limit for existing installations	[Orange bar from 10 ⁻² to 10 ⁻⁵ ; Yellow bar from 10 ⁻⁵ to 10 ⁻⁸ ; Green bar from 10 ⁻⁸ to 10 ⁻⁸]						
Limit for new installations post 2010	[Orange bar from 10 ⁻² to 10 ⁻⁶ ; Yellow bar from 10 ⁻⁶ to 10 ⁻⁸ ; Green bar from 10 ⁻⁸ to 10 ⁻⁸]						

¹² UKHSE, 1992

¹³ UKHSE, 2001, R2P2 &, Trbojevic

¹⁴ UKHSE, 2002

¹⁵ UKHSE, 2009

Source and Application	Risk Criteria (per annum)							
	10 ⁻²	10 ⁻³	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶	10 ⁻⁷	10 ⁻⁸	
International Maritime Organization								
Existing Ships (crew members) (ISIR)	Intolerable	ALARP	ALARP	ALARP	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable
New Ships (ISIR)	Intolerable	Intolerable	ALARP	ALARP	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable
Hong Kong¹⁶ (workers?)								
	Intolerable	Intolerable	ALARP	ALARP	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable
API RP 752:2003 (Management of Hazards associated with the location of Process Plant Buildings) Ed.2* +								
within occupied building (ISIR)	Intolerable	Intolerable	ALARP	ALARP	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable
UK Chemical Industries Association +								
Maximum tolerable risk (within occupied building) (ISIR)	Intolerable	Intolerable	Intolerable	Intolerable				

× Directly sourced data except where indicated
 + Inferred data
 * API RP 752:2009 supersedes Edition 2 and does not include risk acceptance and tolerance levels
 ~ Provided within the Guidance for illustrative purposes only.
 # Exact value not shown - order of magnitude shown only
 ** Netherlands criteria is for as low as reasonably achievable (ALARA) not ALARP.

LEGEND

Intolerable ALARP Broadly Acceptable Negligible

¹⁶ Schmidt, M

Societal Risk

A comparison of published societal risk criteria is presented as Table E - 5. The DSC criteria are very similar to the others it's compared to at the F(1) level, except for UK R2P2. This is also apparent in the criteria presented as Figure E - 3.

Table E - 5: Comparison of societal risk criteria for public adjacent to industrial hazards

Source	Upper Limit F(1)	Aversion Factor	ALARP width (orders of magnitude)
NSW DSC Existing	1.00E-03	1	2
NSW DSC New	1.00E-04	1	2
NSW DOP (indicative)	3.00E-03	1.5	2
NFPA 59A LNG	1.00E-03	1	2
UK R2P2	1.00E-02	1	
UK COMAH	1.00E-03	1.5	
Netherlands	1.00E-03	2	
Hong Kong	1.00E-03	1	2

Note "F(1)" is the frequency of 1 or more fatalities and the typical y axis intercept; hence it forms a useful reference point for societal risk criteria. Hong Kong criteria have a cut off at 1000 fatalities.

Analysis

Individual Risk Criteria

The following comments can be made about the DSC individual risk criteria:

- Are based on UK HSE limits for the public, but are being used as a LSIR whereas the UK HSE values are ISIR.
- Limits do not compare well with LSIR values used for land use planning in NSW, Victoria and WA, being consistently too high and not sensitive to land use.
- Having stricter criteria for new installations is common.

The obvious question is why dams are being treated differently to other industrial hazards. While the new dam criteria are coming into line with the NSW DOP criteria for "active open spaces" they are not as sophisticated as the DOP criteria as they do not consider land use. Hence the recommendation is to converge to the DOP criteria.

Societal Risk Criteria

The DSC criteria are very similar to the others regulations they are compared with at the F(1) level, except for UK R2P2. Again the question can be asked as to why are dams being treated differently from other industrial hazards, and perhaps, should they be using the NSW DOP criteria, which also are similar to UK R2P2 criteria.

Trbojevic (2005) makes a number of criticisms of societal risk criteria, namely that it does not link to more officially gazetted individual risk criteria (note how NSW DOP societal criteria are "indicative"). Additionally Trbojevic criticises that the size of the population the societal risk

criteria can be applied to is undefined and it appears that the same criteria can be used for say 100 and 100,000 people. Using Trbojevic's method to link the DSC existing dam societal risk criteria with the existing dam individual risk criteria requires the exposed population to be 97, which may be higher than what is typical downstream of dams. This makes the societal risk criteria too lax, and as a result the defining criteria are the individual risk criteria.

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'Every Day' Risks

Table E - 6: Hazards and Risk Levels Resulting from Voluntary and Involuntary Activities¹⁷

Risk estimate		Example	
> 1:100	> 10 ⁻²	First year of life, Glasgow 1855	1 : 8
1:100 - 1:1,000	10 ⁻³ - 10 ⁻²	First year of life, Scotland 1990	1 : 130
		Smoking 20 cigarettes/day	1 : 200
1:1,000 - 1:10,000	10 ⁻³ - 10 ⁻⁴	Cancer from all causes	1 : 500
		All natural causes for 40 year old	1 : 850
		Drinking alcohol	1 : 2,600
1:10,000 - 1:100,000	10 ⁻⁵ - 10 ⁻⁴	Influenza	1 : 5,000
		Road accidents	1 : 7,000
		Accidents at home	1 : 9,000
		Leukaemia	1 : 12,000
		Swimming	1 : 20,000
1:100,000 - 1:1,000,000	10 ⁻⁶ - 10 ⁻⁵	Accidents at work	1 : 43,000
		Lung cancer from passive smoking	1 : 50,000
		Homicide	1 : 50,000
		Accidental poisoning	1 : 60,000
		Travelling by aeroplane	1 : 100,000
		Winning Lottery (100 stakes)	1 : 140,000
1:1,000,000 - 1:10,000,000	10 ⁻⁷ - 10 ⁻⁶	Electrocution	1 : 300,000
		Therapeutic use of drugs	1 : 500,000
< 1:10,000,000	< 10 ⁻⁷	Hit by lightning	1: 10,000,000
		Radiation leak from nuclear plant	1: 10,000,000
		Meteorite Strikes	1: 1,000,000,000

¹⁷ Edited from Kempton, RA & NSW Government, Department of Planning 2008

UK HSE Commentary

Boundary between the 'broadly acceptable' and 'tolerable' regions for risk entailing fatalities¹⁸

"HSE believes that an individual risk of death of **one in a million per annum** for both workers and the public corresponds to a very low level of risk and should be used as a guideline for the boundary between the broadly acceptable and tolerable regions. ... we live in an environment of appreciable risks of various kinds which contribute to a background level of risk – typically a risk of death of one in a hundred per year averaged over a lifetime. A residual risk of one in a million per year is extremely small when compared to this background level of risk. Indeed many activities which people are prepared to accept in their daily lives for the benefits they bring, for example, using gas and electricity, or engaging in air travel, entail or exceed such levels of residual risk."

Boundary between the 'tolerable' and 'unacceptable' regions for risk entailing fatalities¹⁹

"We do not have, for this boundary, a criterion for individual risk as widely applicable as the one mentioned above for the boundary between the broadly acceptable and tolerable regions. This is because risks may be unacceptable on grounds of a high level of risk to an exposed individual or because of the repercussions of an activity or event on wider society. Indeed, it would be quite unusual for high levels of individual risk not to engender societal concerns, on equity grounds, for example, as we have already argued.

The converse is not, however, true – society can be seized by hazards that pose, on average, quite low levels of risk to any individual but could impact unfairly on vulnerable groups, such as the young or the elderly or particularly susceptible individuals.

Furthermore, exposure to an activity may result in a low level of average risk to any one individual but the totality of such risks across the affected population would not be acceptable as judged by the socio-political response to a particular event such as a railway disaster. Nevertheless, in our document on the tolerability of risks in nuclear power stations, we suggested that an individual risk of death of one in a thousand per annum should on its own represent the dividing line between what could be just tolerable for any substantial category of workers for any large part of a working life, and what is unacceptable for any but fairly exceptional groups. For members of the public who have a risk imposed on them 'in the wider interest of society' this limit is judged to be an order of magnitude lower – at 1 in 10 000 per annum."

¹⁸ UKHSE 2001

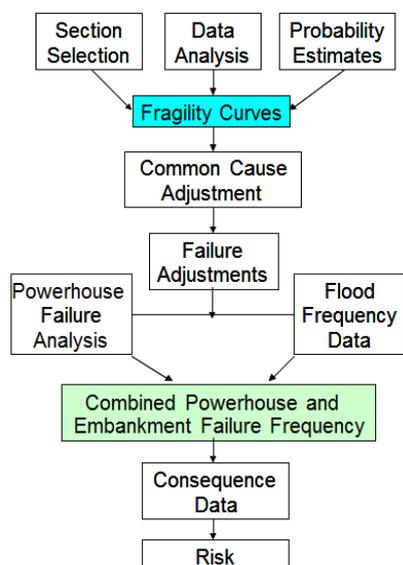
¹⁹ UKHSE 2001

Engineering approach to measuring risk

The Probability of dam failure is estimated using quantitative estimates for the annual probability of the loads that may cause failure of the dam and the system response of the dam or associated structures to the loads. This is depicted in the following diagram for flood loading, which also includes potential failure of a powerhouse, which affects the flood probability.

Given a flood event, what is the response of the structure to the load (probability of failure conditional on the load applied – fragility curve). The system response curves for each of the components are then adjusted to ensure that the probabilities do not sum to more than 1.0 for common cause events and length effects. These adjusted response curves are then integrated with the Flood frequency (probability) data to calculate the annual probability of failure for the structure.

The probability of failure is evaluated for the most likely failure modes affecting the dam and varies according to the dam type.



There are a number of methods used to calculate the system response input data including:

- Reliability Analysis
- Historic performance of structures

Expert Engineering Judgement – This method is the most common method of analysis and relies on the use of experienced personnel to subjectively evaluate the likely response of the structure to the potential failure mode. A number of publications have been developed in recent years to assist in making these judgements, which also make use of mapping schemes to assign probabilities to event descriptions.

Appendix E: Safety standards in other jurisdictions

The two types of safety standards employed by jurisdictions are prescriptive standards and risk based standards. Most jurisdictions use a mix of both, although California and New York only use prescriptive based standards for dam safety. In all jurisdictions, the dam owner has responsibility for dam safety and can be liable for failure.

Victoria's and Queensland's regulations, similar to those for NSW, reference the F-N curve as contained in the ANCOLD guidelines when detailing tolerable societal risk. Canada has a risk curve that is in line with the ANCOLD guidelines, whereas the UK uses guidelines developed by the HSE. The tolerable individual risk is one in 10,000 per year for existing dams and one in 100,000 for new dams in Australian jurisdictions. Both the UK and Canada have an upper limit of risk of death to any individual of one in 10,000 per year. The ALARP principle is used in most jurisdictions with the exception of Canada and the US.

Details of the safety standards across the jurisdictions can be seen in Table F - 1 below.

Table F - 1: Safety standards across jurisdictions

	NSW	Victoria	Queensland	UK (New legislation)	British Columbia (Canada)	California (US)	New York (US)
Safety standards	Prescriptive regulation approach (or a staged risk-based approach) for Extreme Consequence Category Dams and the option to use either a standards or risk-based approach for all other prescribed dams	Public dams: Combination of standards and risk. Private dams: Standards-based.	There are three different standards used: 1. Small dam standard which applies to earthen embankments < 12m high with a PAR ≤ 15 and a depth of flooding <3m, and is a scaled back version of the ANCOLD standards 2. ANCOLD standards which are used for larger dams where the cost of undertaking a full risk assessment is not warranted when weighed against the potential benefits 3. Risk-based standards in all other cases	Dependent on the development of secondary legislation.	Not clearly defined in publicly available documentation related to British Columbia. However, the Canadian Dam Association published risk assessment guidelines in 2007 which are intended to be used by regulators and owners in Canada.	Standards-based approach	Standards-based approach
Tolerable societal risk	The NSW regulations reference the F-N curve as contained in the ANCOLD guidelines, though there is a cut-off at a PAR of 1,000 (to match NSW DoPI societal risk levels)	The Victorian regulations reference the F-N curve as contained in the ANCOLD guidelines.	The Queensland regulations reference the F-N curve as contained in the ANCOLD guidelines.	Dependent on the development of secondary legislation.	The Canadian Dam Association has a risk curve that is in line with the ANCOLD guidelines, except after 100 PAR where the line is not horizontal (as is the case with ANCOLD) but extends down at a slope of -1	N/A	N/A

	NSW	Victoria	Queensland	UK (New legislation)	British Columbia (Canada)	California (US)	New York (US)
Tolerable individual risk	1 in 10,000 per year for existing dams or 1 in 100,000 per year for proposed dams or major augmentations	1 in 10,000 for existing dams; 1 in 100,000 for new dams or major augmentations of existing dams.	1 in 10,000 for existing dams; 1 in 100,000 for new dams or major augmentations of existing dams.	Dependent on the development of secondary legislation.	Upper limit of risk of death to any individual of 1 in 10,000 per annum.	N/A	N/A
Use of risk-based standards and ALARP principles	For all dams that are not classified as Extreme, and where the societal risk levels are not outside the zone of tolerability, ALARP can be used to justify a safety position in the short to medium term. However, in the long run, dams must meet ANCOLD standards. ALARP principles are set out in Guidance notes.	For public dams the ANCOLD approach is applied and the cost-to-save-a-statistical life should be used when determining whether the ALARP principle is satisfied. ALARP principles are defined in guidance notes.	Developed an equation to determine when ALARP is satisfied	Dependent on the development of secondary legislation.	No	No	No

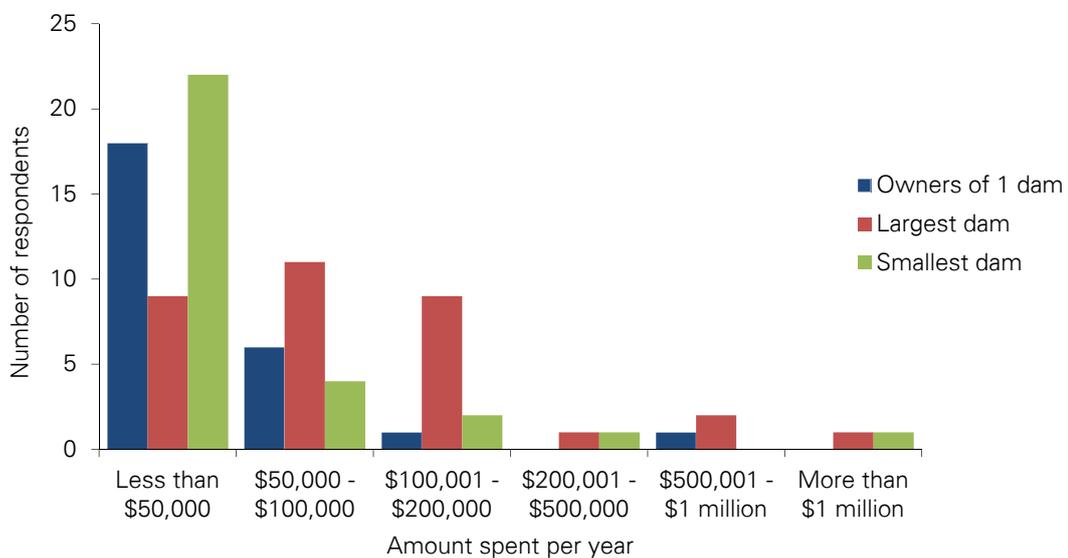
Source: KPMG analysis

Appendix F: Costs of dam safety investment

As part of the online survey, stakeholders were asked various questions around dam safety costs. The section below outlines the key findings from those questions.

As mentioned in Section 5, the costs of dam safety are generally not large for dam owners. The charts below highlight the costs of annual dam safety maintenance that is required by the DSC, as stated by respondents of the online survey. Whilst there are some outliers who spend a large amount annually on dam safety, around 90 per cent of dam owners spend less than \$200,000 annually on dam safety required by the DSC.

Figure G - 1: Regular dam safety maintenance cost required by the DSC



While the results from the survey indicate that costs for dam safety are reasonably low, the costs vary when compared by ownership.

Table G - 1 shows that the majority of dam owners spend less than \$200,000 per year on dam safety, with the exception of State Owned Corporations, who have over 50 per cent of dam owners spending in excess of \$200,000 per year. These high costs may reflect that State Owned Corporation dams have a high consequence of failure and/or that the storage of water is an important part of their business.

Table G - 1: Regular dam safety maintenance cost required by the DSC

Amount spent per year	State Government Departments	State Owned Corporations	Local Council	Mining Companies
Less than \$50,000	1	1	28	10
\$50,000 - \$100,000	1	2	10	7
\$100,001 - \$200,000	0	1	6	3
\$200,001 - \$500,000	0	1	1	0
\$500,001 - \$1 million	0	2	0	0
More than \$1 million	0	2	0	0
Total number of Respondents	2	9	45	20

Section 5 outlined the operating and capital costs spent on dam safety as a proportion of total costs for owners of a single dam. The below charts show the same details but for owners of more than one dam, broken down into their largest and smallest dams. The results are similar to that of single dam owners, with the majority spending less than 10 per cent of operational and capital expenditure on dam safety. The main difference is that large dams tend to have a higher proportion of operating and capital costs spent on dam safety when compared to smaller dams.

Figure G - 2: Average annual cost of undertaking regular dam safety maintenance as a percentage of total operations and maintenance budget

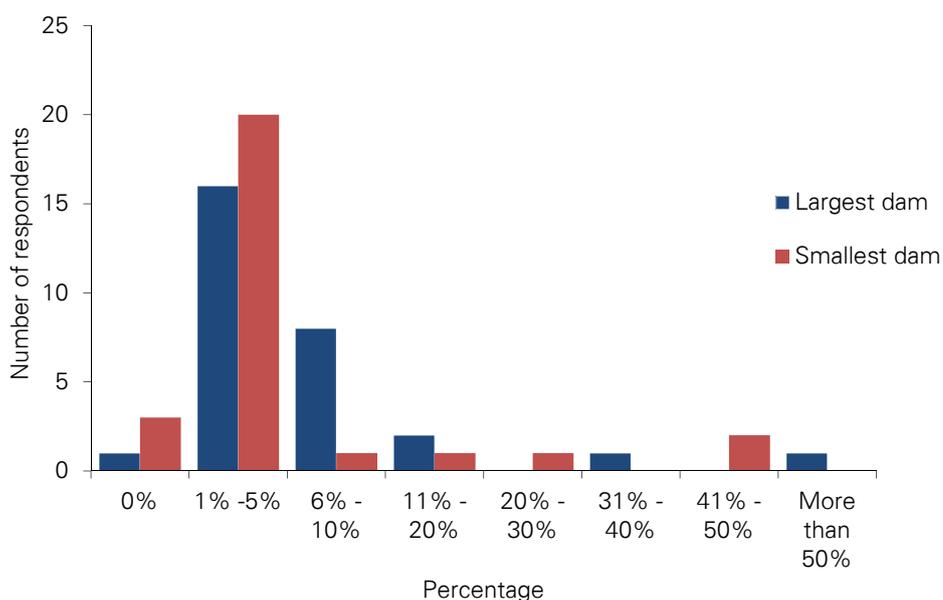
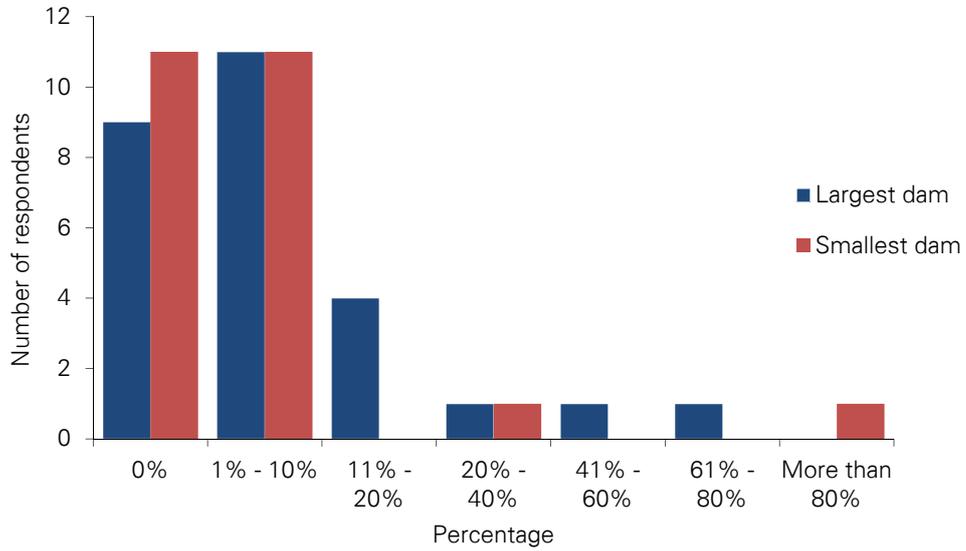


Figure G - 3: Capital expenditure on dam safety upgrades as a percentage of total capital expenditure over the last five years - largest dam



Appendix G: Online survey questions

Survey: NSW Dam Safety Review Survey - Dam owners

NSW Dams Safety Review Survey - Dam Owners

Thank you for taking the time to contribute to this survey about dam safety regulation in NSW. Your feedback will inform the review of the Dams Safety Committee and the Dams Safety Act 1978 being conducted by KPMG.

The review is focussing on whether the current arrangements are cost-effectively and efficiently delivering an appropriate level of dam safety in NSW. It is recommended that you read the Issues Paper on the review, which describes the context in which the survey is being conducted and the purposes for which specific types of information are being collected, before completing the survey.

The survey is structured into 10 sections which cover the following topics:

- Respondent details
- Objectives of the dam safety regime
- Governance arrangements
- Approach to regulating dam safety
- Safety standards
- Compliance costs
- Dam safety and the planning system
- Dam safety and extreme weather events
- Dam safety and seismic activity
- Dam safety and mining

At the end of the survey space is provided for any additional comments you would like to raise.

You can select save and continue if you would like to leave the survey and complete at a later time; if you do so please use the original survey link (below) and you will be asked if you would like to resume the survey.

This survey will take approximately 30 minutes to complete. Please submit your response by **22 March 2013**.

Please provide only **one response per organisation**.

All responses are confidential and will be reported to NSW Trade and Investment in aggregated form to ensure individual respondents cannot be identified.

If you have any queries regarding this survey, please contact Steven Casey at KPMG on (02)9455 9470 or email stevencasey@kpmg.com.au or Nicki Hutley at KPMG on (02) 9346 6240 or email nhutley@kpmg.com.au.

By clicking on the "Next" button below you acknowledge that you have read and understood all of the information detailed in this notification, and agree to undertake the survey.

Further information about how KPMG handles your personal information is set out in our [Privacy Statement](#).

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Background information

Which of these best describes your ownership structure? *

- State government department

- State owned corporation
- Other water corporation
- Local council
- Mining company
- Energy company
- Other company
- Non-government organisation

How many dams do you own? *

How many of these dams are prescribed by the Dams Safety Committee (DSC)? *

Where are these dams located? *Select all that apply*

	Number of dams
Northern Rivers	<input type="text"/>
Mid-North Coast	<input type="text"/>
Hunter	<input type="text"/>
Northern Tablelands	<input type="text"/>
Sydney Metropolitan	<input type="text"/>
Illawarra	<input type="text"/>
South Coast	<input type="text"/>
Central Tablelands	<input type="text"/>
Southern Tablelands	<input type="text"/>
Snowy Mountains	<input type="text"/>
North West Slopes & Plains	<input type="text"/>
Central West Slopes & Plains	<input type="text"/>
South West Slopes	<input type="text"/>
Riverina	<input type="text"/>
Lower Western	<input type="text"/>
Upper Western	<input type="text"/>

What types are the dam/dams that you own? *Please state the total number of dams for each type.*

	Concrete	Rockfill	Earthfill	Tailings
Number of dams by type	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

What is the main use of the dam/dams? *Please state the total number of dams for each type. Please select only one use for each of the dams that you own.*

	Water supply	Flood management	Tailings	Contaminated water	Retarding basin	Recreation
Number of dams by type	<input type="text"/>					

What consequence categories do the prescribed dams that you own fall into? Please state the total number of dams for each category.

	Very low	Low	Significant	High A	High B	High C	Extreme
Number of dams by consequence category	<input type="text"/>						

Does the DSC require that you have a Dam Safety Emergency Plan (DSEP) in place? *

- I am required to have a DSEP in place
- I am not required to have a DSEP in place

Objectives

Do you have a clear understanding of the public safety objectives that the NSW Government is trying to achieve through the Dams Safety Act 1978? *

- I do have an understanding of the public safety objectives the NSW Government is trying to achieve
- I do not have an understanding of the public safety objectives the NSW Government is trying to achieve

Please state what you believe those objectives are or should be, eg., "Maintain dam safety standards to protect populations that live downstream" (list at least one): *



The safety of dams in NSW is currently regulated by the Dams Safety Committee (DSC), the New South Wales state regulator which was constituted under the Dams Safety Act 1978 (the Act). There are no objectives explicitly stated in the Act; the Act only defines the constitution and functions of the DSC. The DSC defines its primary goal as being that "dams meet the DSC safety requirements" and it also has a number of secondary goals.

Thinking about the Act in its current form do you think it:

- Needs to change to include specific objectives
- Seems to be appropriate, and does not need to state any objectives
- Other, please specify

How effective is the Act and the DSC in the current form in enabling you to manage the safety of your dam/dams? *

- Extremely effective

- Very effective
- Somewhat effective
- Not very effective
- Not effective at all

Please use this space if you have any comments relating to the effectiveness of the Act and DSC:

What do you see as being the most important objective of the Act and DSC should be? *

- Maintain dam safety standards to protect populations that live downstream
- Maintain dam safety standards to prevent potential environmental damage in the case of a dam failure
- Maintain dam safety standards to prevent dam failures, irrespective of population at risk
- Manage risks around dam safety to a level consistent with community risk preferences
- Other, please specify

In its current form, the Act defines the DSC's constitution and functions, but does not explicitly include any regulations. If there were changes to the Act, what do you see as being important to include in the new legislation to best achieve the objectives you have identified?

Please rank in order of importance, with 1 being the most important.

Objectives of the Act

Details of the regulations

New/additional powers for the regulator (including for example powers to impose greater penalties and enforce decisions)

Community consultation requirements

Specific regulations

Other

If you ranked 'Other', or wish to provide any additional detail, please specify details here:

Do you think the dams safety regime should: *

- Maintain the risk of dam failure at a negligible level, regardless of the associated cost of dam safety maintenance and upgrades
- Ensure the risk of dam failure does not exceed a defined threshold, regardless of the associated cost of dam safety maintenance and upgrades

- Allow for consideration of the cost of dam safety maintenance and upgrades in determining the acceptable level of risk applying to individual dams
-

Governance

The DSC is a statutory authority that formulates regulations around dam safety in NSW.

What do you think would be the best governance arrangement for dam safety in NSW? *

- Self regulation (i.e. Dam owners are responsible all decisions relating to the safety of their dam)
 - Regulatory body in the form of a statutory authority (i.e. The DSC or similar body remains responsible for dams safety)
 - Regulatory body in the form of a government agency
 - Other, please specify
-

If dam safety was managed by a regulator (DSC or other body), what do you think the role of the regulator should be? *

- Administrator – the regulator does not review any technical information, but ensures that the correct processes are being undertaken. This involves ensuring that the owner is receiving and responding to advice from suitably qualified engineers.
 - Oversight role – the regulator relies on the assessment provided by the owner, and the regulator must approve the person who has provided the assessment and accept the evaluation.
 - Assessor and Approver – the regulator assesses dam conditions using its own resources, and it approves documents provided by the dam owner.
-

Please use this space if you have any comments about the role of the regulator:

If the DSC were to remain as the regulator, should its powers to enforce safety measures (e.g. through mandatory directives and/or fines) be: *

- Increased
 - Kept the same
 - Decreased
-

Please use this space if you have any comments about the level of power of the DSC:

What do you think the outcome, in terms of safety, would be if there was a change in the dam safety regime to require dam owners to self-manage dam safety (eg., there was no longer a body like the DSC setting mandatory standards)? *

- No change - the dam/s I manage would remain unlikely to fail

- Some change - over the longer term I would be less confident about the safety of the dam/s without some level of independent oversight
- Significant change - there would be a much greater chance of dam failures

Please provide a brief explanation of your answer:

What do you think the outcome, in terms of costs of maintaining dam safety, would be if there was a change in the dam safety regime to require dam owners to self-manage dam safety?

- My costs of managing dam safety would fall
- There would be no change in my costs
- My costs of managing dam safety would increase

Please provide a brief explanation of your answer:



If the DSC were to remain as the regulator, what should the composition of the committee look like? *

- Stay the same
- Stay the same, but also include other representatives
- Other, please specify

Which of the following representatives should also be included on the Committee or one of its sub-groups?

Select all that apply

- Representative for the Councils
- Lawyer
- Economist
- Risk expert
- Insurer
- Other, please specify

Approach to regulating dam safety



How clear is the current approach to prescribing dams?

If you are a dam owner, you may wish to consider how easy it was for you to understand whether and why your dam falls under the DSC's regulatory

requirements.

- Extremely clear
 - Very clear
 - Somewhat clear
 - Not very clear
 - Not clear at all
-

How effective is the DSC dam categorisation (by consequence category) as a way of grouping the large range of dam types and sizes in NSW? *

- Extremely effective
 - Very effective
 - Somewhat effective
 - Not very effective
 - Not effective at all
-

How would you rank your understanding of how the risk-based standards work in practice?

- Excellent understanding
- Good understanding
- Average understanding
- Poor understanding
- No understanding

Please use this space if you have any comments relating to your understanding of the standards:

Currently the DSC uses a mixture of prescriptive standards (based on ANCOLD guidelines) and risk-based standards (that allow dam owners to justify a lower safety level for some dams) for regulating dam safety in NSW.

How effective is this approach in achieving an appropriate level of public safety (i.e. preventing dam failures)? *

- Extremely effective
- Very effective
- Somewhat effective
- Not very effective
- Not effective at all

Please use this space to make any comments about the current approach to regulating dam safety:

How useful is the current approach to regulating dam safety in allowing you to manage the safety of your dam/dams in the most cost-effective way? *

- Extremely useful
- Very useful
- Somewhat useful
- Not very useful
- Not useful at all

Please use this space if you have any comments relating to the current approach to regulating dam safety:

What do you think is the best approach to regulating dam safety? *

- Prescriptive standards only (based on ANCOLD guidelines)
- Current combination of prescriptive and risk-based standards
- Combination of prescriptive and risk-based standards, with increased reliance on risk-standards (for example allow large dam owners to only use risk-based standards and small dam owners choose between risk-based and prescriptive standards)
- Risk-based standards only

When should risk-based standards be allowed?

- For all consequence category dams
- In the short-term
- In the medium-term
- In the long-term
- Other, please specify

Safety standards

How well do the current safety standards align to the dam safety preferences of the community near your dams? *

- Completely aligned
- Somewhat aligned
- Not aligned at all

How difficult do you find it to be to meet the safety standards required by the DSC?

- Not difficult at all, my dam/dams typically exceed DSC standards
- Somewhat difficult, my dam/dams typically meet DSC standards
- Very difficult, I typically struggle to meet the DSC standards for my dam/dams

If you reported 'somewhat' or 'very difficult' in the previous question, what makes it difficult to meet the DSC's safety standards?

Please rank the following in order of difficulty, with 1 being the most difficult

- | | |
|---|--------------------------|
| Costs of compliance | <input type="checkbox"/> |
| Time required to comply | <input type="checkbox"/> |
| Lack of access to expertise | <input type="checkbox"/> |
| Insufficiently skilled in-house personnel | <input type="checkbox"/> |
| Other | <input type="checkbox"/> |

If you selected 'Other', please specify details:

Which of the following represents your view of how safety standards should be set by the NSW dam safety regulator? *

- Minimise risks that might lead to dam failure
- Accept risks that might lead to dam failure within tolerable levels

The DSC sets out its risk-based standards in its Guidance notes.

How clear are these risk-based standards, in terms of whether you can use these standards for your dam? *

- Extremely clear
- Very clear
- Somewhat clear
- Not very clear
- Not clear at all

How useful are the DSC's guidance notes in describing the 'as low as reasonably practicable' (ALARP) principal such that you understand how to use ALARP in justifying the current or proposed modified risk status of your dam?

- Extremely useful
- Very useful
- Somewhat useful
- Not very useful
- Not useful at all

How has the introduction of the risk-based standards impacted on the amount you need to spend on dam safety for your dam?

- Reduced my expenditure, please specify the percentage change
 - No change
 - Increased my expenditure, please specify the percentage change
-

Compliance

How much does it cost you each year to undertake regular dam safety maintenance required by the DSC?

If you own **more than 1** dam, please answer for your largest and smallest dams.

Click on the orange "?" icon below for information about the costs to consider when answering this question



	Less than \$50,000	\$50,000 - \$100,000	\$100,001 - \$200,000	\$200,001 - \$500,000	\$500,001 - \$1 million	More than \$1 million
I own only 1 dam	<input type="radio"/>	<input type="radio"/>				
My largest dam	<input type="radio"/>	<input type="radio"/>				
My smallest dam	<input type="radio"/>	<input type="radio"/>				

Please use this space to provide any information relating to your annual dam safety maintenance costs:

What is your average annual cost of undertaking regular dam safety maintenance as a percentage of your total operations and maintenance budget? If you own **more than 1** dam, please answer for your largest and smallest dams.

	0%	1% -5%	6% - 10%	11% - 20%	20% - 30%	31% - 40%	41% - 50%	More than 50%
I own only 1 dam	<input type="radio"/>							
My largest dam	<input type="radio"/>							
My smallest dam	<input type="radio"/>							

How would you rate the current costs of complying with the DSC's requirements for regular dam safety maintenance? If you own **more than 1** dam, please answer for your largest and smallest dams.

	More than what would usually be spent on dam safety maintenance	About what would be spent otherwise	Less than would usually be spent on dam safety maintenance
I own only 1 dam	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My largest dam	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My smallest dam	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Over the last 10 years, how much have you had to spend on capital upgrades of your dam as a result of DSC requirements? Please provide your best estimate, and specify the time frame over which this money was spent. If you own **more than 1** dam, please answer for your largest and smallest dams.

	Amount (\$)	Timeframe (Years)
I own only 1 dam	<input type="text"/>	<input type="text"/>
My largest dam	<input type="text"/>	<input type="text"/>
My smallest dam	<input type="text"/>	<input type="text"/>

Please use this space to provide any information relating to your dam capital upgrade costs:

What was this capital expenditure on dam safety upgrades as percentage of your total capital expenditure over the last 5 years? *If you own **more than 1** dam, please answer for your largest and smallest dams.*

	0%	1% - 10%	11% - 20%	20% - 40%	41% - 60%	61% - 80%	More than 80%
I own only 1 dam	<input type="radio"/>						
My largest dam	<input type="radio"/>						
My smallest dam	<input type="radio"/>						

How would you rate the benefit of the upgrade in terms of increasing the safety of your dam?

	Extremely beneficial	Very beneficial	Somewhat beneficial	Not very beneficial	Not beneficial at all
I own only 1 dam	<input type="radio"/>				
My largest dam	<input type="radio"/>				
My smallest dam	<input type="radio"/>				

How did the upgrade impact on the probability of failure of your dam? *If you own **more than 1** dam, please answer for your largest and smallest dams.*

	Increased the probability of failure	Kept about the same	Decreased the probability of failure
I own only 1 dam	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My largest dam	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My smallest dam	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How did the upgrade impact on the population at risk of your dam? *If you own **more than 1** dam, please answer for your largest and smallest dams.*

	Increased the population at risk	Kept about the same	Decreased the population at risk
I own only 1 dam	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My largest dam	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My smallest dam	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How would you rate the current costs of complying with the DSC's dam safety upgrade requirements? *If you own **more than 1** dam, please answer for your largest and smallest dams.*

More than what would usually be spent on dam	About what would be spent otherwise	Less than would usually be spent on dam safety
---	--	---

	safety upgrades		upgrades
I own only 1 dam	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My largest dam	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My smallest dam	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Thinking about the future, how much will you have to spend on capital upgrades of your dam as a result of DSC requirements? Please provide your best estimate, and specify the time frame over which this money was spent. If you own **more than 1** dam, please answer for your largest and smallest dams.

	Amount (\$)	Timeframe (Years)
I own only 1 dam	<input type="text"/>	<input type="text"/>
My largest dam	<input type="text"/>	<input type="text"/>
My smallest dam	<input type="text"/>	<input type="text"/>

What is the approximate replacement value of your dam? If you own **more than 1** dam, please answer for your largest and smallest dams.

	Amount (\$)
I own only 1 dam	<input type="text"/>
My largest dam	<input type="text"/>
My smallest dam	<input type="text"/>

Dam safety and the planning system

New developments downstream of a dam can impact on the safety requirements by changing the consequence category of a dam.

How do you find out about new developments downstream from your dam/dams? Select all that apply *

- Notification from the developer
- Notification from the local council
- Notification from the DSC
- Other, please specify

Please use this space to make any comments about how you find out about new developments downstream from your dam:

How would you rate the timeliness of the DSC's involvement in the planning process for new development applications?

- Proactive
- Very responsive
- Somewhat responsive

- Not very responsive
- Not responsive at all
- N/A

Please use this space if you have any comments relating to the responsiveness of the DSC to new development applications:

How could dam safety considerations be more effectively integrated into the planning system?

Please rate in order of importance, with 1 being the most important

Requiring all development applications to include a question about whether the proposed development is downstream of a dam and sending this information to the DSC and upstream dam owners

Sending a summary of all development applications to the DSC, who would then notify upstream dam owners

Other

If you ranked 'Other', please specify details here:

Dam safety and extreme weather events

How effective are the current DSC requirements (including DSEPs) in managing the risks around extreme weather events?

- Extremely effective
- Very effective
- Somewhat effective
- Not very effective
- Not effective at all

How clear is the current framework in terms of outlining the requirements on different parties (e.g. dam owners, the SES) in the case of a dam failure in an extreme weather event?

- Extremely clear
- Very clear
- Somewhat clear
- Not very clear
- Not clear at all

How would you rate the current balance of responsibilities between dam owners and the SES in the case of a dam failure as a result of an extreme weather event?

- About right
- About the right distribution of responsibilities between the dam owner and SES, but not enough responsibility on other government agencies (e.g. the Police)
- Too much responsibility on the dam owner and not enough on the SES and other government agencies
- Too much responsibility on the SES and not enough on the dam owner and other government agencies

Please use this space to make any comments relating to the responsibilities of dam owners and the SES in case of dam failure as a result of an extreme weather event:

How would you rate the level of guidance you received in preparing your DSEP from the SES, in particular in regards to setting notification levels?

- About right
- Not enough

Who should be responsible for setting notification/alert levels?

*Please rank the **top 3** in order of importance, with 1 being the most important*

Dam owners	<input type="text"/>
DSC	<input type="text"/>
The Minister	<input type="text"/>
Local councils	<input type="text"/>
SES	<input type="text"/>
Other	<input type="text"/>

If you ranked 'Other', please specify details here:

Dam safety and seismic activity

How important do you consider the risks associated with seismic activity to be for your dam or dams?

- Extremely important
- Very important
- Somewhat important
- Not very important
- Not at all important

How would you rate the current dam safety regulatory requirements relating to seismic activity?

- Set at a level that is too high
 - About right
 - Set at a level that is too lenient
-

Dam safety and mining

How effective is the DSC in currently managing risks around dam safety that are associated with mining?

- Extremely effective
 - Very effective
 - Somewhat effective
 - Not very effective
 - Not effective at all
-

How could the DSC change its approach to managing risks to dam safety associated with mining? *Select all that apply*

- Working more closely with mining companies in the early stages of process of developing a mine - e.g. at the feasibility study stage
- Responding more quickly applications by mining companies
- Making more guidance materials available to help mining companies ensure that there application will be approved without significant re-workings or other delays
- Other, please specify

Any other comments:

Survey follow-up

If you are happy for KPMG to contact you about your survey response as part of this review project, please provide your contact details here:

Name:

Organisation:

Email address:

Phone number:

Thank you for completing this survey. Your input is greatly appreciated.

Please click on the "Submit" button below to ensure your response is counted.

If you have any queries regarding this survey, please contact Ingrid Emery at KPMG on (02) 9335 8131 or email ingridemery@kpmg.com.au.

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NSW Dams Safety Review Survey - Stakeholders other than Dam Owners

Thank you for taking the time to contribute to this survey about dam safety regulation in NSW. Your feedback will inform the review of the Dams Safety Committee and the Dams Safety Act 1978 being conducted by KPMG.

The review is focussing on whether the current arrangements are cost-effectively and efficiently delivering an appropriate level of dam safety in NSW. It is recommended that you read the Issues Paper on the review, which describes the context in which the survey is being conducted and the purposes for which specific types of information are being collected, before completing the survey.

The survey is structured into nine sections which cover the following topics:

- Respondent details
- Objectives of the dam safety regime
- Governance arrangements
- Approach to regulating dam safety
- Safety standards
- Dam safety and the planning system
- Dam safety and extreme weather events
- Dam safety and seismic activity
- Dam safety and mining

At the end of the survey space is provided for any additional comments you would like to raise.

You can select save and continue if you would like to leave the survey and complete at a later time; if you do so please use the original survey link (below) and you will be asked if you would like to resume the survey.

This survey will take approximately 30 minutes to complete. Please submit your response by **22 March 2013**.

Please provide only **one response per organisation**.

All responses are confidential and will be reported to NSW Trade and Investment in aggregated form to ensure individual respondents cannot be identified.

If you have any queries regarding this survey, please contact Steven Casey at KPMG on (02)9455 9470 or email stevencasey@kpmg.com.au or Nicki Hutley at KPMG on (02) 9346 6240 or email nhutley@kpmg.com.au.

By clicking on the "Next" button below you acknowledge that you have read and understood all of the information detailed in this notification, and agree to undertake the survey.

Further information about how KPMG handles your personal information is set out in our [Privacy Statement](#).

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Background information

Which of these best describes you? *

- Government department
- Dam Safety Committee member/employee

- Mining company
- Other stakeholder, please specify

Objectives

Do you have a clear understanding of the public safety objectives that the NSW Government is trying to achieve through the Dams Safety Act 1978? *

- I do have an understanding of the public safety objectives the NSW Government is trying to achieve
- I do not have an understanding of the public safety objectives the NSW Government is trying to achieve

Please state what you believe those objectives are or should be, eg., "Maintain dam safety standards to protect populations that live downstream" (list at least one): *



The safety of dams in NSW is currently regulated by the Dams Safety Committee (DSC), the New South Wales state regulator which was constituted under the Dams Safety Act 1978 (the Act). There are no objectives explicitly stated in the Act; the Act only defines the constitution and functions of the DSC. The DSC defines its primary goal as being that "dams meet the DSC safety requirements" and it also has a number of secondary goals.

Thinking about the Act in its current form do you think it:

- Needs to change to include specific objectives
- Seems to be appropriate, and does not need to state any objectives
- Other, please specify

What do you see as being the most important objective of the Act and DSC should be? *

- Maintain dam safety standards to protect populations that live downstream
- Maintain dam safety standards to prevent potential environmental damage in the case of a dam failure
- Maintain dam safety standards to prevent dam failures, irrespective of population at risk
- Manage risks around dam safety to a level consistent with community risk preferences
- Other, please specify

In its current form, the Act defines the DSC's constitution and functions, but does not explicitly include any regulations. If there were changes to the Act, what do you see as being important to include in the new legislation to best achieve the objectives you have identified? *

Please rank in order of importance, with 1 being the most important.

Objectives of the Act

Details of the regulations

New/additional powers for the regulator (including for example powers to impose greater penalties and enforce decisions)

Community consultation requirements

Specific regulations

Other

If you ranked 'Other', or wish to provide any additional detail, please specify details here:

In your understanding, who pays for dam safety maintenance and upgrades?

- Dam owners/water users
- The DSC/NSW Government
- Commonwealth Government
- Other, please specify

Do you think the dams safety regime should: *

- Maintain the risk of dam failure at a negligible level, regardless of the associated cost of dam safety maintenance and upgrades
- Ensure the risk of dam failure does not exceed a defined threshold, regardless of the associated cost of dam safety maintenance and upgrades
- Allow for consideration of the cost of dam safety maintenance and upgrades in determining the acceptable level of risk applying to individual dams

Governance

The DSC is a statutory authority that formulates regulations around dam safety in NSW.

What do you think would be the best governance arrangement for dam safety in NSW? *

- Self regulation (i.e. Dam owners are responsible all decisions relating to the safety of their dam)
- Regulatory body in the form of a statutory authority (i.e. The DSC or similar body remains responsible for dams safety)
- Regulatory body in the form of a government agency
- Other, please specify

If dam safety was managed by a regulator (DSC or other body), what do you think the role of the regulator should be? *

- Administrator – the regulator does not review any technical information, but ensures that the correct processes are being undertaken. This involves ensuring that the owner is receiving and responding to advice from suitably qualified engineers.

- Oversight role – the regulator relies on the assessment provided by the owner, and the regulator must approve the person who has provided the assessment and accept the evaluation.
- Assessor and Approver – the regulator assesses dam conditions using its own resources, and it approves documents provided by the dam owner.

Please use this space if you have any comments about the role of the regulator:

If the DSC were to remain as the regulator, should its powers to enforce safety measures (e.g. through mandatory directives and/or fines) be: *

- Increased
- Kept the same
- Decreased

Please use this space if you have any comments about the level of power of the DSC:

What do you think the outcome would be if there was a change in the dam safety regime to require dam owners to self-manage dam safety (eg., there was no longer a body like the DSC setting mandatory standards)?

- No change - dam owners would continue to maintain acceptable standards of dam safety
- Some change - over the longer term I would be less confident about the safety of dams without some level of independent oversight
- Significant change - dam owners would definitely not continue to maintain acceptable standards of dam safety and the public would be put at risk of dam failures

Please provide a brief explanation of your answer:



If the DSC were to remain as the regulator, what should the composition of the committee look like? *

- Stay the same
- Stay the same, but also include other representatives
- Other, please specify

Which of the following representatives should also be included on the Committee or one of its sub-groups?

Select all that apply

- Representative for the Councils
 - Lawyer
 - Economist
 - Risk expert
 - Insurer
 - Other, please specify
-

Approach to regulating dam safety



How clear is the current approach to prescribing dams?

If you are a dam owner, you may wish to consider how easy it was for you to understand whether and why your dam falls under the DSC's regulatory requirements.

- Extremely clear
 - Very clear
 - Somewhat clear
 - Not very clear
 - Not clear at all
-

How effective is the DSC dam categorisation (by consequence category) as a way of grouping the large range of dam types and sizes in NSW? *

- Extremely effective
 - Very effective
 - Somewhat effective
 - Not very effective
 - Not effective at all
-

How well do you understand the dam safety standards set by the DSC?

- Not at all, I never use them
 - I am aware of the standards, but have not looked at them in detail
 - Reasonably well, I have applied them in the past
 - Very well, I apply them on a regular basis
-

Currently the DSC uses a mixture of prescriptive standards (based on ANCOLD guidelines) and risk-based standards (that allow dam owners to justify a lower safety level for some dams) for regulating dam safety in NSW.

How effective is this approach in achieving an appropriate level of public safety (i.e. preventing dam failures)? *

- Extremely effective
- Very effective
- Somewhat effective
- Not very effective
- Not effective at all

Please use this space to make any comments about the current approach to regulating dam safety:

What do you think is the best approach to regulating dam safety? *

- Prescriptive standards only (based on ANCOLD guidelines)
- Current combination of prescriptive and risk-based standards
- Combination of prescriptive and risk-based standards, with increased reliance on risk-standards (for example allow large dam owners to only use risk-based standards and small dam owners choose between risk-based and prescriptive standards)
- Risk-based standards only
- I don't know

When should risk-based standards be allowed?

- For all consequence category dams
- In the short-term
- In the medium-term
- In the long-term
- Other, please specify

Safety standards

How well do the current safety standards align to the safety preferences of the NSW government? *

- Completely aligned
- Somewhat aligned
- Not aligned at all
- Not sure

Please provide a brief explanation of your answer:

Which of the following represents your view of how safety standards should be set by the NSW dam safety regulator? *

- Minimise risks that might lead to dam failure
- Accept risks that might lead to dam failure within tolerable levels

Dam safety and the planning system

How would you rate the timeliness of the DSC's involvement in the planning process for new development applications?

- Proactive
- Very responsive
- Somewhat responsive
- Not very responsive
- Not responsive at all
- N/A

Please use this space if you have any comments relating to the responsiveness of the DSC to new development applications:

How effective are other government departments in terms of notifying you about new development applications that may impact on dam safety?

- Extremely effective
- Very effective
- Somewhat effective
- Not very effective
- Not effective at all

How could dam safety considerations be more effectively integrated into the planning system?

Please rate in order of importance, with 1 being the most important

Requiring all development applications to include a question about whether the proposed development is downstream of a dam and sending this information to the DSC and upstream dam owners	<input type="checkbox"/>
Sending a summary of all development applications to the DSC, who would then notify upstream dam owners	<input type="checkbox"/>
Other	<input type="checkbox"/>

If you ranked 'Other', please specify details here:

Dam safety and extreme weather events

How clear is the current framework in terms of outlining the requirements on different parties (e.g. dam owners, the SES) in the case of a dam failure in an extreme weather event?

- Extremely clear
- Very clear
- Somewhat clear
- Not very clear

- Not clear at all
-



How would you rate the current balance of responsibilities between dam owners and the SES in the case of a dam failure as a result of an extreme weather event?

- About right
- About the right distribution of responsibilities between the dam owner and SES, but not enough responsibility on other government agencies (e.g. the Police)
- Too much responsibility on the dam owner and not enough on the SES and other government agencies
- Too much responsibility on the SES and not enough on the dam owner and other government agencies

Please use this space to make any comments relating to the responsibilities of dam owners and the SES in case of dam failure as a result of an extreme weather event:

Who should be responsible for setting notification/alert levels?

*Please rank the **top 3** in order of importance, with 1 being the most important*

Dam owners	<input type="text"/>
DSC	<input type="text"/>
The Minister	<input type="text"/>
Local councils	<input type="text"/>
SES	<input type="text"/>
Other	<input type="text"/>

If you ranked 'Other', please specify details here:

Dam safety and seismic activity

How would you rate the current dam safety regulatory requirements relating to seismic activity?

- Set at a level that is too high
- About right
- Set at a level that is too lenient
-

Dam safety and mining

How would you rate your the timeliness of the DSC's involvement in the planning process for new mining applications?

- Proactive
 - Very responsive
 - Somewhat responsive
 - Not very responsive
 - Not responsive at all
 - N/A
-

How has the DSC's involvement impacted on your mining project?

- Had no major impact
- Caused delays in project timing
- Increased the cost of the project
- Other, please specify

Has the DSC's decisions prevented you from undertaking any proposed mining activities?

- Yes, the project was not allowed to go ahead
 - Yes, the project was allowed to go ahead but some activities within the project were not allowed
 - No
-

What is the estimated value of the mining activities that were not allowed to go ahead due to the DSC's decision?

How effective is the DSC in currently managing risks around dam safety that are associated with mining?

- Extremely effective
 - Very effective
 - Somewhat effective
 - Not very effective
 - Not effective at all
-

How could the DSC change its approach to managing risks to dam safety associated with mining? *Select all that apply*

- Working more closely with mining companies in the early stages of process of developing a mine - e.g. at the feasibility study stage
- Responding more quickly applications by mining companies
- Making more guidance materials available to help mining companies ensure that there application will be approved without significant re-workings or other delays
- Other, please specify

Any other comments:

Survey follow-up

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