



# Modes of dam failure and monitoring and measuring techniques

## Project Summary SC080048/S1

In 2009, Defra produced a strategy for reservoir safety research and development. This identified a number of areas for research projects, which would draw together best practice, operational experience and recent developments in the management of existing dams in the UK. The Environment Agency's new report provides the findings from a scoping study into two of the areas of research identified in the strategy. These are 'modes of failure of dams and failure of monitoring techniques' and 'monitoring and measuring methods for embankment dams'.

The aim of the scoping study was to find out how much information is available to the reservoir industry on these two topics and whether or not there are any gaps in knowledge. The report will be used to help the Environment Agency decide which areas of research it should focus on in the future. In particular, the work will feed into a project on risk assessment of reservoirs, which started in 2010.

We found that to understand fully the modes of failure it is necessary to understand all the potential hazards to a dam. Forty-eight hazards are defined in the report, ranging from rapid drawdown of the reservoir to overflow failure. A summary of existing research is provided for each of the hazards and gaps in knowledge are identified.

Many of the hazards are covered by existing publications, a number of which need to be updated. Some modifications are required to the research projects identified in the Defra strategy and some new research projects are proposed. A few of the new projects could be implemented relatively quickly, as they will only require the production of a 'Reservoir Technical Guidance Note' using existing information:

- surface erosion;
- upstream membranes, and concrete and asphaltic facing;
- crest fissuring;
- controlled holding of water at a low level.

We also examined methods to monitor and measure embankment dams, as well as general monitoring techniques used on all dams. The methods are generally well documented in the publications:

- *Investigating embankment dams: a guide to the identification and repair of defects.* Building Research Establishment Report BR 303 (1996); and
- *An engineering guide to the safety of embankment dams in the United Kingdom. Second edition.* Building Research Establishment Report BR 363 (1999).

However, many monitoring techniques are implemented without a full understanding of their capabilities and purpose and they are not always able to detect failure in advance of an incident. Furthermore, for some techniques the reservoir community requires further guidance, such as seepage monitoring, leakage detection and remote sensing techniques [for example, light detection and ranging (LiDAR), aerial photographs and satellite imagery].

The scoping study on these two research topics concludes that some further research projects are required. Projects of highest priority recommended in the report are:

- Reservoirs and ecological hazards: a best-practice guide to the management of animals and vegetation;
- Reservoir safety: a checklist for surveillance;
- Modes of failure of dams – trial risk assessment.

Projects of medium-to-high priority recommended in the report are:

- Monitoring techniques for different indicators;
- Risk management of reservoirs – a best-practice guide;
- Reservoir engineering design to Eurocodes: draft guide for consultation.

A number of other areas that require research and guidance are identified as lower priority.

It is not possible to confirm at this time which, if any, of these recommendations will be taken forward.

The study was carried out in consultation with individuals from the reservoir industry, including reservoir owners, managers, supervising engineers, all reservoir panel engineers, consultants, academics and representatives from the Environment Agency. It will help the Environment Agency to understand the needs of the industry for guidance in the future. An added benefit is the definition of hazards and modes of failure, which can be used in the upcoming project on risk assessment of reservoirs.

This summary relates to information from project SC080048, reported in detail in the following output(s):

**Report:** SC080048/R1

**Title:** Modes of dam failure and monitoring and measuring techniques

**August 2011**

**Internal Status:** Released to all regions

**External Status:** Publicly available

**Project manager:** Eleanor Heron, Evidence Directorate

**Theme manager:** Geoff Baxter, Sustainable Asset Management (SAM)

**Research Contractor:** Ove Arup and Partners Limited, Admiral House, Rose Wharf, 78 East Street, Leeds, LS9 8EE Tel: 0113 2428498

Current research projects are being carried out by the Environment Agency and Defra following a review of research priorities and direction by the Reservoir Safety Advisory Group (RSAG) of the Institution of Civil Engineers (ICE).



**The British Dam Society** at the Institution of Civil Engineers

The British Dam Society aspires to be a forum for professionals involved with dams to meet and exchange ideas and to be a body of people with authority and/or interest on dam-related issues. It monitors and contributes to the agenda on the provision of technical guidance and wider research on dams for the UK and also promotes best practice in all aspects of the planning, development, maintenance and operation of dams and reservoirs.

In this context it is pleased to support the Environment Agency's production of this report as part of a programme of carefully targeted research aimed at improving the understanding of dam related issues and also the safety of the UK's stock of reservoirs, however, this does not imply endorsement of any particular report recommendations.

---

This project was commissioned by the Environment Agency's Evidence Directorate, as part of the joint Environment Agency/Defra Flood and Coastal Erosion Risk Management Research and Development Programme.

Email: [fcerm.evidence@environment-agency.gov.uk](mailto:fcerm.evidence@environment-agency.gov.uk).

Further copies of this summary are available from our publications catalogue: <http://publications.environment-agency.gov.uk> or our National Customer Contact Centre: T: 08708 506506  
E: [enquiries@environment-agency.gov.uk](mailto:enquiries@environment-agency.gov.uk).

© Environment Agency.