

**INDIVIDUAL RISK ASSESSMENT**

<b>Hazard/threat category</b>	<b>Sub-category</b>
Structural hazards	Major reservoir failure
<b>Hazard and threat description, plus scale</b>	<b>Risk reference number</b>
Collapse without warning resulting in almost instantaneous flooding. Significant movement of debris (including vehicles) and sediment. Complete destruction of some residential and commercial properties and serious damage of up to 500 properties. Several thousand other properties could be flooded. Up to 200 fatalities. Up to 1000 casualties. Up to 50 missing persons and people stranded. Hazardous recovery amongst collapsed infrastructure and debris. Water supply to homes and business is lost. Up to 200 people need temporary accommodation for 2-18 months.	H44
<b>Author</b>	Environment Agency
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December 2007	December 2008

**1. Overview of hazard or threat**

The capacity of a reservoir (i.e. its spillway ) to discharge excess water, brought about by heavy precipitation is exceeded, causing the reservoir to inundate properties within the vicinity. Severe damage both to the reservoir and downstream properties could also occur.

The dam breaches, catastrophic failure occurs, a flood wave  $\frac{1}{2}$  the head of water retained in height is released - downhill - not necessarily into the natural floodplain initially and damages / floods properties. Such an event could be similar in dynamic intensity to that witnessed in Boscastle in 2004 with significant property damage and potentially loss of life. "Sunny day" failure may also occur (e.g. due to internal erosion which could go undetected) for which there may be no prior warning whatsoever.

A register exists for all reservoirs in excess of 25,000 m<sup>3</sup> (approx. 10 Olympic swimming pools) that are subject to the Reservoirs Act 1975. Currently there are a limited number of inundation maps held by Reservoir "Undertakers".

The formal requirement for reservoir Flood (Emergency) Plans will be introduced from late 2006 following introduction of the Water Act 2003.

## 2. Key historical evidence

### National events

The following events are well documented due to the occurrence of fatalities: 352 people have been killed following failure of British dams since 1852. However, there has been no loss of life following the introduction of the first Reservoirs Act 1930.

Bilberry 1852: 81 lives lost

Dale Dyke 1864: 250 lives lost 798 houses destroyed

Eigiau and Coedty 1925: 16 lives lost

Skelmorie 1925: 5 lives lost

The introduction of the 1930 and subsequently the 1975 Reservoirs Act has led to a reduced likelihood of reservoir failure. However a significant amount of uncontrolled development in the lee of reservoirs over the last century has increased the impact of any failure.

Major flood events (eg Autumn 2000, Easter 1998) are likely to have resulted in localised flooding downstream of reservoirs.

The most recent significant reservoir incident was at Ulley, South Yorkshire in June 2007. Heavy rainfall caused part of the earth bank to be severely eroded and required an emergency drawdown. Local villages were evacuated and the M1 was closed whilst many high volume pumps were used to lower the water level, preventing reservoir failure.

## 3. Likelihood

Hazard	Outcome description	Likelihood
Major reservoir failure	Collapse without warning resulting in almost instantaneous flooding. Significant movement of debris (including vehicles) and sediment. Complete destruction of some residential and commercial properties and serious damage of up to 500 properties. Several thousand other properties could be flooded. Up to 200	Negligible (1)

	<p>fatalities. Up to 1000 casualties. Up to 50 missing persons and people stranded. Hazardous recovery amongst collapsed infrastructure and debris. Water supply to homes and business is lost. Up to 200 people need temporary accommodation for 2-18 months.</p>	
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#### 4. Impact

##### Summary

Hazard	Outcome description	Impact				
		Health	Social	Env	Econ	Overall
Major reservoir failure	<p>Collapse without warning resulting in almost instantaneous flooding. Significant movement of debris (including vehicles) and sediment. Complete destruction of some residential and commercial properties and serious damage of up to 500 properties. Several thousand other properties could be flooded. Up to 200 fatalities. Up to 1000 casualties. Up to 50 missing persons and people stranded. Hazardous recovery amongst collapsed infrastructure and debris. Water supply to homes and business is lost. Up to 200 people need</p>	5	5	3	4	4

	temporary accommodation for 2-18 months.					
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### Details

Fortunately few Local Authorities will have experience of dam failure. Since October 2004 there have been 6 emergency drawdowns of reservoirs in England and Wales. This action successfully prevented catastrophic breach of the dam in each case.

In 2004 the Environment Agency assumed the role of enforcement authority under the Reservoirs Act 1975. The Agency's National Reservoir Safety team has published and distributed a register on a Region by Region basis for the 1,930 no. reservoirs in England and Wales. This database is currently incomplete. The consequences of risk from reservoir breach have been categorised (ie A to D) in most but not all instances. The dam construction type (e.g. earthfill) and age of dam is similarly incomplete.

As the enforcement authority the Environment Agency only holds information that relates to compliance with the Act and the key information required by the Register. There is no information on the structural stability of the dams for example and in conducting this assessment such enquiries should not be made to the Undertaker.

The Water Act 2003 introduces the requirement for Flood Plans to be produced for high risk reservoirs. In the event that a reservoir could cause a devastating flood it is important that arrangements are in place so that Emergency Services and Local Authorities can provide effective assistance. The legal requirement for Flood Plans is planned to commence from April 2007. The Environment Agency will be involved with publishing a specification for and on-going programme of works for Flood Plans.

Panel Engineers are a group of specialist civil engineers who are experienced and qualified in reservoir safety. They are required by the Reservoirs Act 1975 to oversee the safe construction, operation and maintenance of reservoirs and inspect their safety every ten years or more frequently if necessary. An Inspecting Engineer is appointed to inspect a reservoir and produce recommendations in the interest of safety (i.e. essential safety works) and a supervising Engineer is appointed to supervise the operation and maintenance of the reservoir.

<b>Impacts</b>
<b>Primary</b>
Major damage to property and surrounding land
Closure, or washing away, of roads, bridges, railway lines
Loss of (and possible damage to) telephone, electricity, gas and water supplies
Pollution/health risks from sewerage systems, chemical stores, fuel storage

tanks
Evacuation and temporary/long-term accommodation needs
Loss of asset eg. water supply reservoir
Drowning of people, pets and livestock
Possible fatalities
<b>Secondary</b>
Need for recovery strategy in aftermath of major flood
Disruption of economic life and major costs of rebuilding infrastructure
Public need for information, advice, benefits/emergency payments
Insurance implications, including help for the uninsured
Safety assessments/possible demolition of damaged buildings and structures
Shortage/overstretch of key resources (equipment and personnel) and agencies
Overstretch of normal communication links, including mobile phones
Loss of confidence nationally in the safety of reservoirs

## 5. Vulnerability and resilience

There are many catchments in the Thames Valley LRF that are provided with a fluvial flood warning service. This service is provided using the new Floodline Warnings Direct, Flood Warning System (FWD). This Flood Warning service could in the future be adapted to provide a warning service to those at risk from reservoir flooding.

Flooding may occur at times when people are at work or asleep; therefore their ability to take effective action is delayed.

“Sunny day “ failure may also occur (e.g. due to internal erosion ) for which there may be no prior warning.

Within all inundation paths (flood risk areas) there are particularly vulnerable residents:

- Elderly
- Disabled
- Non-English speakers
- Single parents
- People new to the area
- Visitors/tourists

Coordination of recovery and restoration following a major incident is likely to be through the relevant LA/Recovery Working Group

## 6. Overall assessment

Category	Sub-category		
Structural hazards	Major reservoir failure		
Outcome description	Impact	Likelihood	Risk

Complete destruction or serious damage to up to 200 downstream properties. Several thousand other properties could be flooded. Extent of downstream effect could reach 50-60km depending on topography. Up to 2000 fatalities could result though this would be mitigated by the extent of warning time given and evacuation taking place effectively.	Significant (4)	Negligible (1)	Medium
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### **Controls in place**

- Panel engineer to oversee the safe construction, operation and maintenance of reservoirs and inspect their safety every ten years or more frequently if necessary
- A Construction Engineer is appointed to supervise the construction or modification of a reservoir.
- An Inspecting Engineer is appointed to inspect a reservoir and produce recommendations in the interest of safety (i.e. essential safety works).
- A supervising Engineer is appointed to supervise the operation and maintenance of the reservoir.
- In Nov 2007 Defra wrote to Water Companies requesting any existing inundation maps they hold for their reservoirs, for emergency planning purposes. This is an interim measure prior to the requirement to produce Reservoir Flood Plans.

### **Environment Agency**

- Regulation and enforcement of the Reservoirs Act.
- Maintain a Statutory Public Register of Dams
- Additional resources provided by agencies detailed in multi-Agency Response Plan (MARP)
- Environment Agency Incident Management Plans
- Environment Agency 24/7 incident response
- Environment Agency Memorandum of Understanding with Fire Brigades, Police, Local Authorities, Highways Agency, Health Protection Agency and Health Authority.

### **Other Organisations**

- Local Authority Major Emergency Plan
- Oxfordshire County Council Emergency Plan
- Milton Keynes Council Major Incident Guide
- Buckinghamshire County Council Emergency Plan
- Aylesbury Vale District Council Emergency Plan
- Chiltern District Council Emergency Plan
- South Bucks District Council Emergency Plan
- Wycombe District Council Emergency Plan
- Oxfordshire, Royal Berkshire and Two Shires Ambulance NHS Trusts Major Incident Plan
- West Berkshire Council – Major Incident Plan
- Royal Berkshire Hospital NHS Trust Major Incident Plan
- Heatherwood and Wexham Park Hospitals NHS Trust Major Incident Plan
- Berkshire Primary Care Organisations Major Incident Plan and Operational Response Manuals
- Berkshire Healthcare Trust Major Incident Plan
- Buckinghamshire Hospitals NHS Trust Major Incident Plan
- Milton Keynes Hospital NHS Trust Major Incident Plan
- Buckinghamshire Mental Health Trust Major Incident Plan
- Buckinghamshire Primary Care Organisations Major Incident Plan
- Oxford Radcliffe Hospitals NHS Trust Major Incident Plan
- Oxford Mental Health Trust Major Incident Plan
- Nuffield Orthopaedic Clinic Major Incident Plan

- Oxfordshire Primary Care Organisations Major Incident Plan
- Thames Valley Strategic Health Authority Major Incident Plan
- Berkshire Integrated Emergency Planning Structure
- Wokingham District Council Emergency Plan
- Reading Borough Council Emergency Plan
- West Berkshire Council Emergency Plan
- Bracknell Forest Borough Council Emergency Plan
- Royal Borough Council of Windsor and Maidenhead Emergency Plan
- Slough Borough Council Emergency Plan

**Additional risk treatment required**

- Identify high consequence risk reservoirs
- Produce Flood Plans for all high risk reservoirs.
- Reservoir flood plans are likely to be required by law from Spring 2009.
- Undertakers to engage with Local Authority
- Increase take up of Floodline Warnings Direct by local residents and encourage better flood preparedness in communities
- Identify rest centres not within floodplain for use during flood events
- Site specific flood response plans, considering schools, hospitals, surgeries, retirement homes, critical utility assets etc.
- Need to engage : Annual Flood Warning, Emergency Planning and response meeting