Environment Agency

Post Incident Annual Report 2010

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Foreword

We publish this report so that all those involved in reservoir safety learn from past incidents and by sharing experience we improve safety in the future. Please continue to help by reporting all incidents no matter how small or insignificant they may appear.

I would like to thank all of those within the reservoir industry who have contributed to and support the post-incident reporting system.

Antony Deakin Reservoir Safety - Manager

Contents

1. Introduction

We have collected information on incidents at both large raised reservoirs (those reservoirs covered by the Reservoirs Act 1975) and small raised reservoirs. We aim to:

- Gather information on reservoir incidents
- Investigate incidents where appropriate
- Learn lessons from incidents
- Inform the reservoir industry of trends and key lessons learned
- Provide information that can contribute to reservoir safety research and incident frequency analysis.

Our aim through post-incident reporting is to improve reservoir safety. We have given a commitment to the reservoir industry that we will not use information acquired through post-incident reporting to retrospectively initiate enforcement action under the Reservoirs Act 1975.

In this report we provide full details of the incidents reported in 2010 and an update on research and development.

We would like to thank all those within the reservoir industry who have taken the time to contribute to the post-incident reporting system this year.

Any requests we receive for information relating to reservoir incidents will be considered under the Freedom of Information Act 2000, Environmental Information Regulations 2004 and the Data Protection Act 1998.

2. Analysis of the reported incidents

We have included the following information in this report:

- The number, type and severity of incidents that have occurred during 2010
- Analysis in terms of threats to reservoirs and mechanisms of deterioration resulting from those threats
- The main lessons that have been learnt from the incidents
- A summary of each incident and lessons learnt where completed post-incident report forms have been received

2.1 Severity and number of reported incidents in 2010

Incidents are entered on the database if they are considered reportable. Table 2.1 defines the three severity levels for reportable incidents.

Incident Severity Level	Definition of incident severity
One	Failure (uncontrolled sudden large release of retained water)
Two	Serious incident involving any of the following: • Emergency drawdown • Emergency Works • Serious operational failure in an emergency
Three	Any incident leading to : • An unscheduled visit by an inspecting engineer • A precautionary drawdown • Unplanned physical works • Human error leading to a major (adverse) change in operating procedures

Table 2.1 Severity levels for reportable incidents

Table 2.2 and Figure 2.1 show the number and severity of incidents that have been reported during 2004-2010. They only include incidents where we have been able to gather enough information to assign an incident level (i.e. where we have received a completed post-incident report form)

	2010	2004-2009
Total number of incidents	5	40
Incidents at large raised reservoirs	3	27
Incidents at small raised reservoirs	2	13
Level 1 incidents	1	2
Level 2 incidents	1	14
Level 3 incidents	3	24

Table 2.2 Incidents reported in 2004-2010 showing severity level

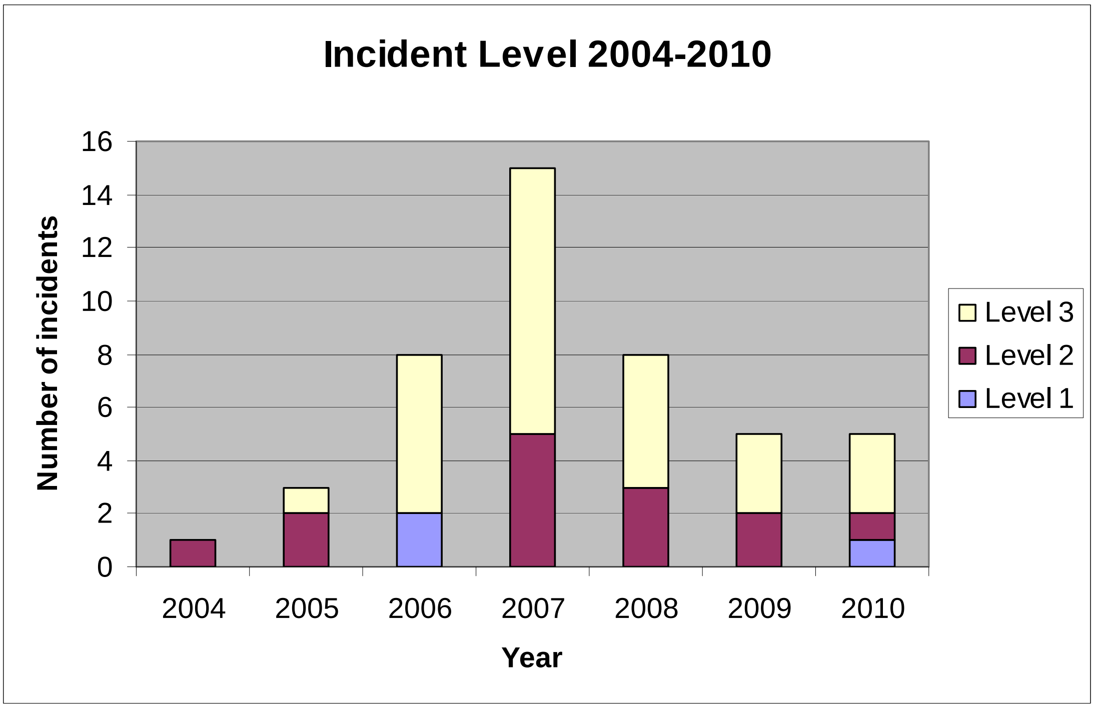


Figure 2.1 Incidents reported 2004-2010 showing severity level.

There were five incidents reported during 2010 and one incident from 2009 that was not included in the last annual report. The number of reported incidents was again low compared to 2006-2008, but was the same as the number reported in 2009.

Figure 2.2 shows incident severity level against dam category for 2010 and Figure 2.3 the distribution by year of incidents against dam category. Dam categories are described in Appendix B.

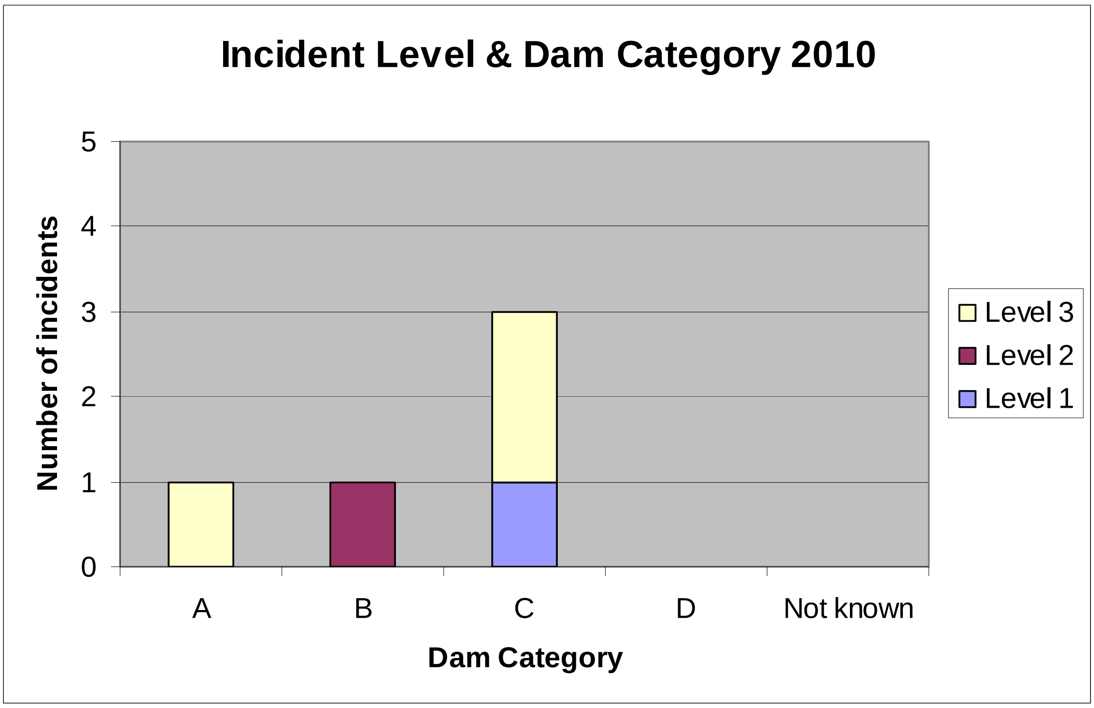


Figure 2.2 Incident level and dam category for 2010

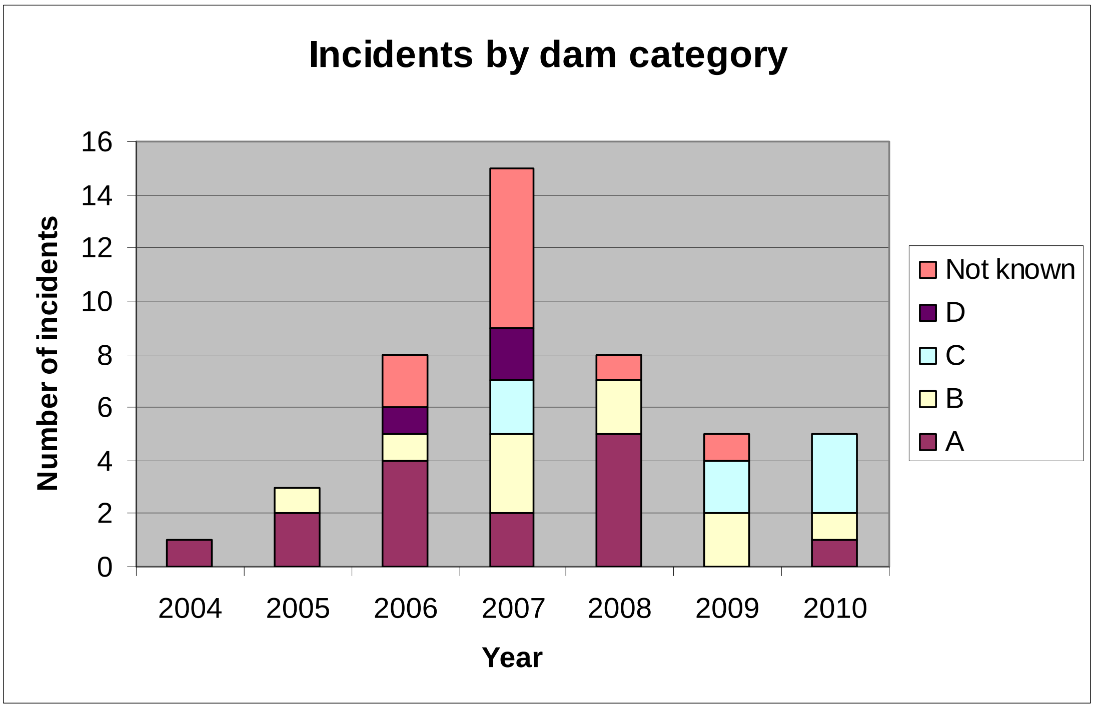


Figure 2.3 Distribution of incidents by year and dam category

2.2 Threats and mechanisms of deterioration

Tables 2.3 and 2.4 provide a summary of the reported incidents in 2010 and include some characteristics of the dams, including dam category and height.

Incident No	Incident Date	Incident Severity	Date Built	Dam height (m)	Dam category	External threat	Internal threat	Mechanism of deterioration
342	Nov-09	2	1875	4.5	B	Inflow flood	n/a	Erosion by overtopping
343	Jan-10	2	1875	4.5	B	Inflow flood	n/a	Erosion by overtopping
345	Jan-10	3	c. 1930	7	C	Vandalism	Foundation stability	Deterioration of foundation
348	Dec-10	3	Not known	5	C	Inflow flood	n/a	Erosion by overtopping

Table 2.3 Summary of reported incidents at statutory reservoirs

Incident No	Incident date	Incident Severity	Date Built	Dam Height (m)	Dam Category	External Threat	Internal Threat	Mechanism of deterioration
346	Jan-10	1	Not Known	10	C	n/a	Material deterioration	Deterioration of gates/valves/equipment
347	Apr-10	3	c.1995	6	A	n/a	Embankment stability	Internal erosion - other

Table 2.4 Summary of reported incidents at non-statutory reservoirs

We have analysed reported incidents in terms of threats to dams and the mechanisms of deterioration resulting from those threats. Threats have been broadly divided into internal and external threats (see Appendix B for details). A summary of incidents for 2010 and 2004-2009 in terms of threats and mechanisms of deterioration is given in Tables 2.5 and 2.6.

Internal and external threats	2010	2004 - 2009
External - Inflow Flood	2	16
Mining	0	1
Wind, trees	0	1
Animals	0	1
Vandalism	1	0
Other	0	3
Internal - Embankment Stability	1	18
Appurtenant works stability	0	3
Abutment stability	0	1
Foundation stability	1	0
Material deterioration	1	0
Vegetation	0	2

Table 2.5 Summary of threats

Mechanism of deterioration	2010	2004 - 2009
Erosion by overtopping	2	12
Internal erosion through embankment	0	9
Internal erosion adjacent to appurtenant works	0	5
Internal erosion - other	1	0
Pipe work/culvert deterioration	0	2
Deterioration of foundation	1	0
Deterioration of gates/valves/equipment	1	0
Damage to safety critical structures	0	1
Pore water pressure increase mass movement	0	2
Settlement	0	2
Wind damage - trees	0	1
Other	0	1

Table 2.6 Mechanism of deterioration

The main threat reported over the last seven years has been embankment stability. Internal erosion has been the mechanism of deterioration in nineteen of the incidents reported in the past seven years.

2.3 Types of lessons learned

Five incidents were reported in 2010, which is below the average of eight, reported over the period 2004-2009.

Incidents 342 and 343 occurred at the same site within a short period of time. Both were caused by the collapse of a river bank which caused an obstruction. Water then overflowed into a feeder channel leading to a reservoir during heavy rain.

These incidents are very similar to incident 344 which occurred in 2009 (Environment Agency 2009 PIR Annual Report). Incident 344 happened when a build-up of gravel in a river channel caused the banks to overtop and partially breach. The similarities between these incidents highlight the need for reservoir engineers and managers to monitor the condition of natural channels wherever out-of-bank flows might affect the safety of reservoirs.

There was one reservoir failure in 2010, incident 346. This incident happened at a non-statutory reservoir and it is believed to have been caused by the failure of a valve within the draw-off tower. Fortunately nobody was injured.

Incidents recorded in the database are classified on the basis of the type of lessons learned. The lessons learned are split into five categories as explained in Table 2.7 and shown in Figure 2.4 below. Categorising the lessons learned in this way makes it easier to highlight trends.

Type	Examples	Possible implications
Surveillance	Inadequate surveillance or processing of instrument observations	Reservoirs require more or better monitoring and surveillance
Operation	Malfunction or misuse of reservoir control facilities	Reservoirs require more or better trained staff or security against misuse
Physical (current condition)	Inadequate performance due to deterioration of a design element by erosion, wear, weathering, corrosion, vandalism, poor maintenance, etc	Reservoir components require better or more frequent maintenance
Physical features (intrinsic)	Inadequate performance due to the original design and/or construction of a structure, or through changes in the loading (structural or hydraulic) experienced	Reservoir components should be designed and built to meet current physical conditions
Emergency planning	Incidents relating to the application of emergency planning provisions (alarms, evacuations, etc)	There is a need for more effective use of emergency planning provisions at reservoirs

Table 2.7 Types of lessons that can be learned

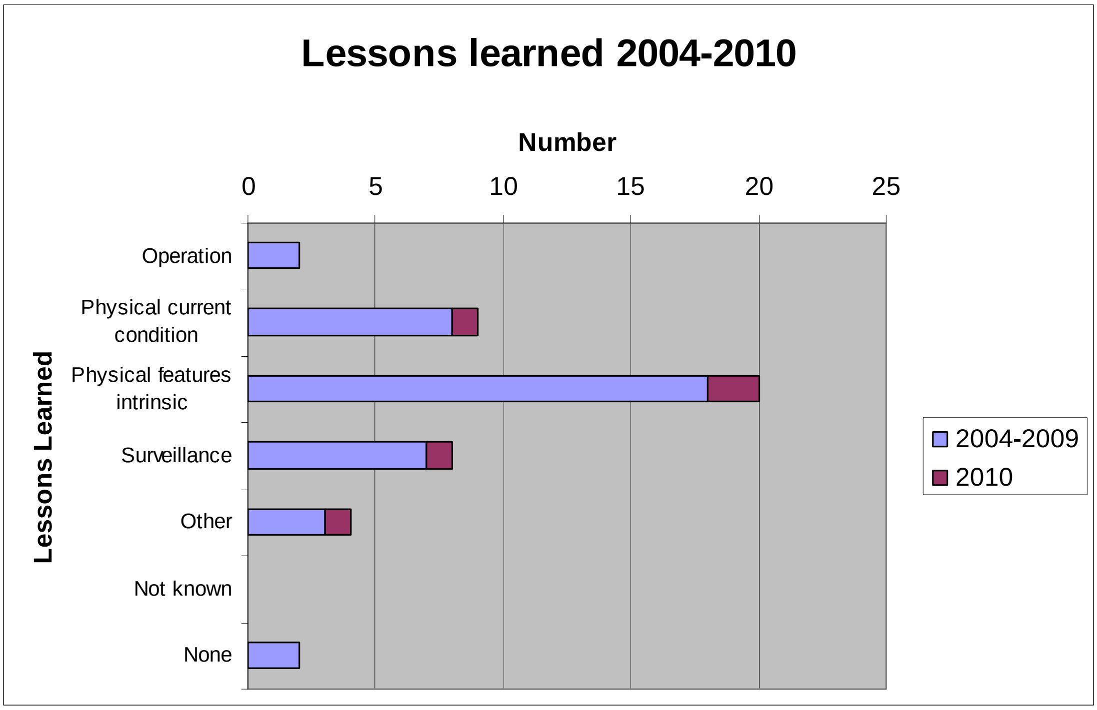


Figure 2.4 Lesson learned 2004-2010

3. Incidents reported 2010

The five reportable incidents that occurred in 2010 are described below. An incident that occurred during 2009 but which did not appear in the 2009 annual report is also included.

Incidents 342 (2009) & 343	
Dam type	Masonry dam
Reservoir legal status	Statutory reservoir
Dam height (m)	4.5
Incident type	Inflow flood, overtopping
Incident severity	2

There were two very similar incidents at this reservoir within a period of two months.

After several hours of heavy rain in November 2009 the river beside the reservoir overflowed into the reservoir feeder channel. The reservoir water level rose, overtopping the dam embankment between the reservoir and the river. The reservoir scour valve was fully opened to allow the water back into the river channel. A large diesel pump was also hired to pump water from the reservoir back into the river and work was carried out to make sure that the spillway remained clear. This, together with the storm passing, allowed the reservoir level to drop.

In January 2010 heavy rain again caused high water levels in the river to overflow into the reservoir feeder channel, which caused the dam to overtop. Once again the scour valve was opened to pass some of the floodwater back into the river. On this occasion the Fire and Rescue service provided two high volume pumps to pump water from the reservoir into the river. The reservoir levels eventually fell as the storm passed.

On both occasions it appears that overtopping happened because the river bank collapsed, partially blocking the river channel leading to a rise in the water level. Following the second incident, the reservoir feeder channel has been restricted so that the rate of water going into the reservoir cannot be greater than the capacity of the spillway.

Lessons learnt

The incident highlights the need to protect reservoirs from large, unplanned inflows of water. The fact that there was an almost identical incident less than 2 months after the first shows that incidents can re-occur if improvements are not carried out soon after the initial incident.

Incident 345	
Dam type	Earthfill embankment
Reservoir legal status	Statutory reservoir
Dam height (m)	7
Incident type	Foundation erosion
Incident severity	3

Leakage through the peat foundation of an embankment dam became obvious as snow melted. The scour valve was opened to lower the reservoir water level. A section of the dam had to be rebuilt.

The leakage is believed to have been due to unusually high reservoir water levels after the spillway culvert was blocked with logs about one month earlier. These logs were believed to have been deliberately placed in the culvert by vandals from a stockpile that had been placed near to the dam following forestry works. The reservoir is used for trout fishing.

Photo 1: Reservoir affected by Incident 345

Lessons learnt

There are several lessons that can be learnt from this incident. The design of the dam meant that it could not withstand the pressure from the raised water levels. The problems with the peat foundation of the dam were solved by rebuilding a section of the dam.

Storing the logs by the reservoir meant that it was easy for vandals to block the spillway. Owners should consider whether items kept close to dams can be misused and threaten reservoir safety.

Surveillance was carried out by the local fishing club, but there was no regular surveillance outside of the fishing season. If the vandalism had been noticed earlier, action could have been taken to reduce the level of water in the reservoir.

Responsibility for routine surveillance has now passed to the forestry company.

Incident 346	
Dam type	Earthfill embankment
Reservoir legal status	Non-statutory reservoir
Dam height (m)	10
Incident type	Outlet works failure
Incident severity	1

Water was found to be seeping into a builder's yard downstream of a reservoir. Reports suggest that a control structure (possibly a valve) had failed within the outlet tower and the reservoir emptied in an uncontrolled manner. Fortunately the reservoir had filled with silt, so despite the dam being 10m high, the water in the reservoir was only 1.5m deep. There is no safe access to the control structure as the access bridge to the draw-off tower is no longer there and the pipe leading from the draw-off tower is too small to enter. At the present time, it is not possible to confirm how the uncontrolled release happened.

Lessons learnt

All non-statutory reservoirs that pose a risk to life should be routinely inspected by experienced engineers to assess the condition of safety features. In this case, it appears that a reservoir outlet control failed. It is likely that the reservoir had not been inspected for some time. Under different circumstances there could have been significant damage downstream. Where access for proper control, operation and inspection is lost, it must be replaced as soon as practicable.

Incident 347	
Dam type	Earthfill embankment
Reservoir legal status	Non-statutory (at the time of the incident)
Dam height (m)	6
Incident type	Internal erosion
Incident severity	3

The owner of the reservoir became concerned with increasing seepage at the toe of the dam and decided to empty the reservoir. The increased cloudiness of the water in the nearby river led to the incident being identified. The reservoir was constructed in 1995 but was only registered under the Reservoirs Act 1975 after this incident occurred. Improvement works were carried out to modify the embankment design on the upstream face.

Lessons learnt

This incident demonstrates the importance of ensuring that statutory reservoir structures are designed and constructed under the supervision of a Construction Engineer.

Incident 348	
Dam type	Earthfill embankment
Reservoir legal status	Statutory reservoir
Dam height (m)	5
Incident type	Potential overtopping failure
Incident severity	3

A new spillway had been designed for this earth embankment reservoir. The owner of the reservoir started construction without any professional supervision. Excavation for the spillway was carried out without any cofferdam and the notch for the new spillway was left unprotected with the sill close to the reservoir level.

The supervising engineer visited the site following heavy snowfall, when rain was forecast. There was no means of lowering the reservoir water level. Urgent works were arranged to protect the spillway excavation from flood erosion using sandbags.

Photo 2: Spillway works at reservoir affected by incident 348

Lessons learnt

This incident highlights the importance of effective surveillance and communication with undertakers, especially when safety works are being planned or under construction. Any construction works at a statutory reservoir that affects reservoir safety must be overseen by a qualified civil engineer in accordance with the Act.

4. Research and Development Activities

Since the last post-incident annual report we have completed two research and development reports

The first considers the lessons we can learn from historical dam incidents. It describes over 130 key historical incidents that have occurred in the UK along with some important international incidents. The report considers how incidents and failures have influenced reservoir safety legislation and guidance and how incidents have been managed. It also classifies and analyses the different types of failure that dams can experience.

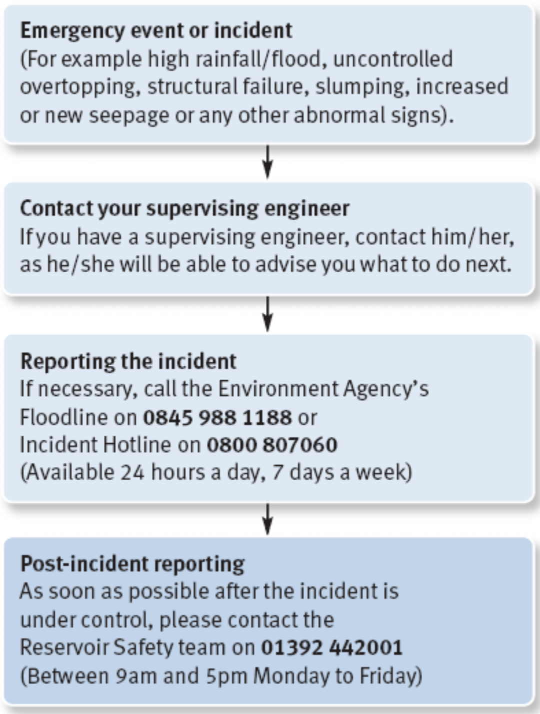
The second provides information on a scoping study covering the modes of dam failure and failure of monitoring techniques as well as monitoring and measuring methods for embankment dams. The study looked at how much information was already available and identified any gaps. It identifies a number of projects which would fill in the gaps in knowledge.

Appendix A: Reporting an incident

Details of how to report incidents, and an example of a post-incident report form are given in our publication ‘Learning from Experience: Post-incident reporting for UK Dams’. This also gives more information on the voluntary post-incident reporting system and answers some of the most common questions we have received.

We deliberately use the term ‘post-incident reporting’ so that it is clear that this system does not include incident management. If a problem arises at a reservoir you should follow the procedure outlined in the flow chart below.

We can receive post-incident information by phone or email. Our contact details are below. We suggest that you contact us as soon as possible after the incident is under control while the facts are still fresh in your mind. If the problem is likely to take some time to resolve, please let us know and we will call you back at a later date to find out more about the actions you have taken, and how effective they were.



Post-incident reporting

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Appendix B: Dam and threat categories

Dam Category (from "Floods and Reservoir Safety", Institution of Civil Engineers, 1996, 3rd edition)

Dam Category	Potential effect of a dam breach
A	Where a breach could endanger lives in a community*
B	Where a breach could endanger lives not in a community or result in extensive damage
C	Where a breach would pose negligible risk to life and cause limited damage
D	Special cases where no loss of life can be foreseen as a result of a breach and very limited additional flood damage would be caused.

A community in this context is considered to be 10 or more persons

The internal threat categories in the database include:

- Instability associated with internal erosion of an embankment dam
- Slope instability associated with slip of an embankment dam
- Instability associated with appurtenant works
- Instability of the dam foundation
- Material deterioration (for example, corrosion)
- Vegetation (for example, tree roots)

The external threat categories used in the database include:

- Inflow - flood
- Inflow - direct rainfall
- Inflow - failure of upstream reservoir
- Seismic event
- Snow/ice
- Aircraft strike
- Vandalism
- Wind (wave generation) and Wind (tree damage)
- Human error; Animals; and Mining

Appendix C: References

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