

The Defra Research Programme and its Management

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SYNOPSIS. This paper describes the current Defra Research Programme. The programme currently includes a number of contracts including producing a new edition of the ‘Guide to the Reservoirs Act, 1975’, a reworking of the Guide to Emergency Planning and the production of a prioritised list of reservoir research topics covering a period of 5 to 15 years. The paper will also describe the formation, purpose and role of the Reservoir Safety Advisory Group (RSAG).

General Research Programme Call Off Contract to Defra and the ‘Guide to the Reservoirs Act 1975’

In 2006 Atkins were awarded a three year contract to:

- give advice on reservoir safety issues to Defra and Government on an ad hoc basis
- produce a bibliography of published papers relevant to the UK
- seek the views of the profession to see whether it was timely to produce a new edition of the ‘Guide to the Reservoirs Act 1975’.

The first two items are the ‘normal’ elements of the contract whilst the third element was the additional item introduced for 2006.

Approach to Revising the ‘Guide to the Reservoirs Act 1975’

The views of the profession were sought principally via a questionnaire and informally via a number of British Dam Society meetings. The questionnaire to all members of the British Dam Society resulted in a small majority in favour of producing a new version of the document. Many positive suggestions were made which included additions to the Guide, areas where more explanation was required, clauses which needed clarity/explanation and requests for more examples. However, concerns were raised over the cost to the profession of producing a new Guide. Thus

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in producing the new Guide the greatest challenges were associated with the proposed format of the Guide – book, loose leaf file or CD, and the costs of the publication.

Having sought comments and questioned the profession a significant number of issues needed resolution. These were resolved by the team, by discussion with the Defra lawyer, or by discussion with the Environment Agency lawyer. Discussions were also held with some of those who responded to the questionnaire, the enforcement team within the Environment Agency as Enforcement Authority and a number of other interested parties.

At the time of writing this paper, the new Guide is being assembled with sections which will bring it up-to-date with respect to the Water Act 2003; provide new Appendices giving information on the Reservoirs Committee of the ICE how it operates; what it expects from candidates seeking appointment or reappointment to the Panel and the way that those candidates are assessed including the work and initiatives of the Enforcement Authority.

These initiatives include the incident reporting system and examples of its output, moves to improve the database of information on the dams subject to the Act.

Once the ‘new’ Guide has been assembled, decisions will be made by Defra on how the information in the ‘new’ Guide is to be disseminated.

The preferred method being suggested by the Contractor is by hard copy but an alternative is via a CD supplied free to all Panel Engineers and Engineers seeking appointment to the Panels constituted. It is hoped that this will be funded by the Environment Agency as the Enforcement Authority.

The Engineering guide to Emergency Planning

The draft Engineering Guide to Emergency Planning has received criticism from elements of the profession and in particular the Category 1 responders comprising what essentially are the emergency services (blue light organisations).

The criticisms centred on:

- unnecessary complexity
- undue costs likely to be incurred
- unsuitable for end user.

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An Atkins led consortium formed with HR Wallingford approached the problem from a different direction whilst still following the principle of the 3 elements defined by the earlier Guide, namely:

- an on site plan
- dam break analysis and inundation mapping
- an off site plan

Atkins approach to the commission was to discuss the needs of the end user with the end users – the Category 1 responders and particularly the Local Resilience Forums (there are 47 of these covering England and Wales). One of the objectives of these discussions was to find out the format and information required, what detail was required and what accuracy was required of the mapping and hence the modelling.

Prioritised List of Research Topics

Atkins, in collaboration with HR Wallingford, Defra, Bristol University and Chris Binnie Consulting were commissioned by the Environment Agency to undertake research to establish the future research needs with respect to dams safety in the UK and identify sources of funding for future research.

Objectives

The main objectives of the project were therefore to:

- identify the issues that will impact dams safety in the future
- identify sources of funding including innovations for obtaining funding for future research projects
- provide a schedule of research projects over the planning period which sets out the order of priority with which projects should be done in order to ensure that the available funding in each year is spent to maximise the benefit to reservoir safety.

Guiding Principles

A number of guiding principles were identified as key to successful development of a research strategy. These were:

- identify the drivers that will shape the future use, and hence safety, of reservoirs.
- identify the likely impact of the drivers on dams safety.
- establish the research baseline to avoid duplication of effort.
- identify research that will address the issues arising from the drivers.
- identify projects which provide tools, guidance or new science deliverables of use to the profession.

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Drivers

In order to develop an effective strategy for research supporting UK reservoir safety, it was first necessary to consider the drivers affecting reservoir design, maintenance and operation in the UK now, and in the future. Actual needs within the strategy may be grouped into theme areas such as supporting design, monitoring, emergency planning etc. Specific actions may then fall into categories such as science, guidance, tools/techniques etc. By analysing drivers and solutions in this way, a strategy was developed to meet industry needs and priorities both in the short and longer term (Figure 1). In addition to short and long term drivers (for example, legislation changes or climate change) specific industry needs and quick wins / opportunities will (and should) also directly have affected how the strategy was implemented.

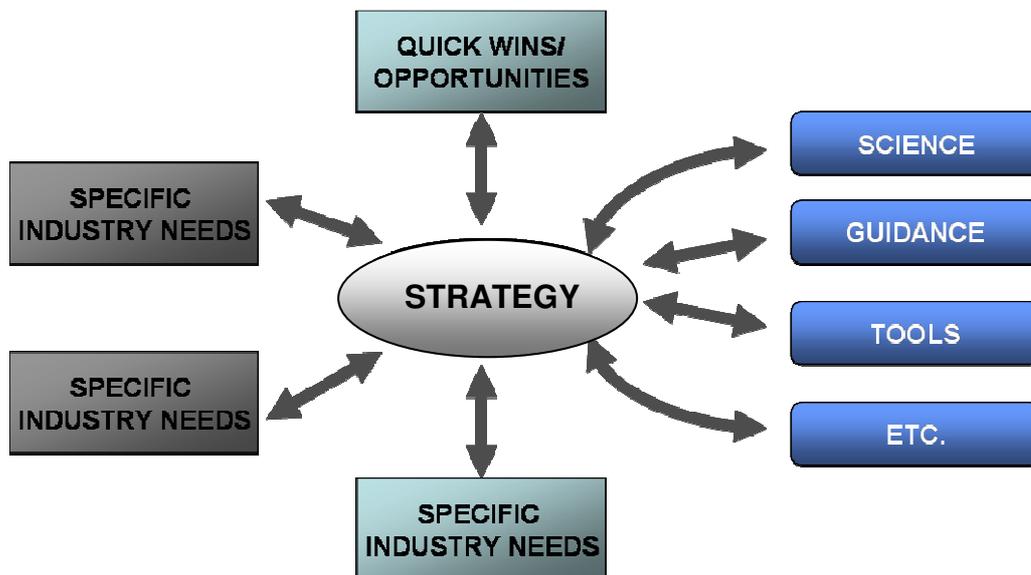


Figure 1: Factors contributing to an overall strategy for reservoir safety in the UK

Short term drivers are more easily identified than long term drivers, since they typically already exist, or are likely to exist in the very near future. Identification of long term drivers requires careful consideration of trends and subsequently a prediction of factors that are most likely to affect UK reservoir operation in the future. The following analysis considers short term to be within the next 5 years and long term to be 15-20 years.

SHORT TERM DRIVERS

UK legislation (Water Act 2003).

The Water Act 2003 enhances reservoir safety by amending the Reservoir Act 1975 to:

- transfer enforcement powers from Local Authorities to the Environment Agency in England and Wales and
- empower the Secretary of State or the Assembly to direct owners of large raised reservoirs to prepare and maintain flood plans.

This requirement to prepare and maintain flood plans will be key to the management of the risks from dams in the future. An engineering guide which was commissioned by Defra has been developed by Jacob's to aide owners in developing these plans, but this is currently being revised. The final guide will be key to establishing the risks posed by large dams and the management of those risks. In addition, they will provide the EA and Emergency services with the information required to manage incidents at each dam thus meeting the requirements of the Civil Contingencies Act, as discussed below.

UK Civil Contingencies Act (2004)

The Civil Contingencies Act (2004) will deliver a single framework for civil protection in the UK. In the context of emergency preparedness, risks are those hazards (i.e. non-malicious events such as flooding) or threats (i.e. malicious events such as terrorist attacks) which could adversely affect an organisation and its ability to carry out its functions. The risk of major dam failure falls into both these categories of risk. There is therefore a requirement to identify and quantify the risks posed by individual dams and establish contingency measures for response to emergencies arising from a dam failure.

European legislation

The Water Framework Directive has established a new, integrated approach to the protection, improvement and sustainable use of surface waters. The Directive requires all rivers to achieve either good ecological status or, if classified as a Heavily Modified Water Body, good ecological potential. This is to be implemented in the UK. This will require variable flows to be released, set by the time of year and the required ecological conditions downstream. Thus specific variable flow releases will be required.

There are a number of reservoirs which have no facilities to release water when the reservoir is below top water level. In many others the current flow release is fixed throughout the year and is of limited size. It can be expected that in some cases new facilities for release will be needed, and these can be

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difficult to provide in dams which do not already have them. There may also be the need to provide the facility to vary the release to provide freshets. This may well require the provision of automatically controlled powered valves.

The aim of the EU Floods Directive is to reduce and manage the risks that floods pose to human health, the environment, infrastructure and property. According to the EU Floods Directive, Member States will have to reduce flood risk for those areas where the risk is deemed significant. This is done by first determining the extent of flood risk (through flood hazard mapping and flood risk mapping). The directive aims to map all sources of flooding including the risk from reservoirs, although it is not clear to what extent flood risk mapping from reservoirs will be required.

Succession

The maintenance of dam safety in the UK is heavily dependent on the availability of skilled and knowledgeable staff to carry out inspections and assessments of dams. There is a need to address the numbers as well as the quality of qualified professionals able to undertake these responsibilities.

LONG TERM DRIVERS

Climate change

Climate change in the UK is projected to result in wetter winters, more frequent and larger floods (magnitude and duration), and hotter and drier summers. Issues arising as a direct result of climate change include:

- more frequent extreme (in terms of magnitude and frequency) floods resulting in more severe and frequent overtopping of dams
- requirement for increased spillway capacity to accommodate larger floods
- requirement to reinforce spillways to prevent damage during long duration flood events
- requirement to raise dams to accommodate larger floods
- increased magnitude of winds on reservoirs, increasing the frequency and depth of overtopping due to waves
- increased vegetation on earth dams resulting in root damage and internal erosion. This will have implications for dam maintenance
- increased erosive power of rainfall
- dessication of earth dams under hotter drier summers leading to cracks and internal piping.

Indirect impacts of climate change include:

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- shorter wetter winters and longer drier summers could lead to a change in the filling and drawdown sequence of reservoirs. This effect might be off-set to some extent by changes in the patterns of demand due to climate change, but there is the potential that the 'excess' water during the winter will need to be stored to meet deficits during summer. This could lead to a requirement to construct new or modify existing reservoirs for both flood retention during winter and water supply during summer
- operating regimes of existing reservoirs could also change due to changes in the timing of releases to meet changes in the timing of demand, and also to provide flood retention benefits and prevent overtopping. Hence reservoirs may have to be drawn down mid season to accommodate floods that may occur later on in the filling season. This could present operational difficulties, and could introduce further uncertainty to water supply in the summer.

Ageing Dams– deterioration

Many UK dams were constructed in the 1850s, 1880s and 1890s at the start of the Industrial Revolution. The average age of large dams in England is 110 years. As these dams continue to age, there will be increasing concerns over safety. Inspection intervals may need to be revised based on age of the dam, and monitoring measures put in place. A number of monitoring techniques are currently available and it would be important to examine these in order to determine which are the most suitable for UK dams.

Dams which are no longer needed may well be taken out of service by abandonment and discontinuance. The need for this may be accelerated by the likely requirements of the Water Framework Directive such as variable flow releases and also by the cost of operation including the preparation of emergency plans. There is also the question of the safety of decommissioned dams.

Dam removal/Discontinuance

One method of reducing the risks posed by dams is to abandon or discontinue them. In the US, dam removal exceeded dam construction for the last 10 years with 80 dams removed in the last 2 years. These were mainly for safety reasons but the regime does differ in as much as in the US the dams were licensed for a specific period with the intention of removing the dam at the end of the licence period.

So far there is little knowledge of the issues involved in dam removal and how best to cope with this requirement. There is therefore a need to provide guidance on the procedure for safe dam removal from both an engineering and environmental/ecological perspective.

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Sustainability and Increased demand

There is the potential problem of more reservoirs being needed because of rising population and the reducing number of people in each home leading to higher per capita demand. While leakage levels are reported to be decreasing (see Ofwat report), new homes are to be constructed with a much lower water usage (see Defra documents and consultations), and Ofwat is setting targets for water companies to reduce the amounts of water delivered (see Ofwat letter to water companies). It is not clear whether these measures will offset the projected increase in demand due to increasing population.

In addition, the British Geological Survey study found that groundwater pollution is likely to reduce the amount of ground water that can be treated economically. Climate change is therefore likely to reduce the yield of direct water supply systems and is likely to reduce the yield of reservoirs. Thus, augmented water resources may well be needed, primarily in the south and east of the country. This could well require increased volumes of storage, possibly by raising existing dams, accepting treated sewage effluent into them, and possibly by a small number of new embankment dams.

Issues such as the planning and consultation horizons for the construction of new dams will need to be reviewed to ensure that the requirement for the construction of new reservoirs take full account of these issues.

Emergency Preparedness and Communication of Risks

With greater variation in flood events, greater understanding of how to handle these in real time is required. Growing concern about risk, safety and terrorism means greater need for emergency preparedness and operational response including: increased stakeholder involvement, management and monitoring of reservoirs, mechanisms of assessing potential dam breach and downstream inundation, disaster preparedness, emergency operational planning, emergency action plans, and remedial measures. An important aspect is the extent to which remotely possible breach impacts are placed in the public domain.

Renewable Energy

Demand for renewable energy will also lead to the construction of new dams, and the retro-fitting of existing dams, with hydroelectric power facilities. Hydroelectric dams may require new draw-off systems being installed, which may result in safety issues both during construction and operation. The Glendoe hydroelectric dam, currently under construction, is the largest to be built in the UK in 50 years. Further new hydroelectric schemes may well be built.

Advances/trends in Sciences

Modelling methods across a number of disciplines related to dams safety, as well as monitoring techniques and equipment, have advanced significantly and provide opportunities to assess and monitor dam safety with greater levels of accuracy. Numerical and physical modelling also enables the examination of unobservable scenarios. It will be important to examine input requirements, model assumptions and simplifications, and expected accuracy of outputs. In addition, guidance on appropriate methods, software and techniques is vitally important.

Risk and uncertainty

Dealing with risk and uncertainty is common in many, if not all, aspects of reservoir design, construction, operation and maintenance. The science of risk and uncertainty is rapidly evolving, and over the last decade a wide range of tools and techniques have been developed to support risk-based analyses.

In the process of making dam safety decisions, it is necessary to consider a plethora of factors including; public safety responsibilities, limitations on borrowings, market or other pricing constraints, business criticality, public opinion, loss financing, liability, and due diligence. Hence, engineers are being challenged to justify expenditure associated with one risk-reduction measure relative to another.

For a dam owner with a portfolio of dams, there is also a need to determine the priority with which to address safety issues related to his stock. Engineers are therefore being asked to provide risk-based assessments which serve as inputs to a business decision making process in which dams are a key asset. Dam safety risks are therefore being managed in a more open, informed, and holistic manner than ever before.

This trend towards a risk-based approach to dam safety management requires a shift in approach to dam assessment. For instance, currently used deterministic methods such as the PMF do not suit this risk-based approach. There are projects currently underway, dealing with this issue in the UK and elsewhere. It is important that the future research strategy ensures that appropriate methods and guidance are supported.

Specific Industry Needs and ‘Quick Wins’

Specific industry needs may be identified through consultation with engineers and owners within the profession. ‘Quick wins’ are situations where projects may be initiated because circumstances offer a unique

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advantage for rapid implementation, whether this is scientific, financial or a combination of both.

DEFINING RESEARCH NEEDS

Establishing the baseline

For most issues that need to be addressed, there is already research that has been undertaken either as a precursor to more detailed work in the UK, or elsewhere in the world with direct relevance to the UK. In developing the strategy, limited research has been undertaken to establish the current state-of-play with respect to most aspects of dam safety. However, it is imperative that the baseline of each topic/issue is established before any detailed assessments are undertaken. For this reason, most projects proposed will start with a preliminary stage which will look at previous work.

The outcome of research undertaken in this phase is likely to be documents reviewing the existing state of the topic and also outline the scope for further work to address the problem during the main study. Some topics have already established baselines and can therefore move into detailed assessment. In addition, 'quick win' projects can also be started immediately.

Defining research Needs

Having identified the drivers contributing to the strategy, an initial assessment of the existing research was undertaken for all aspects of dam safety. To this end, the broad topic of dam safety was broken down into disciplines, and searches conducted and summarised on all research falling under each discipline. Given the time and cost constraints on this project this initial assessment was restricted to research undertaken in the last 2 to 5 years in most cases. In addition, early consultation was sought with dam owners and panel engineers, which resulted in a list of their requirements with respect to dam safety. The wider profession was also included in this initial consultation through a questionnaire posted on the BDS website requesting contributions.

A database of research projects and article references was developed to aide the searches, and could form part of the project deliverables. Once previous and current projects were identified, these were examined against the research needs arising from the drivers discussed above to determine whether they addressed any of the issues. From this assessment, research gaps were identified and specific research projects formulated including project scope, estimated cost and duration, expected outcomes and products (guidance, tools, methods etc.).

PRIORITISATION OF RESEARCH PROJECTS

The prioritised list of research projects was developed as follows:

- Projects were categorised based on the following criteria:
 - Long Term/Short Term/Industry/Quick Win
 - Likely Outcome – Science, Methods, Tools, Guidance
 - Level of Difficulty – Hard/Easy
 - Cost/Sources of Funding
 - Duration of Project
- ‘Quick wins’ were identified from the list of projects. As a general rule, projects which meet the immediate needs of owners and reservoir engineers generated from the list of research requirements dictated by Panel Engineers and Owners, which could be easily achieved, and which would provide tools or guidance (either interim or final) on a particular topic, were considered to be quick wins. Quick win projects were given high priority
- Second consultation – experts from all disciplines involved in dam safety were consulted during a 2-day workshop which involved discussions and voting on each project presented
- A final prioritised list of scheduled projects was then prepared and different spending scenarios considered
- Consultation was carried out via the BDS web site in the later stages to enable those who were not at the workshop to take part and secondly to seek contributions.

The prioritised list, is then used by the Reservoir Safety Advisory Group (RSAG). The RSAG is an Institution of Civil Engineers (ICE) managed group of Panel Engineers, owners, academics and representatives of the EA and Defra and is supported by a secretariat supplied by the ICE. The RSAG meets at 6 monthly intervals to ensure that existing projects are on time and in budget and also to consider new projects and the most appropriate source of funding to seek. The formation of this group will ensure the appropriate research is done on time and to budget.