

# A GUIDE FOR RESERVOIR OWNERS AND OPERATORS

## Introduction

Dams and reservoirs are an important part of our national infrastructure.

If we do not manage them properly, they could cause serious flooding, major damage and loss of life. They need monitoring and maintaining to keep them as safe as possible. We want to work together with reservoir owners and operators (known as 'undertakers') to reduce the risk of dams failing.

We have produced this guide to inform those of you that manage and operate reservoirs.

It contains general advice on:

- the roles involved in managing reservoirs
- your role as an undertaker
- common problems
- how to spot them
- how to reduce the risk of these happening

This guide is not a substitute for professional advice. If in doubt, always consult a [qualified civil engineer](#).

## WATCH OUT!

Reservoirs can be dangerous places. You should always consider your health and safety when visiting your reservoir. Take these steps to reduce the risks:

- Wear appropriate clothing and footwear for the site
- Take extra care not to slip on wet sloping surfaces such as the upstream (where water goes into the reservoir) and downstream (where water leaves the reservoir) faces of the dam
- Wash your hands after touching reservoir water or wet vegetation. This prevents leptospirosis (Weil's disease) and other waterborne diseases
- Wear gloves and use appropriate tools. Spindle extensions, lever bars and other specialist equipment are available for operating valves
- Specialist safety training is available for dealing with confined spaces - do not enter confined spaces (such as manhole chambers or tunnels) unless you are trained
- If visiting a remote reservoir, let people know where you are and when you expect to return. Take a telephone in case of emergency and check your signal on arrival.

## Contents

1. Legislation.....	3
Overview.....	3
2. Roles.....	4
Environment Agency.....	4
Undertakers .....	5
Panel engineers.....	5
3. Responsibilities of an undertaker .....	7
4. What type of reservoir do you have?.....	9
5. Reservoir Failure.....	12
What is a reservoir failure .....	12
Why do embankments fail? .....	13
Overflowing.....	13
Internal erosion .....	14
6. Checking your reservoir .....	15
Where to inspect your dam.....	15
How monitoring can help .....	22
How often should I visit?.....	22
7. Typical maintenance tasks and why they are important.....	23
Trees, vegetation and grass cover .....	23
Maintain clear spillways/pipes.....	24
Discourage animal activity .....	25
Check valves.....	26
What other legislation should I be aware of .....	28
8. Asking for help .....	29
When should I ask for professional advice? .....	29
How do I prepare for an emergency? .....	29

# 1. Legislation

## Overview

The Reservoirs Act 1975 provides the legal framework for ensuring reservoir safety. Reservoir safety means prevention of flooding from an uncontrolled escape of water (failure). The safe operation and management of reservoirs reduces the risk of dam or reservoir failure. The act covers any large raised reservoir (LRR). This is one where the volume of water held above the surrounding land is 25,000 cubic metres or more. That is approximately 10 Olympic swimming pools.

Within the category of LRRs, they are split into 'high risk' and 'not high risk'.

High risk reservoirs are those where "an uncontrolled release of water from the reservoir could endanger human life". It does not mean that these reservoirs are at high risk of failure.

High risk LRRs must fulfil all the requirements of the act. Those designated not high risk have specific requirements to fulfil also.

As an undertaker, you should be aware that under common law, you may be held responsible for any damage or injury caused by a failure. If an undertaker fails to ensure reservoir safety, they could also face criminal prosecution.

Employers also have a duty for the safety of others under current [health and safety legislation](#).

## 2. Roles

### Environment Agency

As the enforcement authority for England, we follow the [Regulator's Code](#). We are responsible for comprehensive regulation and enforcement of the act.

We are responsible for:

- Maintaining a register of reservoirs and making this available to the public
- Reporting to Defra
- Making sure that undertakers have their high risk reservoirs regularly inspected by inspecting engineers
- Making sure that undertakers appoint a supervising engineer for their high risk reservoirs
- Making sure that undertakers appoint construction engineers to design and build their reservoirs
- Making sure that undertakers carry out maintenance and necessary repairs to high risk reservoirs. An inspecting engineer will have said what is required at each reservoir
- Making sure undertakers report on any incidents
- Making sure that undertakers prepare on-site emergency flood plans for their reservoirs
- Sharing the lessons learnt from incidents with the industry
- Enforcing the act by working with undertakers to ensure they comply. If needed, warning and prosecuting those that do not
- Commissioning engineering services and repairs if undertakers fail to comply. We then recharge our costs to the undertaker
- Acting in an emergency if the undertaker is not available or incapable. We may recharge our costs to the undertaker

We are happy to advise undertakers and engineers on how to manage compliance. If you have any questions or would like to discuss any concerns relating to your reservoir, please [contact us](#).

## Undertakers

Undertakers are the legal operators or owners of a reservoir and have ultimate responsibility for its safety.

They can include:

- water companies
- navigation authorities
- the Environment Agency
- the MoD
- private landowners
- businesses, including commercial enterprises, farms etc
- other reservoir users such as sailing and fishing clubs

Even if a reservoir is not being used, responsibility rests with the undertaker. Section 4 of this guide gives an overview of the responsibilities an undertaker has.

## Panel engineers

Panel engineers are a group of specialist civil engineers known as 'qualified civil engineers' (QCEs). The Secretary of State appoints them. They are specifically experienced in, and are qualified for, reservoir safety.

Panel engineers may be construction engineers, inspecting engineers or supervising engineers. The act requires them to oversee the safe construction, operation and maintenance of reservoirs. The undertaker must appoint a construction engineer when building a new reservoir. They must also appoint a construction engineer when existing reservoirs are repaired or changed. Inspecting engineers must inspect high risk reservoirs every 10 years (or more frequently if necessary).

The role of a **construction engineer** is to supervise the design and construction of a new reservoir. They are also required when modifying an existing reservoir. A construction engineer will be on the All Reservoirs Panel.

The role of an **inspecting engineer** is to inspect a reservoir, report their findings and make recommendations to improve safety. These could be measures in the interest of safety, or maintenance measures. In their role as a QCE, they supervise and certify that the measures have been acted upon. Inspecting engineers are members of the All Reservoirs Panel of engineers. To find an inspecting engineer, visit our [all reservoir panel engineers: contact details](#) page.

The role of a **supervising engineer** is to supervise the operation and maintenance of a reservoir at all times. They must prepare a written statement at least every 12 months. This summarises the activities carried out to fulfil the inspecting engineer's recommendations. It should also highlight if they are not. The supervising engineer can help you prepare incident reports and flood plans. They must certify on-site flood plans. To find a supervising engineer, visit our [supervising engineers: contact details](#) page.

### 3. Responsibilities of an undertaker

As an undertaker, you must do certain activities to make sure your reservoir stays compliant with the act. These activities change depending on the risk designation that the Environment Agency has given it.

After construction is finished and certified, the Environment Agency will give your reservoir a risk designation using this process:

1. Environment Agency gives provisional risk designation (high risk or not high risk)
2. Period for undertaker representation (the chance to provide further evidence if you disagree with the provisional designation)
3. Environment Agency gives final designation
4. Period for appeal if reservoir designated as high risk
5. Designation takes effect

If you have any questions about the designation of your reservoir, please [contact us](#).

For ALL statutory reservoirs (high risk and not high risk), you must:

- Register any LRR with the Environment Agency
- Appoint a construction engineer when building a new reservoir (this also applies to changing an existing reservoir)
- Prepare an on-site emergency flood plan, certified by a qualified civil engineer
- Review and test the on-site emergency flood plan
- Provide the Environment Agency with an initial report after an incident. This should be as soon as practicable once the incident is under control (a supervising engineer can assist you with this)
- Provide the Environment Agency with a full post incident report within 12 months of the incident (a supervising engineer can assist you with this)
- Appoint a qualified civil engineer from the All Reservoirs Panel to advise what work to do if you wish to abandon or discontinue a reservoir. The engineer must then certify when the works have been completed.

For high risk reservoirs, you must:

- Have a supervising engineer appointed at all times (enforceable by law)
- Maintain a prescribed form of record (PFR) for your reservoir. This brings together key information about the reservoir. It acts as a diary for the reservoir, recording behaviour, maintenance, problems, and the steps taken to resolve these problems. A QCE will tell you exactly what information needs to be included
- Inform the Environment Agency if you appoint or change an Inspecting or Supervising Engineer. This must be within 28 days
- Have the reservoir inspected every 10 years (or more frequently if specified). This must be by an independent qualified civil engineer ('Inspecting Engineer') and is enforceable by law
- Have the supervising engineer produce a written statement every year. This summarises the actions taken at the reservoir. It reports if the engineer's recommendations are being implemented.
- Make sure you complete any measures in the interest of safety (MIOS) recommended by the inspecting engineer. It must be within the given timescale. Failure to complete safety measures within the timescale given by your engineer is an offence, and is enforceable by law
- Make sure you complete any maintenance measures recommended by the inspecting engineer.
- Make sure your appointed engineer sends copies of all qualified civil engineers reports and certificates to the Environment Agency
- If you do not agree with an inspecting engineer's recommendations, you have 60 days to refer the matter to a referee (an independent qualified engineer).
- Make sure you record water levels and repairs, as recommended by an inspecting engineer

Information on how to do these things can be found in the [Reservoirs: owner and operator requirements](#).

There are other processes which you must follow in some circumstances. This could be if you wish to change or discontinue your reservoir. It could also be if you have to register a reservoir that is already built. It is important you understand these processes, and you should seek the advice of a qualified civil engineer.

If you have any questions about any of these stages, please [contact us](#).

#### 4. What type of reservoir do you have?

Earth embankments form most raised reservoirs in England. They can be impounding reservoirs, which block the flow of a river or drainage from an area. They can also be non-impounding, where the embankment forms all sides of the reservoir.

This photo shows a typical impounding reservoir.



Photo by kind permission of Severn Trent Water

This photo shows a typical non impounding reservoir. These are generally filled by piped inflow or pumped water into the reservoir. The embankment dam forms the entire edge of the reservoir. We use the term 'inner face' to describe the upstream side, and 'outer face' for the downstream side.



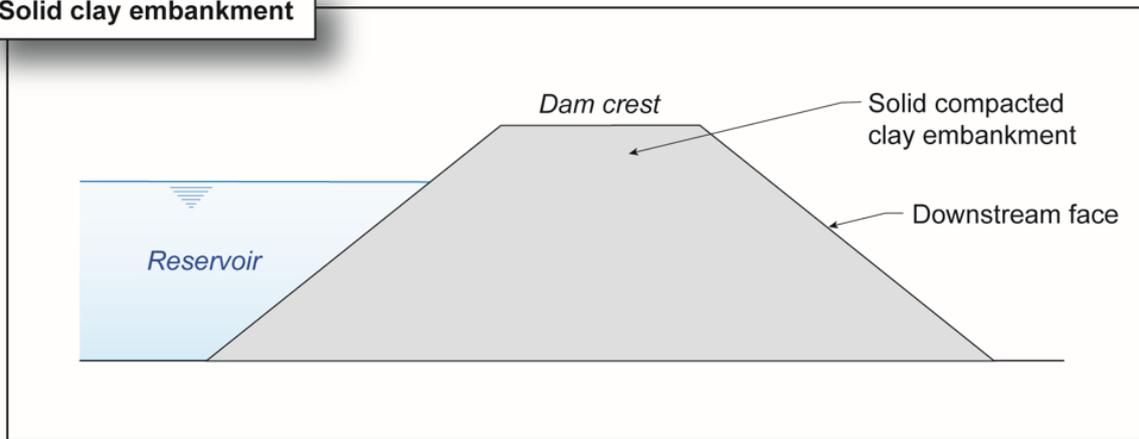
Photo by kind permission of Severn Trent Water

The 'spillway' is the overflow that, in normal operation, allows water out of the reservoir in a controlled and safe way. This is like the overflow of a bathtub. It prevents the potentially dangerous effect of water flowing over the crest of the dam. The overflow is usually formed by a control weir and channel, although sometimes by pipes.

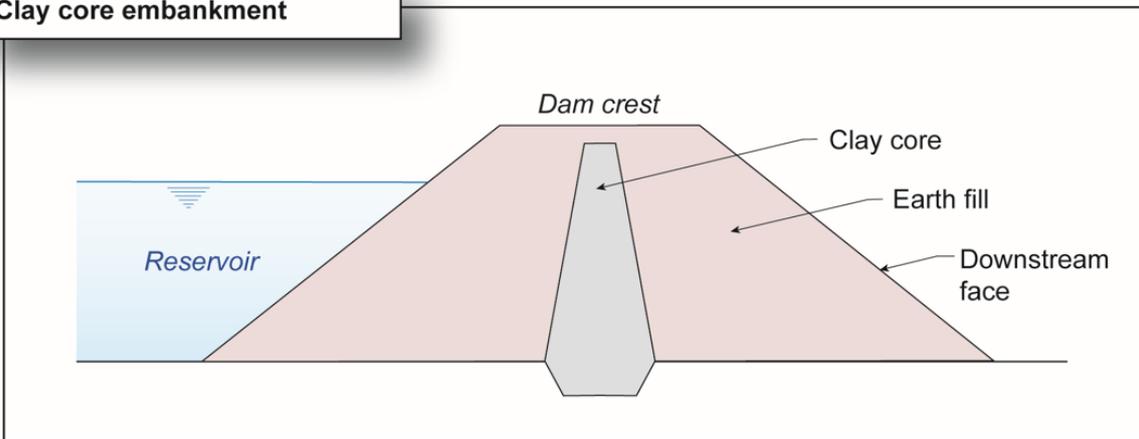
When the reservoir is full, most of the upstream face is underwater. The downstream face is the side of the embankment normally exposed. This is where you may first spot any problems.

These diagrams show typical configurations of earth embankments. Note the different ways to make them waterproof.

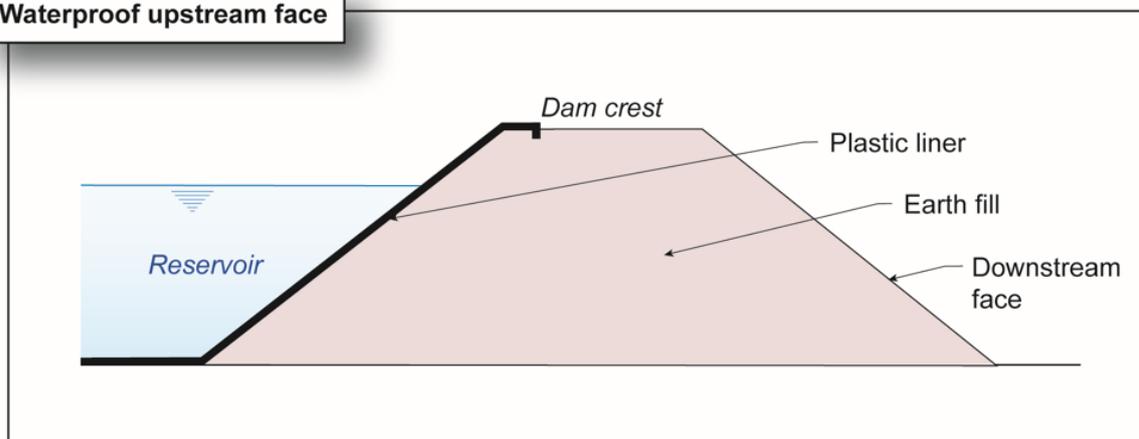
**Solid clay embankment**



**Clay core embankment**



**Waterproof upstream face**



Diagrams by kind permission of C Goff

Masonry or concrete dams are less common in England. Some are impounding. They can also be completely enclosed, containing treated drinking water. These are called service reservoirs and are normally owned by water companies.

For more information on types of dams and the different terms used, please refer to the [‘About Dams’](#) section of the British Dam Society website.

## 5. Reservoir Failure

### What is a reservoir failure

A reservoir failure is an uncontrolled release of water from the reservoir.

This photo shows a major failure of an earth embankment in 1992.



Photo by kind permission of D. Archer (Tyne and Tide: A celebration of the River Tyne, Daryan Press, 2003),

## Why do embankments fail?

The two most common ways that embankment dams fail is overflowing and internal erosion.

### Overflowing

Overflowing of the dam crest happens when the spillway overflow is too small or becomes blocked. Normally, there is storage for a certain amount of excess water above the overflow level. If the amount of water coming in is greater than this capacity, flood water may start to overflow the dam crest.

When water overflows the reservoir, it will run down the downstream face. If the flow is too large, or it lasts too long, the water will start to erode the surface of the embankment. It may erode so much that there is not enough support to hold back the water, and the reservoir will fail.

This photo shows an overflowing event at a reservoir.



Photo by kind permission of the Environment Agency

## Internal erosion

This happens when the pressure of the water in the reservoir manages to create a seepage path through the embankment. It then erodes from within. This could be due to:

- poor construction of a clay core/embankment or plastic liner
- tree roots or vegetation growing through the embankment
- animals burrowing into the embankment

When internal erosion occurs, it will leave voids or 'holes' within the dam. This can weaken the embankment. When this happens, the water may burst through.

The embankment may also sink down to fill these voids (settlement). This can lower the crest height and leave it vulnerable to overflowing.

A common sign of seepage or leakage is patches of reeds appearing, or muddy puddles on the downstream face or toe.

This diagram shows how internal erosion may occur.

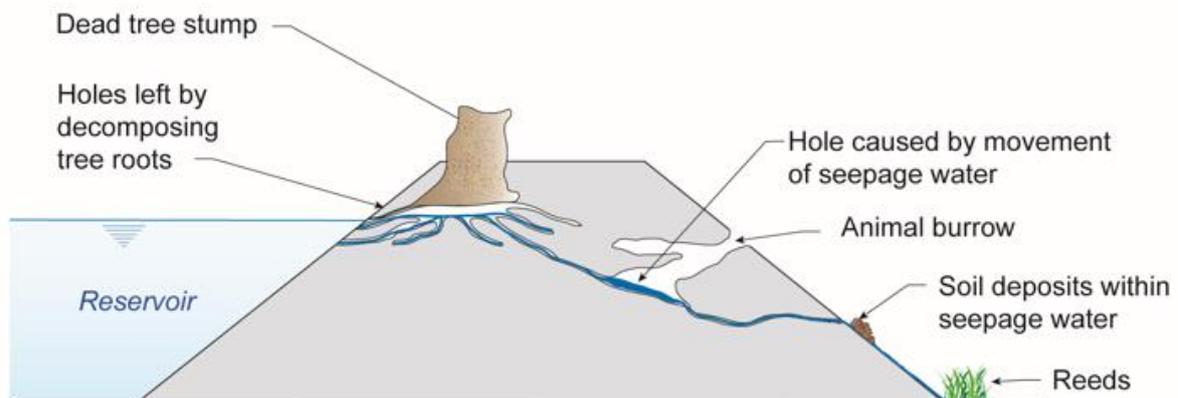


Diagram by kind permission of C. Goff

## 6. Checking your reservoir

You should walk around your site regularly to inspect your reservoir. This section highlights where to look, what to look out for and why. There are photographs showing some of the issues listed in each section.

### Where to inspect your dam

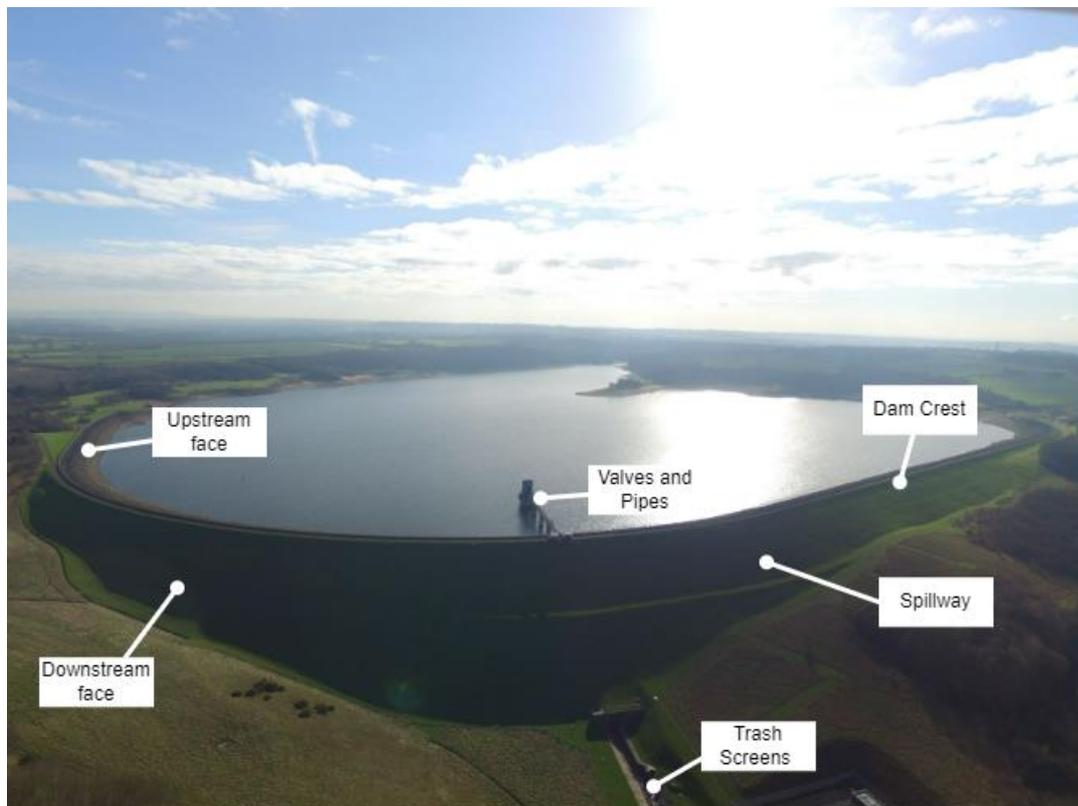


Photo by kind permission of Severn Trent Water

- A. Upstream face
- B. Trash screens
- C. Dam crest
- D. Spillway
- E. Downstream face
- F. Valves and pipes

## **A: Upstream face**

### What to look out for:

- erosion by waves
- erosion by anglers/ recreational users or animals



Photo by kind permission of the Environment Agency

### Why?

Erosion can weaken the dam

### What to do if you spot signs of erosion

Seek professional advice – call or send some photos to your supervising engineer. It may need protection, which a qualified civil engineer will advise you on.

## **B: Trash screens**

### What to look out for

- Blockages by vegetation and debris



Photo by kind permission of the Environment Agency

### Why?

Blocked spillways and pipes can lead to overflowing during flooding

### What to do

Seek professional advice from your supervising engineer. It is likely that you will need to clear the screens. You may be able to do this safely by using a long-handled rake from a position on the dam crest.

## C: Dam crest

### What to look out for:

- sink holes
- cracks
- low spots
- changes in the appearance of fencing or on the ground. This may suggest ground movement



Photo by kind permission of D. Brown



Photo by kind permission of the Environment Agency

### Why?

Sink holes and low spots may mean there is internal erosion below. Cracks can allow rainwater into the body of the dam or indicate the start of a slip. These areas may concentrate flow when overflowing and contribute to erosion or failure.

### What to do

Try to avoid driving vehicles on the dam crest (unless there is a surfaced roadway). This can cause rutting and erosion. If you see anything that worries you, seek professional advice from your supervising engineer.

## D: Spillway weir or overflow

### What to look out for:

If you have a masonry or concrete spillway:

- debris or vegetation growing
- cracks in masonry
- changes in the condition of any structures.

If you have an earth spillway:

- cracks
- ruts
- animal damage
- evidence of slips.



Photo by kind permission of P. Mason

### Why?

Blocked spillways can lead to dam crest overflowing. Damaged spillways increase the risk of failure when water is overflowing.

### What to do

If blocked; clear the blockage if it is safe to do or arrange a professional to do this. Cut back and prevent vegetation from growing on the spillway. If you spot anything that worries you, seek professional advice from your supervising engineer.

## E: Downstream face

### What to look out for:

- wet patches, particularly if the water is muddy
- growth of reeds
- slips
- cracks
- animal burrows



Photo by kind permission of D. Brown

### Why?

Any of these issues can indicate stability or internal erosion problems. These could lead to dam failure.

### What to do

Limit vegetation to short grass if possible. If there are mature trees on the downstream face, check they are healthy and stable.

Monitor any changes and if you spot anything, seek professional advice from your supervising engineer.

## **F: Valves and pipes**

### What to look for:

- signs of leakage
- rust on moving parts
- damage

### Why?

Leaks can lead to erosion. Inoperable valves make responding to an incident difficult. It may mean expensive pumps will be needed to on site to draw down the water.

### What to do

You should regularly operate your valves to ensure they are working as they should be. This can help stop them from seizing up. If doing this will discharge water to a downstream watercourse and cause potential environmental damage, you may need approval from the Environment Agency. [Contact us](#) to check if this is the case.

If you spot any damage, leakage or your valves are not working; seek professional advice from your supervising engineer.

## How monitoring can help

Finding any of these problems does not always mean urgent and expensive repair work.

By monitoring over time, it can be possible to find out the cause. Sometimes it is from rainfall and groundwater and not a problem with the reservoir.

Always seek professional advice when you spot a new problem, particularly if you can see it is getting worse.

## How often should I visit?

You should visit your reservoir at least once a month. Most will need this more often. If your spillway or trash screens are in a wooded area, for example, they may need clearing multiple times a week. A qualified civil engineer will advise you on what you need to do.

You should inspect your reservoir often enough to carry out regular maintenance and monitoring. This allows you to spot any changes or potential problems early. This can save a lot of money through early management of risks.

## 7. Typical maintenance tasks and why they are important

### Trees, vegetation and grass cover

The ideal dam has a healthy, short (50-150mm) covering of grass on its crest and downstream face. There should be no trees or other vegetation. This allows you to spot problems early - before they become difficult and expensive to fix.

This photo shows an excellent example of a downstream face in good condition.



Photo by kind permission of Severn Trent Water

Vegetation can cause water to form concentrated flow paths, which speeds up erosion.

Trees are a big problem on dams, the main reasons being:

- They can blow over in storms. This tears holes in the banks which may become unstable and cause more erosion to occur.
- Roots can puncture waterproof liners, leading to internal erosion.
- Roots can damage structures, increasing risk of erosion and failure
- Dead roots can leave holes, which act as seepage paths and speed up internal erosion

This photograph shows a downstream face with vegetation, bare earth, and debris. This increases the risk of surface erosion during heavy rain. The trees will concentrate flow paths and make erosion worse.



Photo by kind permission of C. Goff

What you should do:

- Remove young trees before they become established.
- Monitor mature trees. Keep the canopies high to allow light to reach the base for better grass growth.
- Get a tree surgeon to assess top heavy, dead or dying trees. If any need to be removed, seek advice from a qualified civil engineer.

Maintain clear spillways/pipes

Spillways, trash screens and pipe inlets can become blocked by debris (such as leaves, sticks and litter). This can cause the water level to rise and eventually overflow the dam.

You should:

- Check trash screens regularly and clear away debris. Always check the screens after heavy rainfall or windy days.
- Cut back reeds and other vegetation growing near to the spillway or inlet pipes.

Always take care not to put yourself in danger when cleaning the spillway.

## Discourage animal activity

Burrowing animals make holes in embankments. This leads to settlement, sink holes or leakage paths. In severe cases, embankments full of badger setts, mole tunnels or rabbit warrens have collapsed.



Photo by kind permission of the Environment Agency

As far as possible, you should discourage animals from burrowing by:

- Keeping grass short so the face is easy to inspect
- Filling in animal burrows with compacted clay – provided this is not against the law
- Humanely trapping or culling - provided this is not against the law

Always take care to comply with wildlife legislation.

Contact the [Environment Agency](#) or [Natural England](#) if you are unsure what activities you can legally do. Always discuss with your supervising engineer before you do any work on the dam.

## Check valves

If you spot a problem at your reservoir, your supervising engineer is likely to recommend lowering the water level.

The simplest way to do this is to open the bottom outlet valve (if your reservoir has one).

If you have a bottom outlet valve (also referred to as a scour valve), you should keep it in good working order in case of emergency.

To do this, you should:

- Protect the valve by using grease, paint or a galvanised coating
- Keep the spindle (turning mechanism) greased
- Fully open and close the valve at least twice a year to ensure it has not seized up. Make a note of doing this in your prescribed form of record. This maintains evidence of good maintenance measures. If doing this will discharge water to a downstream watercourse, you may need approval from the Environment Agency. [Contact us](#) to check if this is the case.
- Have the valve inspected by your supervising engineer, who will advise on how to fix any problems
- Keep a note of the direction and number of turns needed to open and close the valve.
- Keep the contact details of a 24-hour pump supplier in your onsite plan in case of emergency

If the valve stops working, or you do not have one, the only way to lower the reservoir will be by external pumps. If you need to do this, you should seek professional advice from your supervising engineer as it may cause downstream erosion. This can be an expensive solution.



Photo by kind permission of the Environment Agency

## What other legislation should I be aware of

It is important to remember when making decisions regarding managing your reservoir, that there are other laws which may impact what you can and cannot do.

Common examples are:

- Protection of Badgers Act 1992 – this makes it illegal to harm badgers or their setts
- Wildlife and Countryside Act 1981 – this makes it illegal to release crayfish into a watercourse, and to disturb or damage a bird's nest.
- Water Resources Act 1991 – this controls what water you can release into a water course.

If you think any activities you plan may be breaking the law, contact the [Environment Agency](#) or [Natural England](#) and they will be happy to advise you.

If you need to build or change part of your reservoir, you will need to check if you need [planning permission](#) or an [environmental permit](#).

## 8. Asking for help

### When should I ask for professional advice?

Dam failures can kill, and all reservoir owners should take this risk very seriously. All dams are different - in general you should seek professional advice if:

- The dam crest is in danger of overtopping
- There is a sudden increase in seepage/leakage from the bottom of the bank
- Seepage or leakage becomes muddy or cloudy
- There are signs of slips or cracks on the dam
- A low spot appears on the dam crest
- You spot anything unusual or feel uneasy about any aspect of your reservoir.

Your supervising engineer and the Environment Agency can help advise on what you need to do.

### How do I prepare for an emergency?

It is a legal requirement to prepare an [emergency on site plan](#) for your reservoir. Your supervising engineer can help with this.

If your dam is in danger of collapse, you must contact:

- Your supervising engineer – always keep their contact details to hand
- The Environment Agency [incident hotline](#). This is a 24-hour service.
- The emergency services.

They will help advise on an emergency drawdown and notify anyone living downstream.