What is the problem under consideration? Why is government intervention necessary?
The Government is committed to modernising reservoir safety legislation. The independently-led review into the summer 2007 floods concluded that the current statutory regime for reservoir safety did not adequately cater for risks to public safety from uncontrolled releases of water from reservoirs and concluded in particular that a more risk-based approach should be adopted. In this connection the review noted that risks existed from reservoirs whose capacity is less than that which qualified them to be included in the controls in Reservoirs Act 1975, as amended.

What are the policy objectives and the intended effects?
The policy objective is to adopt a risk-based approach to reservoir safety in place of the current controls, which assume an equal level of risk from any reservoir above the statutorily-defined capacity of 25,000 cu metres and, through their exclusion from the controls, implicitly that there is no risk from reservoirs below this capacity. The proposal is to a) modernise and extend the current system of controls to all reservoirs above a de minimis capacity that pose a risk to public safety, and b) introduce a regime of minimal controls for any reservoir which pose minimal risks to safety.

What policy options have been considered? Please justify any preferred option.
The proposal is to require registration of all reservoirs above the de minimis level; and to provide for the proportionate risk-based controls to be set out in detailed rules once registration is completed and risks assessed in detail. Market-based, "do-nothing" and reactive approaches have been discarded at the primary legislation stage as a means of full risk assessment is not available against which their effectiveness can be properly addressed. Consideration of their applicability will be reviewed post-registration in the light of knowledge gained as detailed rules are developed.

When will the policy be reviewed to establish the actual costs and benefits and the achievement of the desired effects?
A review of the requirement will be held two years and 5 years after they come into effect.

Ministerial Sign-off For consultation stage Impact Assessments:

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.

Signed by the responsible Minister:

.................................................................................................................. Date:
### Summary: Analysis & Evidence

**Policy Option:** 1  
**Description:** Registering all reservoirs, deregulating LRRs of low risk, and regulating SRRs which are seen to be at high risk of breaching.

#### ANNUAL COSTS

<table>
<thead>
<tr>
<th>Description</th>
<th>One-off (Transition)</th>
<th>Average Annual Cost (excluding one-off)</th>
<th>Total Cost (PV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs to owners of public safety controls on reservoirs, including extension of existing controls to high risk reservoirs in the 10-25,000 cu metres capacity range</td>
<td>£21.6 million</td>
<td>£19.9 million</td>
<td>£508 million</td>
</tr>
</tbody>
</table>

Other **key non-monetised costs** by ‘main affected groups’

#### ANNUAL BENEFITS

<table>
<thead>
<tr>
<th>Description</th>
<th>One-off</th>
<th>Average Annual Benefit (excluding one-off)</th>
<th>Total Benefit (PV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction in risks to public safety from flooding caused by breach in reservoirs in 10-25,000 cu metres capacity range, along with savings to low risk LRRs</td>
<td>£ -</td>
<td>£40.0 million</td>
<td>£522 million</td>
</tr>
</tbody>
</table>

Other **key non-monetised benefits** by ‘main affected groups’ Benefits resulting from reducing the risk of a reservoir breach on property prices in the inundation area and from reducing the likelihood of court cases resulting from the public liability of reservoir owners.

**Key Assumptions/Sensitivities/Risks** Assumptions about numbers and risks from small raised reservoirs and impacts of a reservoir breach on people have been made in the absence of hard evidence.

<table>
<thead>
<tr>
<th>Price Base Year</th>
<th>Time Period Years</th>
<th>Net Benefit Range (NPV)</th>
<th>NET BENEFIT (NPV Best estimate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>45</td>
<td>£ -</td>
<td>£ 14 million</td>
</tr>
</tbody>
</table>

**Key:** Annual costs and benefits: Constant Prices (Net) Present Value

---

- **What is the geographic coverage of the policy/optit?** England and Wales
- **On what date will the policy be implemented?** April 2011
- **Which organisation(s) will enforce the policy?** EA
- **What is the total annual cost of enforcement for these organisations?** £
- **Does enforcement comply with Hampton principles?** Yes
- **Will implementation go beyond minimum EU requirements?** N/A
- **What is the value of the proposed offsetting measure per year?** £0
- **What is the value of changes in greenhouse gas emissions?** £0
- **Will the proposal have a significant impact on competition?** No
- **Annual cost (£-£) per organisation (excluding one-off)**  
  - Micro: Not quantified
  - Small: Not quantified
  - Medium: Not quantified
  - Large: Not quantified
- **Are any of these organisations exempt?** Yes / No

**Impact on Admin Burdens Baseline (2005 Prices)**  
<table>
<thead>
<tr>
<th>Increase of</th>
<th>Decrease of</th>
<th>Net Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>£0.6m</td>
<td>£0.9 m</td>
<td>£0.3m decrease</td>
</tr>
</tbody>
</table>

**Key:** (Increase)
### Policy Option: 2  
**Description:** Deregulating LRRs of low risk

#### ANNUAL COSTS

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Yrs</th>
<th>Cost (£)</th>
<th>Total Cost (PV) (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-off (Transition)</td>
<td>Costs of registration of reservoirs over 10,000 cu metres capacity.</td>
<td>45</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Average Annual Cost (excluding one-off)</td>
<td></td>
<td></td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Total Cost</strong> (PV)</td>
<td></td>
<td></td>
<td><strong>£ N/A</strong></td>
<td><strong>£ N/A</strong></td>
</tr>
</tbody>
</table>

**Other key non-monetised costs** by ‘main affected groups’ NA.

#### ANNUAL BENEFITS

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Yrs</th>
<th>Cost (£)</th>
<th>Total Benefit (PV) (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>One-off</td>
<td>Reduction in costs for those LRRs classified as low risk following registration.</td>
<td>45</td>
<td>£ -</td>
<td>£ 19.9 million</td>
</tr>
<tr>
<td>Average Annual Benefit (excluding one-off)</td>
<td></td>
<td></td>
<td>£ 19.9 million</td>
<td>£ 204 million</td>
</tr>
<tr>
<td><strong>Total Benefit</strong> (PV)</td>
<td></td>
<td></td>
<td><strong>£ 204 million</strong></td>
<td><strong>£ 204 million</strong></td>
</tr>
</tbody>
</table>

**Other key non-monetised benefits** by ‘main affected groups’

### Key Assumptions/Sensitivities/Risks

Assumptions about numbers and risks from small raised reservoirs have been made in the absence of hard evidence.

<table>
<thead>
<tr>
<th>Price Base Year</th>
<th>Time Period Years</th>
<th>Net Benefit Range (NPV) (£)</th>
<th>NET BENEFIT (NPV Best estimate) (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>45</td>
<td>£ -</td>
<td>£ 204 million</td>
</tr>
</tbody>
</table>

---

**What is the geographic coverage of the policy/option?** England and Wales

**On what date will the policy be implemented?** April 2011

**Which organisation(s) will enforce the policy?** EA

**What is the total annual cost of enforcement for these organisations?** £

**Does enforcement comply with Hampton principles?** Yes

**Will implementation go beyond minimum EU requirements?** N/A

**What is the value of the proposed offsetting measure per year?** £ 0

**What is the value of changes in greenhouse gas emissions?** £ 0

**Will the proposal have a significant impact on competition?** No

**Annual cost (£-£) per organisation (excluding one-off)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Micro Not quantified</th>
<th>Small Not quantified</th>
<th>Medium Not quantified</th>
<th>Large Not quantified</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Are any of these organisations exempt?**

---

**Impact on Admin Burdens Baseline (2005 Prices)**

<table>
<thead>
<tr>
<th>Increase of £</th>
<th>Decrease of £</th>
<th><strong>Net Impact £</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Summary: Analysis & Evidence

**Policy Option: 3**

**Description:** Regulating Small Raised Reservoirs

| **ANNUAL COSTS** | Description and scale of key monetised costs by 'main affected groups'
| Costs to owners of SRRs with a 'high' risk of breach. These costs to not include the preliminary costs of inundation mapping and registration costs described in option 1 (one off costs) |
|---|---|
| **One-off (Transition)** | **Yrs** |
| £ 0 | 45 |
| **Average Annual Cost** (excluding one-off) | **£ 29.5 million** |
| **Total Cost (PV)** | **£ 508 million** |

**ANNUAL BENEFITS**

| Description and scale of key monetised benefits by 'main affected groups'. |
|---|---|
| **One-off** | **Yrs** |
| £ - | 45 |
| **Average Annual Benefit** (excluding one-off) | **£ 13.6 million** |
| **Total Benefit (PV)** | **£ 316 million** |

**Key non-monetised costs by 'main affected groups'**

Other key non-monetised costs by 'main affected groups'

**Key non-monetised benefits by 'main affected groups'**

Benefits resulting from reducing the risk of a reservoir breach on property prices in the inundation area and from reducing the likelihood of court cases resulting from the public liability of reservoir owners.

**Key Assumptions/Sensitivities/Risks**

Assumptions about numbers and risks from small raised reservoirs and impacts of a reservoir breach on people have been made in the absence of hard evidence.

<table>
<thead>
<tr>
<th>Price Base Year</th>
<th>Time Period Years</th>
<th>Net Benefit Range (NPV)</th>
<th>NET BENEFIT (NPV Best estimate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>45</td>
<td>£ -</td>
<td>£ -192 million</td>
</tr>
</tbody>
</table>

**What is the geographic coverage of the policy/option?** England and Wales

**On what date will the policy be implemented?** April 2011

**Which organisation(s) will enforce the policy?** EA

**What is the total annual cost of enforcement for these organisations?** £

**Does enforcement comply with Hampton principles?** Yes

**Will implementation go beyond minimum EU requirements?** N/A

**What is the value of the proposed offsetting measure per year?** £ 0

**What is the value of changes in greenhouse gas emissions?** £ 0

**Will the proposal have a significant impact on competition?** No

**Annual cost (£-£) per organisation (excluding one-off)**

<table>
<thead>
<tr>
<th>Micro</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not quantified</td>
<td>Not quantified</td>
<td>Not quantified</td>
<td>Not quantified</td>
</tr>
</tbody>
</table>

**Are any of these organisations exempt?** Yes / No

**Impact on Admin Burdens Baseline (2005 Prices)**

<table>
<thead>
<tr>
<th>Increase of</th>
<th>£</th>
<th>Decrease of</th>
<th>£</th>
<th>Net Impact</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Increase)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key:**

Annual costs and benefits: Constant Prices (Net) Present Value
Contents:

Section 1: Current policy
1.1 Status of Evidence
1.2 Background on reservoirs
1.3 Consequences of reservoir incidents

Section 2: Proposed change in policy
2.1 Policy rationale
2.2 Overview of proposed changes to primary legislation
2.3 Key elements of the proposals
2.4 Detailed changes
2.5 Consultation on the development of flood plans

Section 3: Further work
3.1 Ongoing consultation and evidence gathering
3.2 Post-implementation review

Section 4: Policy options
4.1 Alternative policy options

Section 5: Costs of the proposals
5.1 Direct costs of the Government’s proposals
5.2 Liability for compliance costs by reservoir type
5.3 Estimates of reservoir numbers

Section 6: Benefits
6.1 Main quantifiable benefits
6.2 Other benefits
6.3 Net benefits and break even scenario
1.1 Status of Evidence

This Impact Assessment is concerned with those clauses in the Floods and Water Bill dealing specifically with reservoir safety. The assessment has been based on a combination of existing information from numerous sources and our current best estimates of a number of factors that potentially affect the safety of reservoirs.

The effects of the draft Bill, if enacted, would be both regulatory and deregulatory. That is because the clauses would:

(a) remove some existing regulatory requirements that undertakers of some reservoirs of a capacity of over 25,000 cubic metres currently have to comply with, by virtue of the Reservoirs Act 1975 (as amended); and

(b) add regulatory requirements on those who would be defined as ‘Reservoir Managers’ of reservoirs of between 10,000 and 25,000, not currently covered by the provisions of the 1975 Act.

Post-consultation, decisions would need to be taken by Government on whether to proceed with the regulatory and/or deregulatory provisions.

Current knowledge gaps
The Impact Assessment is based on a number of assumptions, which we have had to make since we do not yet know:

- with any great degree of certainty how many Small Raised Reservoirs (SRRs) exist;
- how many of those SRRs might present a risk to the public;
- the likelihood of a reservoir breach occurring in this country which might affect people (partly because of a lack of any recently recorded events; partly because we have limited information on the condition of SRRs; and partly because the likelihood is inherently difficult to assess).

The nature of reservoir breaches also means that the damage caused is likely to be specific to each reservoir. At this stage we can estimate the benefit of preventing such breaches only in relation to illustrative examples using generic data. Similarly the cost of the proposals can be estimated only using generic data which cannot take account of the circumstances of each reservoir.

We hope the pre-legislative scrutiny and the public consultation will help us to fill some of these knowledge gaps. In addition, some information will emerge from current work on inundation mapping and the proposed registration and monitoring of SRRs.
It is important to note that this consultation is the first. It attempts to look beyond the direct requirements of the Bill to the indirect effects that it might have. The direct effects are to require registration of a greater range of reservoirs than is currently included in the Reservoirs Act 1975. The indirect effects are how reservoirs once registered will be dealt with in detailed rules. Until the direct effects have been felt and we are able to fill the gaps in knowledge referred to above, the assessment of the indirect effects is, of necessity, built on a number of assumptions. Further consultation on the specific measures we plan to take forward will be made and a more specific impact assessment developed as and when proposals for detailed rules can be framed.

1.2 Background on reservoirs

Reservoirs are civil engineered structures that together with the surrounding land hold water above normal ground levels. In England and Wales the water stored is used for a number of purposes, the most obvious being water supply but also includes recreational uses, flood water storage (to attenuate flood flows on a watercourse), industrial processes, landscape features etc.

Ownership is similarly diverse: water companies, local authorities, industrial concerns and fishing clubs are included in this, as well as the Environment Agency itself which manages a number of flood storage reservoirs. Although official controls do exist on reservoir safety (see below), the liability under common law for any effects the reservoir has on third parties – e.g. through flooding caused by overtopping or breach of the retaining structures – lies with the reservoir owner. For this reason, we understand that many reservoir owners maintain public liability insurance against such risks. Further evidence on how reservoir owners perceive the benefits of insurance will be sought during consultation. One effect of the official controls in reducing the likelihood of flooding from reservoirs is assumed to be a lessening in the cost of that insurance. However, no figures exist on this, nor is it clear how far the existence of the common law liability influences the behaviour of reservoir owners in reducing the risk.

Since 1930, reservoirs with capacity in excess of 25,000 cu metres have been classified as Large Raised Reservoirs (LRRs). The origins of this figure lie in the size of those reservoirs which breached in the 1920s causing loss of life. Policy since that time has been to apply a system of safety controls for LRRs which has sought to minimise the risks to public safety from uncontrolled releases of water. There are no such provisions for reservoirs below this capacity (i.e. SRRs).

The Reservoirs Act 1975 (RA 1975) provides for undertakers of LRRs to appoint supervising and inspecting engineers to oversee the safety of the reservoir and recommend works in the interests of safety. Recommended works are mandatory and inspections must take place at least once every 10 years. The RA 1975 provides for the Secretary of State to appoint panels of civil engineers who are qualified and can be called on by undertakers to provide the supervising and inspecting services required. It also provides for enforcement including powers
and penalties, currently through the Environment Agency in England and Wales; for the keeping of records of such matters as water levels in the reservoir and leakages from it as well as specific provisions on “new Build” reservoirs, on abandonment and on discontinuance.

1.3 Consequences of reservoir incidents

Flooding from reservoirs can occur in two ways. One, a rainfall event in the reservoir’s catchment may lead to flows in the feeder watercourse that exceed the design standard for handling such flows. The overtopping that might occur will cause water to flow over the crest of the dam and might cause flooding downstream. However, the amounts will be limited to the “excess”. Overtopping might link to the second cause, that of breach of the dam structure, if it erodes the downstream face of the retaining embankment to the point where it can longer support the pressure of water behind it. This is not the only reason for embankment collapse. Others include internal erosion over time, signs of which may be evident to the trained eye in subsidence in the embankment, growing leakages and/or leakages which contain debris. Whatever the reason, the effects of embankment collapse would be sudden and lead to catastrophic flooding. The extent of this would depend on the height of the embankment, its elevation above surrounding land and the capacity of the reservoir, all of which would contribute to the amounts, depths and velocities of water that would be released. Impacts in the downstream area would be destructive of any life and property in the path until flows reach the point where they attenuate to become the same type of flooding of an area as would be seen from rivers or the sea. The areas subjected to these two types of flooding would depend on topography as well as the volumes and velocities of water released.

Generally, the capacity of the reservoir is a determining factor only in the volumes of water released: other things being equal, impacts would be less from smaller reservoirs but may be as great or greater if smaller volume is offset by the other factors. However, below a certain capacity, breaches and so impacts are unlikely: engineering assessment is that up to around 10,000 cubic metres capacity excessive leakage, for example, would so effectively drain the reservoir that breach would be extremely unlikely. However, in the current state of knowledge of the reservoir stock, it is not possible to say that in all cases risks from overtopping from such reservoirs would not be sufficient to cause harm to people and property.

The most serious level of incident would involve a breach of the reservoir embankment leading to a sudden and uncontrolled release of water. In an area immediately downstream (and delineated by the nature of the topography) flooding would be catastrophic in nature, with property destroyed or damaged and people in the area drowned or crushed by debris. Flooding from the sea or rivers is rarely of this type: only in exceptional cases such as Boscastle in North Cornwall in 2004 can the type of effects be seen. In an area beyond that - when flows have attenuated - flooding of the type typically seen from rivers or the sea would occur, with waters rising to flood levels. For impounding reservoirs – where a dam is constructed across a river valley – the valley would funnel the flows and the impacts would be in a relatively long, narrow
area of inundation. Depending on the location, attenuated flooding might add to the already existing flood risks on that watercourse from fluvial flows (indeed, in some cases a reservoir might be operated so as at least partially to contain those flows). For non-impounding reservoirs such as those in the Thames and Lea valleys where the reservoir stores water from rainfall directly on to it or which is pumped into it), the inundation area would be a relatively wide and short area and may not be associated with any watercourse (i.e. the attenuated flows do not present an additional flood risk).

Particularly in cases where no monitoring has taken place and so early warning signs are not spotted, risks of embankment collapse without warning exist. Early warning signs are typically identified at regular, visual inspection of the state of embankments, the content of leakages (which might indicate erosion of an embankment from within), blockages of overflow spillways and pipe-work. Early warning will prompt the undertaker to seek professional advice and in serious cases to his calling in of an Inspecting Engineer to advise on immediate measures and to his alerting the emergency services in case precautionary evacuation of local people needs to be arranged and to his notifying other authorities if, for example, roads or other infrastructure might be at risk. For the most part there is no specific contingency planning in place for particular reservoirs.

Since the current controls serve to lessen the likelihood of uncontrolled releases of water, they also serve to reduce the likelihood of emergency response having to be activated. However, likelihood can never be reduced to zero and it is usual in any case where an emergency might occur to reduce the impacts from an event by having contingency planning in place. Currently, there are no requirements for monitoring or contacts with emergency services. Provision exists in S12 of the Reservoirs Act (an amendment introduced in the Water Act 2003) for undertakers to be given a Direction to prepare flood plans. This has not yet been implemented. Proposals to do so have been prepared and part of the consultation on this Bill incorporates the question as to whether respondents wish to introduce the Direction ahead of the Bill.

The effect of such a Direction ahead of the enactment of new provisions extending to SRRs would be to require undertakers of LRRs only to prepare on-site emergency plans, including a communications plan with the emergency services and the public and an inundation map (although, in response to a recommendation from the Review into the summer 2007 floods, the Government is preparing these maps for all existing LRRs and subsequently SRRs). The Direction would not, however, require undertakers to fund the preparation of off-site emergency plans.

2.1 Policy rationale

In his report on the summer 2007 floods, Sir Michael Pitt recommended that the Government should implement the legislative changes proposed in the Environment Agency biennial report on dam and reservoir safety through the forthcoming flooding legislation. In its December 2008
response, the Government said it accepted the need to improve the efficacy of the Reservoirs Act 1975, as amended, and was developing proposals for revised legislation, to include in the draft Floods and Water Bill.

Based on the evidence gathered and presented by Sir Michael Pitt, there are a number of weaknesses in the current controls relating to risk:

- they assume that controls should apply to all LRRs, regardless of whether or not there are risks to downstream populations from uncontrolled releases of water;
- they exclude any reservoir below the 25,000 cubic metre criterion; and
- there are unsatisfactory or high risk levels of enforcement.

On the basis of the costs and benefits contained in this impact assessment, the economic case for extending the reach of primary legislation to reservoirs not within the scope of the 1975 Reservoirs Act (as amended) is not clear cut. However our calculations are largely illustrative and based on assumptions and estimates that may prove to be incorrect or inaccurate. So the opportunity of a draft Floods and Water Bill and the accompanying public consultation will enable us to test that evidence and gather further information to inform Ministers’ decisions on how to take these matters forward.

2.1.1 Elaboration of risk-based approach as it applies to reservoirs

A risk-based approach starts with the notion that the costs of measures to address risks to the public should at least be matched by the benefits derived from those measures. Risk is typically the likelihood of an event occurring and its impact. In this context, the risk is that posed to the public from uncontrolled releases of water from reservoirs.

There are peculiarities in the application of a risk-based approach in this sector. The main one is that it is not possible to lay down in legislation broad criteria that with any degree of objective certainty will identify one reservoir within a particular description (e.g. for illustration a broad description might be earth embankment construction) as being more or less likely to fail than another. A wide range of factors affect likelihood which can be assessed only on an individual basis by engineering experts. For this reason the proposals seek to allow the possibility of the full suite of substantial controls to all reservoirs whose failure would pose an actual risk to the public. They would apply certain common measures such as regular monitoring of the site. Detailed rules would apply other measures according to type of reservoir; but otherwise they would maintain the primacy of independent, engineering, judgement on a case by case basis.

However, objective certainty can be achieved in relation to impacts. Reservoir inundation mapping enables identification of whether an uncontrolled release of water from a particular

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1 See Annex A for more details
reservoir could result in loss of life; and so serves to determine whether a reservoir is high risk or low risk.

For legislative purposes, therefore, the substantial controls would include any reservoir from which an uncontrolled release of water could result in loss of life. The proposals would provide for those types of reservoir to be defined where other circumstances mean that risks from such releases are actually negligible and the reservoir can therefore be treated as low risk. This is discussed further in section 2.3 below. However, for a high risk reservoir, the reduction in the likelihood of an uncontrolled release of water is managed through the application of professional judgement to individual cases. In effect, the combination of common measures and engineering judgement assesses and manages risk at the level of the smallest unit, i.e. the individual reservoir.

For “people” the proposals envisage that the area of high impact will cover not only residential areas but also those where people might be expected to gather, e.g. at school or at work. In short, it is intended that it will cover day time and night time populations. This is because the overall causes of reservoir breach are not limited to “wet weather” events but may include “sunny day” events. However, for impounding reservoirs there is expected to be a number of cases where the additional risk of flooding from attenuated flows adds negligibly to that from fluvial events.

2.2 Proposed changes to primary legislation

2.2.1 Overview

The essential changes from the current regime are extension of legislation to reservoirs below 25,000 cu metres capacity and moves towards a risk-based approach in place of the standards one in the Reservoirs Act 1975. At the level of primary legislation, this means enabling a risk based approach to be applied by:

- redefining what is meant by a reservoir with reference in particular to its capacity; and

- providing procedures for a risk based approach to be adopted. The essential requirement in primary legislation to enable this approach is one of registration of all reservoirs within the revised definition. The other requirement is for the primary legislation to provide procedures for risk based controls to be applied, recognising that no such controls can be developed until registration has been completed and a professional view can be taken of the nature of the risks.

The key changes to the existing primary legislation on which we are consulting are summarised as follows:
We should redefine “reservoir” to include structures with a capacity of less than the current criterion - over 25,000 cubic metres. There would be provisions to allow the definition to be amended by secondary legislation, should this be necessary either to include or exclude further reservoirs.

We should introduce a requirement for registration of all structures within the new definition, together with sufficient information to enable the enforcement authority to determine its risk class.

We should provide procedures to be developed to impose differential requirements according to whether or not a structure poses risks to the public from uncontrolled releases of water. The requirements for “high risk” reservoirs (both LRRs and SRRs) are assumed in what follows to be broadly those contained within the current controls but with some additional provisions for operational regimes and for flood plans.

Those differential requirements are therefore assumed to mean that:

- Large Raised Reservoirs (LRRs) – i.e. those which come within the current legislation - that are classed as not being high risk will have to meet fewer requirements than currently under the RA 1975; those that are classed as high risk will have to meet the requirements set out above;

- those reservoirs currently below the threshold in the RA 1975 (i.e. SRRs) that are classed as high risk would have to meet the same requirements as high risk LRRs as set out above; whereas low risk SRRs would have similar requirements to low risk LRRs.

The primary legislation will set out the controls that will apply to high risk reservoirs. These will be: appointment of supervising and inspecting engineers; monitoring and record keeping; and adherence to flood plans (see below). At another level of detail, the precise impact of these controls on any one reservoir will depend on the individual circumstances.

2.2.2 Key elements of the proposals in more detail

2.2.3 Definition of a reservoir

The current Act applies only to large raised reservoirs capable of holding more than 25,000 cubic metres of water (roughly equivalent to 10 Olympic-sized swimming pools) above natural ground level. Removing the capacity criterion entirely would not be consistent with a risk based approach. The draft Bill provides for a new de minimis criterion such that bodies of water below 10,000 cubic metres would not be subject to controls.

A consensus has begun to emerge within the reservoir safety profession that this capacity represents the lowest one that could pose risks to the public. However, the profession’s
knowledge of smaller reservoirs is necessarily incomplete and once the process of registration has been finished it will be possible to refine this figure. The proposals would provide a procedure for the figure to be extended downwards if necessary if particular circumstances are identified in the future where risks arise from reservoirs below 10,000 cu metres capacity. The proposals would also provide a procedure for defining circumstances in which reservoirs can be considered a negligible risk (see below) even if they are close to areas of population. Otherwise the proposals would cover any structure (whether wholly or partially artificial) which is designed to collect and store a large volume of water for any purpose. Typically, water will be stored for water supply purposes, either in its untreated or potable form. Reservoirs are also often used for recreational or leisure activities, such as fishing or sailing or as ornamental lakes.

The revised regime would also apply to structures which were not originally designed to collect and store water but which are subsequently modified or adapted to do this. The definition would, therefore, extend to any place where water is artificially retained to form or enlarge a lake whether or not use is intended to be made of the water.

The term “reservoir” would cover, where appropriate, its entire water-retaining structure, including the reservoir basin and all ancillary apparatus and control structures, such as spillways, valves and pipe work.

2.2.4 Registration

There would be a proposed legal obligation on all undertaker(s) to register with the Environment Agency any reservoir which is subject to the proposed requirements. We are proposing to set out the detailed registration requirements in secondary legislation; however, at this stage we envisage the registration requirements would include the following:

- details of how the undertaker(s) monitor the reservoir’s safety, the frequency of this monitoring and the details of the persons responsible for carrying out this monitoring;
- a statement of each undertaker’s financial resources and any insurances they hold; and
- an inundation map in relation to the reservoir (however in response to a separate recommendation from the Review of the summer 2007 floods, the intention is that the Government will provide these for all existing reservoirs – which means that, in practice, this provision would apply only in limited circumstances e.g. where there is a new reservoir).

An undertaker who had been an undertaker of a LRR prior to the commencement of this requirement would not need to supply any information held on the register under the previous regime.
Since such details can change, undertakers would be required to inform the enforcement authority of any changes to any of the details the undertaker has previously provided, within 28 days.

Undertakers of registered reservoirs would be required to maintain an information board in conspicuous places on reservoir sites clearly setting out up-to-date details of the registration number, the name of the reservoir and emergency contact telephone number(s), for emergency response purposes.

2.5 Classification of reservoirs

Reservoirs are currently categorised on a non-statutory basis as to whether uncontrolled release would cause risks to 10 people or more (category A); under 10 people (B); property damage (C); and little or no damage (D). Our proposals would provide for delegated powers to establish a more risk-based classification.

The proposed approach is for all reservoirs to be classified by reference to two broad classes:

- “High risk reservoirs” – any reservoir subject to the revised Act, which if it failed, could result in the loss of life to downstream populations (daytime and night time); or
- Other (ie“Low risk”) reservoirs” – any reservoir subject to the revised Act, which if it failed, should not result in the loss of life to downstream populations.

Whether or not a reservoir could result in the loss of life, if it failed, will be determined:

by reference to the inundation map for each reservoir. Inundation maps will show in each case the inundation zone for the reservoir and the daytime and night time populations in that zone and will need to be prepared to a prescribed methodology; and

by any characteristics which mean that in practice certain classes of reservoir pose negligible risks to the public. For example, it has been proposed that concrete service reservoirs fall into this category. This is, of course, only one description of type: other descriptions might involve embankment height, for example. It is expected that further proposals will be made once the process of registration has been completed.

In addition to the suite of existing controls on LRRs involving supervision and inspection by qualified engineers, undertakers of “high-risk” reservoirs (whether they are LRRs or SRRs) will be required to ensure that their reservoirs are monitored for any signs that a reservoir’s safety may be affected and to have emergency planning and response measures in place, in concert with the emergency services and local authorities in the area.

2.2.6 Charging
There is currently no provision under the Act to charge undertakers for the costs and expenses the enforcement authority incurs from carrying out its enforcement functions. The proposals include the introduction of powers for recovery of these costs, excluding costs of registration.

The proposals also include a requirement for costs of off-site emergency planning to be met by undertakers, in line with the approach under the Control of Major Accident Hazards (COMAH) Regulations.

2.2.7 Detailed changes

A number of important detailed provisions are proposed. These are summarised below.

- **Reducing capacity and draw downs** – for high risk reservoirs, we propose to: (i) extend the requirement for a construction engineer to be responsible and to certify any *increase* in capacity of a reservoir to include any *reduction* in capacity, since both require major works; and (ii) require a supervising engineer to oversee any drawdown and re-fill of a reservoir to ensure that it is done safely.

- **Quality checking of all reports** – we propose to introduce an independent review process of Inspecting Engineers’ reports and Supervising Engineers’ annual statements. The specific details of this would be set out in secondary legislation.

- **Maintenance/operation issues to be binding on the undertaker** - The RA1975 requires inspecting engineers to note in their reports any recommendations they see fit as to measures that should be taken in the interests of safety. We now propose to ensure: (i) that these recommendations include, where appropriate, details of what maintenance should be carried out and how particular parts of the reservoir should be maintained; and (ii) that supervising engineers be required to include information of the action they have taken to implement them in their annual statement.

- **Reservoir Flood Plans** – we propose to require undertakers to obtain a certificate in a prescribed form from the Supervising Engineer that the on-site emergency plan meets the required technical standards.

- **Mandatory incident reporting** - we propose to change the current voluntary system to a mandatory one, so that serious incidents at reservoirs which have safety implications are reported.

2.3 Consultation on the development of reservoir flood plans

Section 12 of the Reservoirs Act was introduced by the Water Act 2003 and enables Ministers to make a direction on undertakers to prepare flood plans. The proposals in the Floods and
Water Bill would carry forward those provisions amended to include provision for undertakers to fund the preparation of off-site emergency response plans.

The power in S 12 has not been used to date. Depending on decisions on the scope and timing of the introduction of a Floods and Water Bill (post this consultation), it is possible that the Government will choose to make use of it before new primary legislation is put in place.

Various aspects of reservoir flood plans have been under development for some time. Such plans would comprise four elements:

- On-site plan - guidance on the content of on-site plans is being prepared, which will set out the requirements for an operational plan which will enable the reservoir undertaker to deal with potential incidents on the site of the reservoir;

- Communications plan – there should be a simple plan of whom to contact in the event of an incident, including Panel engineers and the emergency services;

- Inundation map - as noted above, the Government will produce and provide the inundation map which will show the potential area that would be affected by a reservoir breach; and

- Off-site plan - this would detail the actions needed by the Category 1 responders - emergency services and local authority - in the event of a likely or actual reservoir breach. Guidance is being prepared on the content of these plans, which would be drawn up by the Category 1 responders.

Should the Government proceed with a Direction based on existing primary legislation, it is assumed that specific off-site planning would be required only for high risk LRRs; for low risk LRRs it is assumed that off-site planning would be part of generic flood response plans. The requirements to produce on-site and communications plans would apply only to LRRs. Undertakers of SRRs would not have to meet any new requirement (since the power to require them would not exist unless and until changes are made to primary legislation).

3.1 Ongoing consultation and evidence gathering

The proposals have been discussed widely within Government Departments and Agencies. In order to strengthen the evidence base, Defra commissioned a number of research and data gathering projects, the findings of which have fed into this Impact Assessment. Projects commissioned included a mapping of sites to estimate the numbers of SRRs in England and Wales. Responses to the review of the summer 2007 floods have also informed the Impact Assessment.
Data and information gathering to provide evidence of the impact of our proposals is an ongoing process. We will encourage input from all sources, especially reservoir owners and undertakers through the consultation process.

Prior to introducing a Floods and Water Bill based on our current proposals, we will provide a Final Impact Assessment updated to include all relevant information and further research gathered following publication and scrutiny of this Consultation Impact Assessment.

The proposals are for a flexible regime that will be implemented over a period of time, much of it through secondary legislation and guidance which will set out the detail of how the various elements are intended to operate. The flexibility will allow a range of possible outcomes and ongoing review. Further cost benefit analysis and consultation within Government and in public may therefore be necessary for many elements of the proposals.

3.2 Post-implementation review

The Government intends to conduct a review of any new reservoirs provisions in primary legislation within two years of Enactment or the entry into force of the relevant secondary legislation (as appropriate). Key to such reviews will be the numbers of:

- SRRs that have registered;
- SRRs that have appointed supervising and inspecting engineers;
- LRRs and SRRs which have flood plans;
- LRRs and SRRs which have off site plans prepared; and
- LRRs and SRRs which have been designated as high risk and low risk

Such post-implementation review will be informed also by the Environment Agency’s series of biennial reports.

4.1 Alternative policy options

In addition to the Government’s proposals as set out in the draft Floods and Water Bill, we have explored three main policy options for primary legislation. We treat these below only in relation to primary legislation: their application at the level of detailed rules and Regulations may well be a different matter. We will be discussing the risks further with the insurance industry as registration and inundation mapping proceed. It is possible that, for example, the approach of insurers to reservoir risks might play a part in future consideration of detailed rules..

4.1.1 The “do nothing” option

This option would mean that only LRRs would be subject to substantial controls; and would apply those controls largely regardless of risks to people. This is inconsistent with a risk-based
approach to the point that people are exposed to a higher level of an identical type of risk because of the operation of an arbitrary criterion in the RA 1975. The incident referred to in Annex A is one example of the types of risks that can occur in for reservoirs which are not subject to the RA 1975 and where people are at risk from uncontrolled releases of water. This option provides the base option against which other options are judged.

The ‘do nothing’ option does not preclude other measures to improve reservoir safety that could be taken on the basis of existing legislation. But there are drawbacks to many, if not all, of these measures.

4.1.3 “Market-based option.”

Another approach might be to have the risks managed through the common law or through compulsory public liability insurance. Because the common law liability remains regardless of whether the RA 1975 applies, the rationale for this approach is that reservoir owners should accept the costs of measures to maintain their reservoirs in a safe condition against the benefits that they derive from them and the public liability should an incident occur.

To manage the risk, owners might rely on public liability insurance. In assessing the risks, insurers would take all relevant factors into account and set premiums accordingly (or decide not to accept the risk). It is assumed that insurers would seek engineering assessment as to condition, management, impacts and other factors and provide cover accordingly. The incentive would be for undertakers to manage the risk, the cost of not doing so being either in higher premiums or in lack of availability of insurance cover, with the liability then falling entirely on the owner.

However, it is unlikely that in the current state of knowledge, insurers would have sufficient information to price the risks for insurance purposes. The essential information would seem to be: the consequences to the public and to publicly and privately-owned assets, which could be obtained only through inundation mapping; and condition reports on individual reservoirs. It is unclear whether insurance would cover the full extent of the liability in every case or whether it would even be available in many cases. In such circumstances in the event of a breach, it is unlikely that reservoir owners would be able to meet the full costs of public liability which would be likely to leave them bankrupt. In that event, the residual liability could be met only from the public purse.

The costs of public liability insurance might well be prohibitive, particularly if it were to cover the full liability for an uncontrolled release of water. This might lead reservoir owners either: to sell the reservoir, which might fall out of use with consequent loss of economic and other benefits; or to declare themselves bankrupt. In the latter case, the asset would revert to the Crown and the effect would be for the public purse to assume management of the risks. Such a transfer of risks to the market would not remove the emergency response planning costs that would
continue to be needed. Nevertheless, this option is not entirely discarded for the future. Consultation with insurers will take place as policy develops in detail on the basis of information from inundation mapping and registration and the role of insurance will be explored further in the light of that. However, we do not consider that it is an adequate substitute for the primary legislation, which would seek to establish the scope of the risk before the detailed rules that it provides are developed.

4.1.4 Other options

The Water Act 2003 introduced the power to direct reservoir owners to produce flood plans, and amended the Reservoirs Act. This could be implemented in its own right and would provide added controls in the event of emergency. However, it would apply only to LRRs and does not provide for funding of off-site emergency planning.

The Building Act 1984 provides a mechanism for local authorities to take emergency action in the event that any building – which includes any structure – poses a risk to the public. It is understood that local authorities have in some cases acted under the Building Act. However, it is very much a reactive measure and is unlikely therefore to reduce the levels of risk significantly.

Another approach would be to include requirements on safety within sector-specific legislation (as with, for example, the Mines and Quarries Directive). However, this option may only be for sectors where oversight by a statutory regulator would provide an adequate system of controls. Currently, the water sector owns and operates only 35% of the reservoirs in England and Wales, the remainder being in diverse ownership. Only horizontal legislation will address the risks from the whole reservoir stock. This option is therefore rejected.

4.1.2 The “deregulation” option

The second main alternative to the Government’s proposals would involve removal of controls on low risk LRRs only. If that was to happen, the benefits in savings to owners of LRRs would amount to an estimated £25m annualised over a 10 year period (see Total direct costs and savings below). Other savings (£1.38 m / year) would continue indefinitely, as LRRs of low risk would not have to be supervised and monitored. Whilst this would clearly benefit owners and undertakers of low risk LRRs, it would not address the concerns over risks from some SRRs.

5.1. Direct costs of the Government’s proposals

The estimated direct costs of applying the full proposed requirements for one reservoir are set out below. We would welcome consultees’ views on these estimates.
5.1.1 Registration

This is expected to impose relatively minor costs on LRR undertakers since they would not need to supply any up to date information held on the register under the current regime. But there would be a largely one-off cost to SRR undertakers, for whom there is no current requirement. Both LRR and SRR undertakers would incur costs when changes to registration details are required if and when they occur.

We envisage the registration requirements would include the following:

- details of how the undertakers monitor the reservoir’s safety, the frequency of this monitoring and the details of the persons responsible for carrying out this monitoring;
- a statement of each undertaker’s financial resources including any insurances they hold; and
- a requirement to maintain an information board in a conspicuous place on reservoir sites, clearly setting out up to date details of the registration number, the name of the reservoir and the undertaker(s) emergency contact telephone number(s).

All undertakers would be required to inform the enforcement authority of any changes to their registration details within 28 days of that change.

The direct costs of the full set of registration requirements are estimated at up to £800. This is a one off cost which has come from an Environment Agency estimate based on previous experience. We assume that the need for re-registration would be infrequent. This would be required when the reservoir’s characteristics are changed.

5.1.2 Inundation maps for registered reservoirs

Each registered reservoir (both LRRs and SRRs) will require an inundation map. But the costs to undertakers will be limited since the Government has committed to providing such maps in the first instance.

Costs to undertakers will only be incurred where there is a new reservoir or where the inundation map is considered no longer suitable for emergency planning purposes and a new one is needed.

Average costs for producing inundation maps are expected to be around £1,000. For new reservoirs, they would be required anyway as part of the planning process.

5.2 Indirect costs
These paragraphs concern the costs that might result from application of detailed rules to high risk reservoirs. They presuppose that a reservoir has been registered; is classified as high risk on the basis of its inundation map; and does not meet any conditions which would mean it could be considered as not being high risk.

5.2.1  **Capital costs arising from Inspecting Engineers’ recommendations**

Costs can be expected to occur in relation to normal upkeep and maintenance of a reservoir, for example as assets reach the end of their useful life. Under this head, costs considered are specifically those additional costs that result from an Inspecting Engineers’ recommendations in the interests of safety. Such costs may be incurred depending on the condition of the reservoir. The upper bound could be as high as £7.5 million, based on experience of previous recommendations: however, this is exceptional.

Inspecting Engineers recommend that major works take place within 10 years (depending on the urgency). The typical range per annum would be £0-£250,000, the upper limit being the costs of decommissioning a reservoir (£25,000 on an annualised basis). It is assumed that costs at the higher end of this range would be incurred for larger, older structures: smaller, newer structures could generally be expected to incur much lower costs, subject to their having been kept in good repair.

5.2.2  **Management and operational matters**

Evidence from owners of a number of LRRs and SRRs of different ages and types has been used to give ranges of costs of day to day management and operation of reservoirs. Unless stated otherwise, the source for the following figures is the water industry and reservoir profession average operational costs.

- **On-site and off-site flood plans:** initial costs of £2,640 and £5,280 respectively would be incurred plus regular plan maintenance and validation costs of around £1,000 and £2,000 respectively. Sources are water industry estimates of the costs of on-site planning based on their own costings for this work where it has already been undertaken. For off-site planning, costs are local authority estimates for the costs of site specific off-site planning (it is envisaged that only generic planning will be required for low risk reservoirs). The estimates assume that site specific plans will be needed in all cases. However, costs may be lower in some cases, where additions to existing emergency plans might be appropriate or areas of inundation of one or more reservoirs overlap. Whilst off-site plans are normally validated (exercised) every 3 years on average, it is not envisaged that this will include every reservoir in the area of a Local Resilience Forum (police area). So the figure of £5,280 is expected to be the average cost for all high risk reservoirs.
- **Reservoir monitoring programmes**: water industry estimates indicate a figure of £5,000 per annum on the basis of visits every 48 hours for earth embankment dams and 3 times a week for concrete dams. These costs take account of the human resources needed to visit and “walk” the site: no expertise is required other than a basic knowledge of warning signs such as embankment slippages to look out for. It is envisaged that the monitoring regime for any particular reservoir would be set down by the Supervising or Inspecting Engineer and these figures are based on a strict stringent monitoring regime. Although this might not be appropriate in all cases – for example, the relatively newer structures should need less - given the increasing age of our reservoir stock, we are assuming this level of costs for the purpose of this Assessment.

- **Supervision by qualified supervising engineer and record-keeping**: estimated at £1,500 per annum.

- **Inspection by Inspecting engineer**: Estimated at £1,500-£3,000 per 10 years minimum, giving a range for the annualised cost of £150-300 (£225 average).

- **Preparation and maintenance of on-site flood plan**: Estimated a £940 per annum, with one-off initial costs of £2,640.

- **Preparation and maintenance of off-site flood plan**: Estimated at £1,800 per annum, with one-off initial costs of £5,300. See below for further details.

- **Occasional costs** of around £2,700 may be incurred as a result of plan testing and validation but it is not expected that this would be needed for each and every reservoir (annualised costs, based on 25% of reservoirs, £675).

- **One-off costs** in producing reservoir inundation maps £1,000 (costs to be borne by Government)²

- **Charging by the enforcement authority**: (For high risk reservoirs) £1,100 per annum (source Environment Agency estimates of the costs to the enforcement authority of regulatory activity in e.g. monitoring progress with implementation of recommendations of Inspecting Engineers and serving notices on undertakers for non-compliance with the Act.)

### 5.3 Costs by reservoir type

The effects of the proposals according to type of reservoir is summarised in the table below.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>High risk LRR</th>
<th>Low risk LRR</th>
<th>High risk SRR</th>
<th>Low risk SRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

² Source: Environment Agency
<table>
<thead>
<tr>
<th>Service</th>
<th>Requirement</th>
<th>Removed</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervision</td>
<td>As now</td>
<td>Requirement</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Inspection</td>
<td>As now</td>
<td>Requirement</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>On-site plan</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Off-site plan</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Record keeping</td>
<td>As now</td>
<td>Requirement</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Charging</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Capital</td>
<td>As now</td>
<td>Requirement</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Total direct and indirect costs/savings**

**Present value of additional direct costs/savings of new regime**

<table>
<thead>
<tr>
<th>Service</th>
<th>LRRs high risk (stock of 1200)</th>
<th>LRRs low risk (stock of 800)</th>
<th>SRRs high risk (stock of 500)</th>
<th>SRRs low risk (stock of 4,200)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Registration</strong> (£800, one off cost)</td>
<td>£0.96m</td>
<td>£0.64m</td>
<td>£0.4m</td>
<td>£3.36m</td>
</tr>
<tr>
<td><strong>Inundation maps</strong> (note i) (£1,000, one off cost)</td>
<td>£1.2m</td>
<td>£0.8m</td>
<td>£0.5m</td>
<td>£4.2m</td>
</tr>
<tr>
<td><strong>Capital costs for repair works</strong> (average of £250k over 10 years)</td>
<td>0 (existing requirement)</td>
<td>-£20.0m</td>
<td>+£12.5m</td>
<td>0</td>
</tr>
<tr>
<td><strong>Management and operational maters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Monitoring (£5,000 a year)</td>
<td>+£6.0m</td>
<td>0</td>
<td>+£2.5m</td>
<td>0</td>
</tr>
<tr>
<td>- Supervision (£1500 a year)</td>
<td>0 (existing requirement)</td>
<td>-£1.2m</td>
<td>+£0.75m</td>
<td>0</td>
</tr>
<tr>
<td>- Inspection (£225 a year)</td>
<td>0 (existing requirement)</td>
<td>-£0.18m</td>
<td>+0.113m</td>
<td>0</td>
</tr>
<tr>
<td>- On-site flood plan (£940 a year +£2640 one-off cost)</td>
<td>+£1.128m</td>
<td>+£3.168m</td>
<td>0</td>
<td>+£0.470m</td>
</tr>
<tr>
<td>- Off-site flood plan (£1800 a year+£5280 one-off cost)</td>
<td>+£2.160m</td>
<td>+£6.336m</td>
<td>0</td>
<td>+£0.900m</td>
</tr>
</tbody>
</table>
5.4 Estimates of reservoir numbers

Estimated numbers of reservoirs are derived from Environment Agency figures for LRRs; and from data from Halcrow Group for SRRs. The figures for SRRs may be an over-estimate since within the methodology available for such mapping it is not always possible to distinguish between artificially raised bodies of water and those that lie in the natural landscape.

Bodies of water estimated at below 25,000 cu metres

<table>
<thead>
<tr>
<th>Capacity</th>
<th>5-10,000 cu metres</th>
<th>10-15,000 cu metres</th>
<th>15-20,000 cu metres</th>
<th>20-25,000 cu metres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7,451</td>
<td>2,598</td>
<td>1,304</td>
<td>779</td>
</tr>
<tr>
<td>Total</td>
<td>12,132</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In addition, the Halcrow work did not identify whether bodies of water posed a risk to populations. Although it is planned to derive an estimate through further work, this is not likely to be available until late in 2009. For the purpose of this assessment we have reflected that a very high proportion of all the SRRs are in the East Anglia and Midlands areas and are very likely to be low risk, farm reservoirs used for irrigation or produce washing purposes (5,400 or 45% of the total SRRs); within the 10-25,000 cu metres bands the figures are 2,148 or 46% of the totals in those bands.

Of the remaining 2,533 SRRs in the 10-25,000 bands (i.e. E&W excluding East Anglia and the Midlands), we do not consider it is realistic to assume that the numbers in the high risk and low risk categories will follow the same proportion as is the case with LRRs (1,200 out of a total of 2,000 or 60%). We consider that a proportion of 20% high risk is more realistic, reflecting the
wider usage across the country – albeit not as wide as East Anglia and the Midlands – of SRRs as farm reservoirs and that SRRs should, other things being equal, pose a lower level of risk. Nevertheless, we would appreciate any information to assist in further consideration of these assumptions.

It is also not possible for mapping based exercises such as Halcrow’s to identify two types of reservoir. The first, service reservoirs, which are covered structures and will not be identifiable from mapping. However, as suggested above those newer, concrete, structures are unlikely to require controls. The second, flood storage reservoirs, would also not be identified as they are empty of water except during periods of high river flow. However, such structures should already be maintained as part of flood defence assets and the consideration the requirements for such structures under detailed rules will take place in the context of asset management programmes already in existence.

6.1 Main quantifiable benefits

Benefits arising from the proposals are considered in the context of minimising the risks to public safety of uncontrolled release of water from reservoirs. The review of the summer 2007 floods stated that while there have been a number of such releases since the 1920s, these caused no recorded loss of life and that this improved record must in part be owing to the effects of the controls in the 1930 and 1975 Acts. However, the review also noted that with an increasing average age in the reservoir stock, the future likely impacts of climate change on variability in weather patterns and other events during summer 2007, there were no grounds for complacency.

The main aim and effect of the proposals will be felt on SRRs. LRRs are already subject to most of the measures proposed, although those relating to on-site monitoring and flood plans would be new. On the other hand, low risk LRRs will be subject to much fewer controls than now and overall for this sector there will be savings. Net reductions in costs may be felt by owners, such as water companies, with a large stock of reservoirs of different sizes and risk type. For owners of single reservoirs the effects will depend on the reservoir’s classification – if it is classified as low risk, there will be a clear reduction in costs; if it classified as high risk, there will be additional costs. However, although all additional costs have been included, not all will be felt: for example, many owners will already carry out regular site monitoring as part of their asset management regimes; and inundation maps are being prepared for them by Government. The same will be true for the SRR sector but, again, all costs have been included. For this sector there will be no savings.

The main quantifiable benefits accrue in two ways:

- from reducing the likelihood of uncontrolled releases of water (or ‘breach’); and
avoids costs on the emergency services in mitigating the impacts of such releases and consequential costs on others as a result of breaches.

6.1.1 Breach

A breach is where a dam embankment collapses resulting in almost instantaneous flooding. This collapse can be caused by internal erosion within the dam structure or by external erosion of an embankment as a result of overtopping. Deliberate, controlled, releases of water take place for example in anticipation of heavy rain, which might otherwise create a chance of overtopping. By way of description, a breach would create a significant movement of water, which would lead to the accumulation of debris (including trees, vehicles and sediment), the complete destruction of some residential and commercial properties and serious damage to others. It may also cause loss of life.

However, the likelihood of such an event occurring is difficult to assess. The President of the British Dam Society has suggested that on the basis of international comparisons, a breach of a reservoir could be expected to occur on a 1 in 45 year rate of frequency, giving an annual likelihood of 2.2% in Great Britain (reference: evidence to “Lessons from the 2007 Floods: an independent review by Sir Michael Pitt June 2008). It is not clear whether this figure assumes the existence of precautionary controls or takes account of the age of our reservoir stock; and it should be remembered that the proposals apply to England & Wales only.

In terms of likelihood, there is additional information that needs to be considered:

- The evidence from the review of the summer 2007 floods that between 1960 and 1971, there were 10 dam failures, fortunately none involving loss of life.
- The Environment Agency’s 2008 Report “Learning from Experience” which cites a number of incidents of overtopping leading to external embankment erosion, all at SRRs.

The three cases in 2008 cited in the Environment Agency’s report where emergency action was involved were all at SRRs. However, it cannot be assumed that details of all cases are recorded. Nevertheless, it does indicate a prevalence of particular problems at SRRs.

Recent cases of serious incidents that are recorded are:

- Ulley Reservoir, Nr Rotherham, a LRR - over 1,000 people were evacuated, trunk roads and the M1 were closed.
- Maich fishery, Scotland, a SRR - around 20 properties would have been affected by a potential breach.
- Cottage Pool, Shropshire - a SRR with residential properties and a junior and infant school 500m downstream.
Some details for these cases are available because Panel engineers were brought in to advise on emergency measures. Such details will become available only when inundation mapping has been completed. However, it cannot be assumed that details for these that are recorded are a precise estimate of the consequences. For comparison, one reservoir at Hameldon in Lancashire (a LRR of around 130,000 cubic metres capacity), for which more precise details are known, has around 880 properties in the inundation zone (and over 2,000 people). But individual reservoirs have very different levels of potential harm, depending on a host of factors – proximity and position of communities, infrastructure and businesses being the obvious factors: capacity is also a factor, of course, but in individual cases may well be outweighed by others. It is not possible without detailed mapping and knowledge of the physical characteristics of the stock of reservoirs to give more precise information now.

Of the LRRs, the Environment Agency figures indicate that 61% could result in 10 or more fatalities in the event of catastrophic failure with little or no warning time to evacuate (with an upper bound in the thousands). There are several emergency lowerings of water levels each year for remedial works to be undertaken as a consequence of problems identified with dams. Although, as noted above, figures for SRRs are not available, the known incidents indicate a real threat to people.

There have been no recently recorded fatalities. However, from looking at the examples listed above, there have been instances where serious damage has been averted. The Government’s proposals will reduce the likelihood of these incidents occurring.

Once all reservoirs are registered, detailed rules will be set by type of reservoir based on objective technical criteria such as type of construction, embankment height relative to surface area etc.

6.1.1.1 Breach scenarios

Given the wide variety of circumstances presented by the stock of reservoirs, we have presented below only a limited number of illustrative assumed scenarios. In the absence of any actual event as a guide, the following is a broad assumed assessment of possible impacts for comparative purposes: other examples appear below to give a range of costs and benefits. Note that this scenario may apply in the case of SRRs or LRRs and is not an extreme case – as noted previously, the populations at risk can number in the thousands:

For the purposes of this impact assessment we are assuming the following primary scenario:

- 500 properties could be destroyed and several thousand other properties could be flooded – estimated costs of repairs/reconstruction = (500x£75,000) + (3,000x25,000) = £37.5m+£ 75m = £112.5m.
- 350 fatalities are assumed plus up to 1,000 casualties. Using DfT figures for road traffic fatalities (£1.145m at 2000 prices) and serious casualties (£128,000 at 2000 prices) this equates to £529m,

- and up to 250 families needing temporary accommodation for one year, based on an assumed rental cost of £500 a month - this equates to £1.5m

These costs amount to £643 million; annualised on a 1 in 45 year basis gives an annual figure for impacts of £14.3m a year, and NPV benefit of £316 million. There is an additional £2 million benefit from costs saved by reduced emergency response due to potential breaches. However, the aim of the proposals cannot be to remove this risk entirely but to reduce the likelihood of such an uncontrolled release of water. An estimate of the reduction in risk needs to be made.

In general terms, reservoir safety standards are very high. This recognises the catastrophic effects of flooding caused by an uncontrolled release of water. In some cases, the aim is to reduce likelihood to a 0.01% chance of occurrence. However, this level of safety could not, we believe, be achievable or justifiable in all cases. We therefore assess the achievable reduction in risk at one tenth of this figure, i.e. a 0.1% chance of an uncontrolled release of water or a 1 in 1,000 year standard. This is the same as the design standard for the Thames Barrier and its downstream defences: although the impacts in total would not, of course, be so great from an uncontrolled release of water, neither would the costs of precautionary controls.

Accordingly, we assume that the proposals would reduce the likelihood of an uncontrolled release of water from a 1 in 45 year chance to a 1 in 1,000 year chance, a 95% reduction. Applying this to the annual impacts of £14.3m leads to a benefit (in terms of reduction of this figure by 95%) of £13.6m.

6.1.1.2 Sensitivity analysis on breach

Since the main effect of the proposals will be on high risk SRRs, account needs to be taken of a number of other possible, smaller, scenarios. It cannot be assumed that smaller reservoirs create less of an impact from a breach than would be the case for a bigger reservoir. However, in the absence of any definitive information, an assumed range of impacts can be set out as follows (the side-headings in the first column below relate to the descriptions in the primary scenario above):

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Alternative scenario 1</th>
<th>Alternative scenario 2</th>
<th>Alternative scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers</td>
<td>Impacts (£m)</td>
<td>Numbers</td>
<td>Impacts (flood damages)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Numbers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Impacts (£m)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>125/750</td>
<td>250/1,500</td>
<td>375/2,250</td>
</tr>
<tr>
<td>----------------</td>
<td>---------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>Properties</td>
<td></td>
<td>28.1</td>
<td>56.2</td>
</tr>
<tr>
<td>Fatalities</td>
<td>100</td>
<td>114.5</td>
<td>150</td>
</tr>
<tr>
<td>Casualties</td>
<td>200</td>
<td>25.6</td>
<td>300</td>
</tr>
<tr>
<td>Temporary</td>
<td>400</td>
<td>3.0</td>
<td>600</td>
</tr>
<tr>
<td>accommodation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>171.2</td>
<td>270.6</td>
</tr>
</tbody>
</table>

Based on these figures, the benefits can be calculated on the same basis as above as follows:

<table>
<thead>
<tr>
<th></th>
<th>Alternative scenario 1</th>
<th>Alternative scenario 2</th>
<th>Alternative scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated reduction in impacts (i.e. benefits from Government’s proposals) (£m)</td>
<td>3.6</td>
<td>5.7</td>
<td>7.8</td>
</tr>
<tr>
<td>NPV benefit (£m)</td>
<td>84</td>
<td>133</td>
<td>182</td>
</tr>
</tbody>
</table>

6.1.2 Emergency response

The costs of mounting an emergency response are assessed under two types: an actual breach scenario; and a potential breach scenario.

6.1.2.1 Actual breach scenario

For an actual breach event, we have based our cost estimates (benefits being the costs averted) on the Boscastle flood event in 2004, for which we have good cost information. Those costs have been estimated at around £568,000 plus the cost of helicopter rescue (around £300,000). On the basis of an assumed breach once every 45 years, that gives an annualised figure of about £20,000. On the basis of a reduction in risk to 1 in 1,000 years, the annualised figure would reduce to £868, giving an annualised benefit of around £19,000.

Boscastle is not an ideal case study. There were, thankfully, no lives lost and the numbers of people at risk were small (Boscastle being a small town). But the populations in the inundation areas of reservoirs and the scale of potential impacts will vary widely. So we believe the Boscastle figures, though not ideal, provide a reasonable estimate of the costs.

Another caveat we should attach to the figures stem from the fact that they exclude the costs to the reservoir owner in managing the aftermath of a breach and any subsequent costs of repair. These costs may be substantial and will include costs of responding to a public enquiry and legal actions.
6.1.2.2 Potential breach scenario

Costs of emergency response for a potential, but not realised, breach are equally difficult to assess. We have used an estimate of £100,000 per event for the costs of evacuating people on a precautionary basis and use of equipment such as pumps. And we have assumed that one such event would occur every year on average under the current regulatory regime. We have assumed that this risk would reduce to one event in every 10 years following implementation of the Government’s proposals, giving an annualised benefit of £90,000.

Summary of benefits of Government’s proposals based on scenarios outlined above

<table>
<thead>
<tr>
<th>Description</th>
<th>Impacts (£m)</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary scenario above</td>
<td></td>
<td>3.6</td>
<td>5.7</td>
<td>7.8</td>
</tr>
<tr>
<td>Averting Breach</td>
<td>13.6</td>
<td>3.6</td>
<td>5.7</td>
<td>7.8</td>
</tr>
<tr>
<td>Emergency response – actual breach</td>
<td>0.019</td>
<td>0.019</td>
<td>0.019</td>
<td>0.019</td>
</tr>
<tr>
<td>Emergency response potential breach</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>13.709</td>
<td>3.709</td>
<td>5.809</td>
<td>7.909</td>
</tr>
</tbody>
</table>

The great majority of these benefits will accrue as a result of the regulation of SRRs, since high risk LRRs are already subject to most of the proposed regulatory regime. So, for the purposes of this impact assessment, we are assuming that, using the primary scenario, 90% of the benefits can be set against the costs of regulation of SRRs.

6.2 Other benefits

Benefits may accrue to householders in terms of property prices if, for example, properties are situated downstream of a reservoir, which, if subject to precautionary controls, is less likely to pose a risk. This is difficult to quantify. Awareness of risks from reservoirs is probably low, especially as the areas at risk may be some distance from the structure. It is not known, therefore, whether property prices have suffered because of proximity to a reservoir. Evidence on this point would be welcomed.

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3 We would welcome responses from stakeholders as to what makes up these costs
Further benefits from a precautionary approach would also accrue to reservoir owners. Again this is unquantifiable. It arises because owners would have a greater degree of assurance that their reservoir would not cause a risk to people. In the event that it did, the common law liability would fall on the owner and a precautionary approach lessens that risk to the owner. In addition, it might also lower the costs of public liability insurance, although we would appreciate evidence as to whether this would be so.

6.3 Net cost and break even scenario: all costs

<table>
<thead>
<tr>
<th>LRRs</th>
<th>SRRs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total costs (£m)</td>
<td>+4.095</td>
</tr>
<tr>
<td>Benefits (£m)</td>
<td>-1.371</td>
</tr>
<tr>
<td>Total costs</td>
<td>£2.724</td>
</tr>
</tbody>
</table>

These figures suggest that the break even scenario, when costs equate to benefits, would be one in which the range of costs from a reservoir failure significantly exceeds our primary scenario in terms of fatalities, casualties and other damage. The following scenario is close to that on which the figures would break even.

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Numbers</th>
<th>Impacts (£m)</th>
<th>NPV (£m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Properties</td>
<td>1,500 / 6000</td>
<td>262.5</td>
<td></td>
</tr>
<tr>
<td>Fatalities</td>
<td>600</td>
<td>687</td>
<td></td>
</tr>
<tr>
<td>Casualties</td>
<td>3,000</td>
<td>384</td>
<td></td>
</tr>
<tr>
<td>Temporary accommodation</td>
<td>600</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1337.1</td>
<td></td>
</tr>
</tbody>
</table>

| Benefit from reduction in risk from 1 in 45 years to 1 in 1000 years | £29.7 m | £692 m |
| Compared to total costs for SRRs and LRRs (see above) | £29.5 m | £688 m |

6.4 Cost/ benefits using direct costs only.

The above analyses are made on certain assumptions about the overall effects of the proposals, including the detailed rules that might follow registration, and include both those that are direct – ie those that would be imposed by the Bill itself – and indirect (those that would be imposed by the detailed rules that the Bill provides for). Of necessity, there are many uncertainties about the scope of detailed rules and thus the indirect costs. We also think that it is necessary to look at the benefits against the direct costs since at this stage it is only the proposals in the Bill that are under consideration: detailed rules would be subject to their own detailed consideration and
analysis must allow for the possibility that detailed rules may not be justifiable for any or all sizes and types of reservoir that might be classified as high risk. For the purpose of the table below, costs of registration of all relevant reservoirs are included, including inundation mapping (whose costs will be met by Government); and the savings from deregulation of low risk LRRs. No benefits from risk reduction are included since none arises directly from the Bill itself, although it is assumed that existing regulation of high risk LRRs would continue pending the introduction of new detailed rules.

**Direct costs and savings**

<table>
<thead>
<tr>
<th></th>
<th>LRRs</th>
<th>SRRs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total direct costs of registration and inundation maps (£m)</td>
<td>+3.6</td>
<td>+8.46</td>
</tr>
<tr>
<td>Savings from deregulating low risk LRRs (£m)</td>
<td>-19.94</td>
<td>NA</td>
</tr>
<tr>
<td>Total costs</td>
<td>£-16.34</td>
<td>£+8.46m</td>
</tr>
</tbody>
</table>

Or put another way:

<table>
<thead>
<tr>
<th></th>
<th>Amount (one off / annual)</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs of SRR and LRR registration and inundation maps:</td>
<td>£ 12.1 million (one off)</td>
<td>£ 12.1 million</td>
</tr>
<tr>
<td>Saving of low risk LRRs deregulation:</td>
<td>£19.94 million (annual)</td>
<td>£ 204 million</td>
</tr>
</tbody>
</table>

**Specific Impact Tests**

**Competition Assessment**
There will be no impact on competition because the requirements relate to physical characteristics of individual structures and not to the nature of the business operating that structure.

**Small Firms Impact Test**
There will be no impact on small firms because the requirements relate to physical characteristics of individual structures and not to the nature of the business operating that structure. Depending on who owns the small firms, the size of enterprise owning or managing a reservoir is not related to the capacity of the reservoir. So while the proposals will have impacts on small firms, they will also have impacts on big firms.

**Legal Aid**
There will be no impact on legal aid as a result of implementing the preferred option.

**Sustainable Development**
Protecting the surrounding environment, society and local economy by reducing the risk of a reservoir breach will support sustainable development.

**Carbon Assessment**
There will be no impact on carbon assessments as a result of implementing the preferred option.

**Other Environment**
By reducing the likelihood of a reservoir breach, the risk of environmental damage is also reduced.

**Health**
There will be no impact on health as a result of implementing the preferred option, other than protecting human welfare including health.

**Race, Disability or Gender Equality**
There will be no impact on race, disability or disability equality as a result of implementing the preferred option.

**Human Rights**
There will be no impact on human rights as a result of implementing the preferred option.

**Rural Proofing**
There will be no impact on rural proofing as a result of implementing the preferred option.
Annex A

1. **Deficiencies with current policy**

1.1 **Example of the potential consequences of current policy**

Mention has been made above of the deficiencies arising from the present unofficial and unsystematic system of categorisation. More seriously incidents have occurred at reservoirs that do not fall within the RA 1975. It is not possible to ensure that all such incidents are recorded and for the purpose of this Impact Assessment detail must rely on a limited number of cases.

One such involved a reservoir of around 12,000 cubic meters capacity with residential properties and an infants school downstream.

- In September 2008 it was found by the local authority to be in distress and emergency action was taken to remove stop logs and other obstructions across the right and left hand overflows to lower the water level and drain the reservoir.
- There was significant erosion of the downstream shoulder as a result of overtopping of the dam crest and the water level remained perilously close to the top of the embankment.
- Water was also seen to be leaking through the embankment adjacent the left hand overflow, and this was successfully plugged with cement/sand bags. The bottom outlet valve was found to be inoperable due to it being silted up.
- Later, the outlet was water jet cleared and the valve was found to be fully operable.
- The police had been alerted to the risk of the dam breaching and the sensible precaution of closing the school was taken.
- Any further overtopping would have resulted in rapid erosion of the crest with the possibility that the dam could then be breached within a matter of minutes resulting in an unstoppable release of water.

This incident would have been avoided had proper monitoring, supervision and safety works been carried out. Indeed, if the distress of the reservoir had not been noticed, emergency action might not have been taken. It does serve to illustrate that risks to people exist from small raised reservoirs (SRRs) just as they do from LRRs. Nevertheless, there is no requirement on the undertakers of such reservoirs to take even basic precautions or to reinstate the reservoir in a safe condition.

1.2 **Enforcement Issues**

The provisions of the RA 1975 have led to inconsistencies in enforcement, e.g:

1. Inspecting Engineers’ reports are not required to be sent to the enforcement authority if they contain no recommendations in the interests of safety.
2. The enforcement authority is therefore unable to build a picture of the condition of all reservoirs within the controls.

3. The enforcement provisions are also inflexible: they provide for serving of notices when compliance with the requirements has not been achieved and prosecution.

4. Modern regulation as set out in the Regulatory Enforcement and Sanctions Act 2008 takes a much more flexible and proportionate approach with penalties being able to be set in relation to the risks posed by individual instances of non-compliance.

A voluntary system of incident reporting was introduced by the Environment Agency in 2007. The aim is to provide reservoir undertakers and the civil engineering profession with a source of information on problems identified so that these can be shared and others learn from individual experiences. This system has met with a variable response from undertakers, not all of whom provide information to make the system a comprehensive picture of problems to be shared.