Cyfoeth Naturiol Cymru
Natural Resources Wales

Biennial Report to the Minister for Environment, Energy and Rural Affairs

Reservoir Safety in Wales

For the period 1 April 2017 to 31 March 2019

Natural Resources Wales

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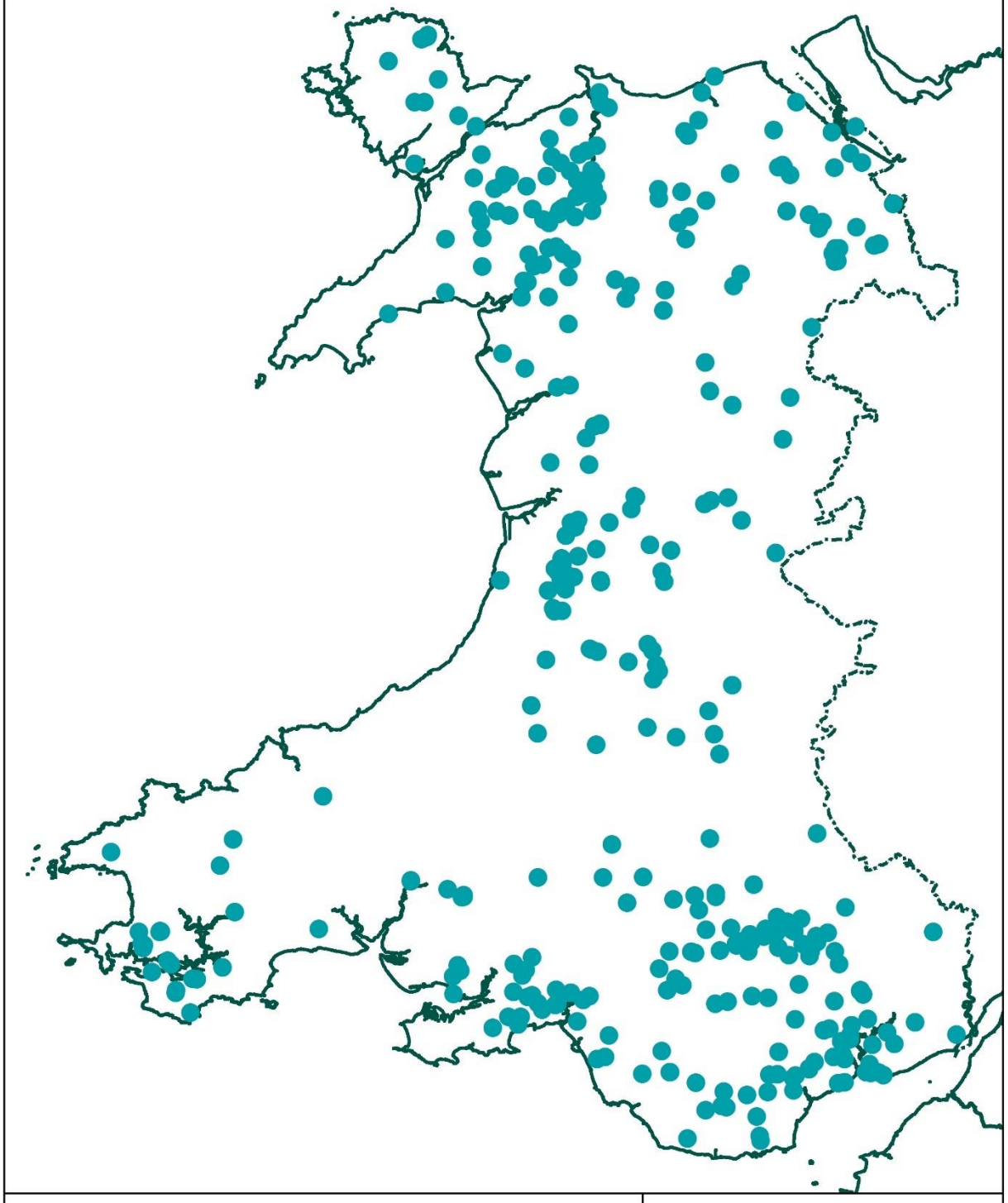
The Large Raised Reservoirs of Wales



Legend

- The Large Raised Reservoirs of Wales, March 2019

Contents

1. Introduction

Natural Resources Wales is the enforcement authority in Wales for the Reservoirs Act 1975. The purpose of this law is to protect people and property from the uncontrolled release of water from large, raised reservoirs[1] and the potentially catastrophic consequences that can arise. This law is deeply rooted in Wales with its predecessor legislation enacted in direct response to the death of 16 people at Dolgarrog in 1925.

The main principles of the law are that large raised reservoirs are constructed, supervised, inspected, maintained, altered and removed under the guidance of qualified civil engineers. Amendments introduced in 2016 brought 150+ smaller reservoirs into regulation, whilst at the same time reducing the burden on reservoir undertakers[2] where there is a lower hazard to people.

NRW is required to report on the steps we have taken to ensure reservoir undertakers observe and comply with the law. Specifically, this report fulfils our duty[3] to confirm—

(a) the number of large raised reservoirs that have been registered;
(b) the steps we have taken to ensure the undertakers of large raised Reservoirs have complied with the requirements of the 1975 Act; and
(c) a statement as to—
    (i) the number of large raised reservoirs for which we are the undertakers; and
    (ii) any steps we have taken to observe and comply with the requirements of the 1975 Act.

Regardless of ownership or use, our purpose as the enforcement authority is to provide Welsh Government, and the people of Wales, with reassurance that the large raised reservoirs of Wales are kept in an appropriately safe condition to hold water and to protect the people who live and work downstream.

This report is produced in compliance with the above requirement, covers the period 1st April 2017 to 31st March 2019. During the reporting period we have:

- Begun a Wales-wide project to provide new reservoir flood maps, and update previous versions, to show the possible consequences of a dam breach;
- Identified and brought into regulation previously unregistered reservoirs;
- Maintained checks on the appointment of qualified civil engineers for reservoir engineering purposes;
- Received and collated incident reports to share with other regulatory bodies and the engineering community to improve our understanding of why dams fail; and
- Sought to ensure safety measures are carried into effect.

1 A large raised reservoir is one which is designed or capable of holding 10,000m^3 of water above the natural level of the adjoining land.
2 The undertaker is the legal term for the person, people, company or organisation who operates or manages the reservoir. If no activity is undertaken at the reservoir, the owner is the undertaker.
3 Regulation 7 of the Reservoirs Act 1975 (Capacity, Registration, Prescribed Forms, etc.) (Wales) Regulations 2016

In 2016, the amendments to the Reservoirs Act 1975 in Wales changed the definition and registration requirements for large raised reservoirs. A large raised reservoir, subject to regulation, is defined as a structure designed or used for collecting and storing 10,000 cubic metres (m^3) of water above the natural level of any part of the surrounding land and includes natural lakes where they have been raised by artificial means. Prior to the change, the capacity threshold was set at 25,000m^3.

366
Large Raised Reservoirs Registered in Wales

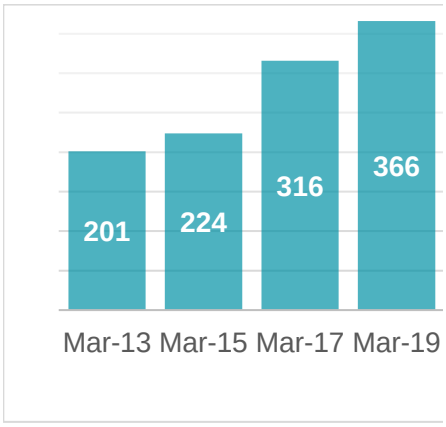


Figure 2-1: The total number of registered large raised reservoirs in Wales.

Since the change in Regulations we have sought out and secured a steady rate of registrations of reservoirs and at the end of the reporting period there were 366 large raised reservoirs registered with us (Figure 2-1). These reservoirs include those which are in operation, formally abandoned or under construction.

The number of registrations has levelled off during the last 12 months and the total number correlates with our early assumptions (prior to the change in threshold) about the total number of reservoirs. However, we consider it probable that other reservoirs have yet to be identified or confirmed as large raised reservoirs and we will continue with our programme for identifying these.

The increase in the number of reservoirs has also resulted in a change of the demographic profile of undertakers. The types of reservoir undertakers are varied but can be summarised into four broad categories, which are listed below and shown in Figure 2-2:

1. **Water Company** – the statutory water undertakers: Dŵr Cymru Cyf and Hafren Dyfrdwy Cyf.
2. **Public Good** – NRW, Local Authorities, National Park Authorities, Cadw, etc.
3. **Commercial Interest** – typically Hydro-Electric Power and industrial companies.
4. **Private Use** – private ownership where there is little use other than the amenity and recreational opportunities afforded.

Figure 2-2: The proportion of reservoir management by undertaker category

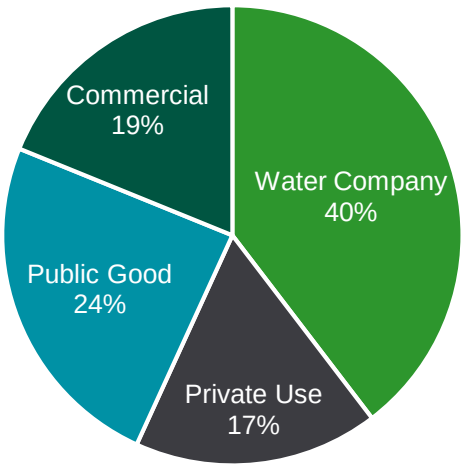


Table 2-1 and the graph in Figure 2-3 show that all undertaker categories have seen an increased duty to register and comply with the Reservoirs Act 1975. The greatest increase has fallen to public bodies and private landowners.

		2013	2019	Increase
Water Company	Dŵr Cymru Cyf; Hafren Dyfrdwy Cyf.	94	145	51 (54%)
Commercial	Industrial, Hydro-Electric Power	30	36	6 (20%)
Public Good	NRW, Local Authorities, National Park Authorities, Cadw, Heritage & Conservation Charities	33	91	58 (176%)
Private Use	Other landowners, Orphan reservoirs	44	94	50 (114%)

Table 2-1: the number of reservoir registered in 2013, compared to 2019, by undertaker category

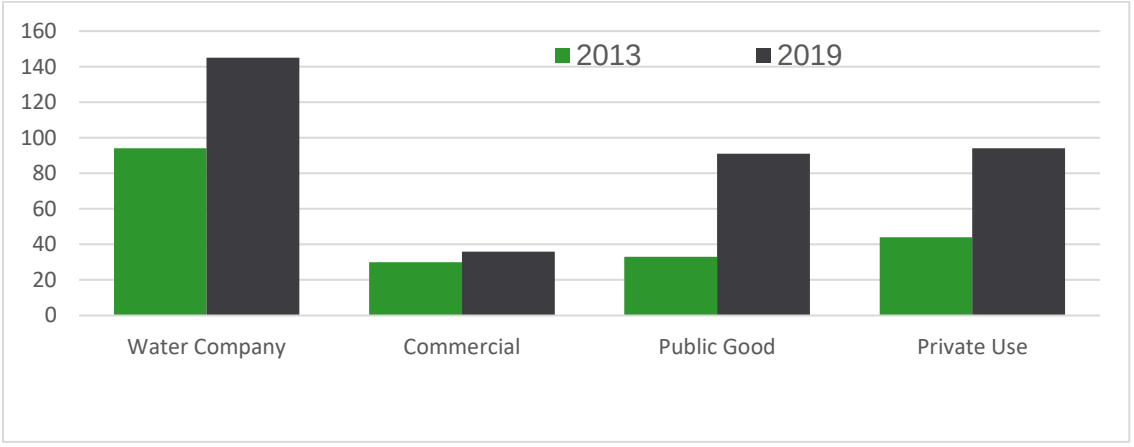


Figure 2-3: Graphical representation of the increased number of reservoirs in each broad undertaker category

3. Regulatory Principles

The Reservoirs Act 1975 directs undertakers as to how they are required to manage their reservoirs. Not all requirements have an equal bearing on safety. Our approach to enforcing the law has focussed on the activities most likely to impair the safety of reservoirs and have a direct impact on people and property downstream.

The fundamental principle of the Reservoirs Act 1975 is that undertakers appoint and act under the guidance of qualified civil engineers to construct, supervise, maintain, inspect, abandon and remove reservoirs. The process and timing of the appointment of engineers ensures that reservoirs have a regular review by a qualified and experienced professional who can recommend action to prevent deterioration and enhance safety.

We guide our regulatory work by balancing the need for qualified oversight and intervention with the consequences of reservoir failure. Engineers assign a dam risk category to indicate the scale of population at risk. This scale also informs our overall risk designation. The importance of each principal activity is described below and then illustrated in Table 3-1 relative to reservoir risk.

The appointment of a Construction Engineer (CE)
The earliest reservoir safety legislation recognised that poor construction was a leading cause of failure. The CE must be appointed to supervise the design and construction of reservoirs, including alteration and re-use.

The appointment of a Supervising Engineer (SE)
These engineers have an ongoing "*at all times*" responsibility. Where appointed, the reservoir will benefit from a qualified pair of eyes that can review records and spot signs of deterioration.

Periodic Inspection
After construction, high-risk reservoirs must be inspected within 2 years and then periodically as determined by an Inspecting Engineer (IE), and at least every 10 years. An SE may require an early inspection as needed.

Measures in the Interests of Safety (MITIOS)
MITIOS are recommendations made by the IE to bring the reservoir up to safe operating standard.

Maintenance, monitoring, surveillance and record keeping.
These activities provide a written and numeric history for the structure which allow undertakers and engineers to understand the dam better and longer-term trends to be identified.

Reporting of Incidents
Reports must be made to us to collect root cause information for sharing with the engineering community. (Responding to incidents falls predominantly to the undertaker, advised by their engineers, but we may step in using Emergency Powers.)

Risk	Higher			Lower
Activity / **Dam Cat.**	**A**	**B**	**C**	**D**
The appointment of a Construction Engineer (CE) or Supervising Engineer (SE)	**1**	**2**	**3**	**3**
Periodic Inspection	**2**	**3**	**3**	**4**
Measures in the Interests of Safety and Maintenance	**3**	**3**	**4**	**5**
Maintenance, monitoring, surveillance and record keeping.	**3**	**4**	**5**	**6**

Table 3-1: Table of priority showing NRW's risk-based approach to regulating reservoir safety.

We have verified that every engineer belongs to an appropriate engineering panel. This appointment process is administered by the Reservoirs Committee of the Institution of Civil Engineers on which NRW has representation. On the Committee's recommendation, appointments are made by the Secretary of State and Welsh Minister acting jointly for England and Wales.

Appointment of Construction Engineers

All large raised reservoirs must be designed and have their construction supervised by a Construction Engineer, regardless of their risk designation. There are eight reservoirs recorded as being under the supervision of a Construction Engineer. The type of reservoirs being built is shown in Table 3-2, with half being for flood risk management purposes:

New Reservoir Purpose	No. of Reservoirs under construction	Preliminary Certificate issued	Final Certificate issued
Flood Management	4	2	0
Water Supply	2	1	0
Heritage	1	0	0
Recreation	1	1	0

Table 3-2: Breakdown of the types of new reservoir being built during 2017-19

- One reservoir remains under investigation for design and construction without the appointment of a Construction Engineer. An engineer has now been appointed to fulfil this role;
- We have received Preliminary Certificates for half these reservoirs, and expect to receive Final Certificates within the normal period of a further 3—5 years;
- We have received no Final Certificates for reservoirs currently under construction within the reporting period, and none is overdue.

Appointment of Supervising Engineers

Supervising Engineers are only required to be appointed to high-risk reservoirs.

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Supervising Engineer statements responded to

There are currently 224 Reservoirs requiring a Supervising Engineer. We have recorded two occasions where a Supervising Engineer has not been properly appointed. In one case, we served an enforcement notice which was duly complied with. In the other, we are finalising the reservoir's risk designation to guide our next action.

There is a requirement, new since 2016, for Supervising Engineers to provide a copy of their statements to us. The submission of these reports highlights several issues about which we were not previously aware, such as undertakers failing to keep appropriate records. During this period, we received, read and acknowledged 362 statements with subsequent advice to the undertakers about the engineers' findings.

Appointment of Inspecting Engineers

Inspecting Engineers are only required to be appointed to high-risk reservoirs, or pre-2016 reservoirs which have not yet received a designation.

The periodic inspection of reservoirs must take place at least every 10 years, or sooner if required by the Inspecting or Supervising Engineers to address a particular concern. The inspecting engineer must be independent of the undertakers.

We have provided reminders to undertakers reminding them of their duty and in response have received inspection reports for 49 reservoirs, including eight reports for reservoirs where inspection is not statutorily required but done as a matter of good practice.

49
Inspection reports processed

Safety Measures

The average age of dams in Wales is over 100 years and to make sure the dams remain safe Inspecting Engineers may make recommendations for measures in the interests of safety or maintenance. It is a common occurrence for reports to include these measures, which are timebound, and there are approximately 120 measures are due to be completed in any given year across Wales.

Figure 3-1 shows that there has been a decrease during the reporting period in the overall number of outstanding safety measures, but a rise in the number which are overdue. This corresponds with a spike in the number of inspections carried out in earlier periods, when more reservoirs were inspected than usual, and reflects the lag between inspection and completion of measures arising. In our last Biennial Report for the period 2015-17, we observed: "…*the rise in safety measures which are currently pending prompts concern for the future. There is an increased chance of compliance timescales being exceeded and we will monitor progress against these*".

Figure 3-1: the number of reservoirs with outstanding safety measures at the close of each biennial reporting period.

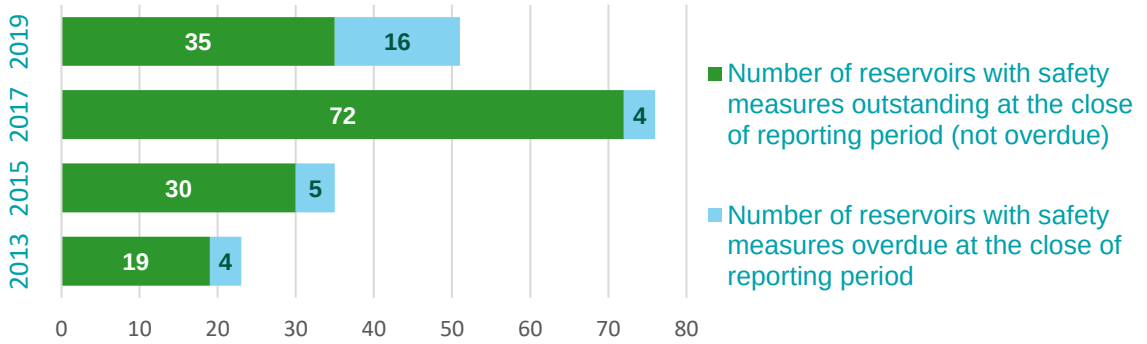
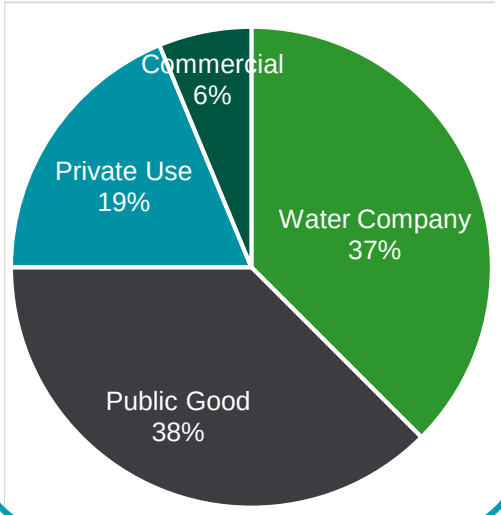


Figure 3-1 shows reservoirs with recommendations which were outstanding during the reporting period or for the future.

Our monitoring has confirmed that work to implement required safety measures is underway at most of these reservoirs and that engineers are appointed for oversight. At one reservoir a lack of progress by the undertakers has resulted in us serving enforcement notices requiring completion of the works within a timescale advised to us by the Inspecting Engineer.

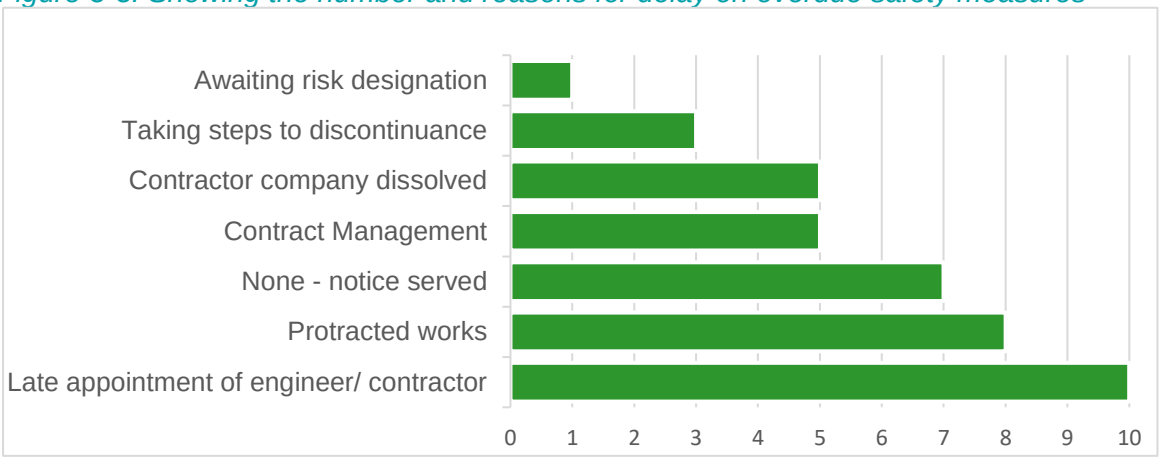
Reservoirs which have overdue safety measures fall across all undertaker types and the distribution is shown in Figure 3-2 which appears proportionate to the number of reservoirs managed by each group, for example 75% of overdue measures fall to the two undertaker categories that manage 64% of Wales' reservoirs (Figure 2-2).

Figure 3-2: Undertaker types for reservoirs with overdue safety measures



The reasons for failing to implement safety measures within the timeframe specified fall into eight key areas, as shown in Figure 3-3.

Figure 3-3: Showing the number and reasons for delay on overdue safety measures



Abandonment

One abandoned reservoir is recorded as under supervision by an engineer for its re-use as an operational reservoir. This has recently received certification enabling it to be safely re-filled with water.

Discontinuation

We received one notification and certificate for the discontinuance of a large raised reservoir.

4. Hazard assessment & designation

The Reservoirs Act 1975 gives us the power to designate large raised reservoirs as high-risk reservoirs[4] if we think an uncontrolled release of water could endanger human life. Undertakers for high-risk reservoirs must adhere to all the requirements of the law, most importantly the inspection and supervision elements provided by qualified civil engineers. Lower risk reservoirs do not have this requirement.

Reservoir construction, inspection, supervision and maintenance can involve significant expenditure. It is important that this expense is justified and balanced against the risk we seek to protect against through regulation. The standard of safety required is set by the engineers which allows for downstream flood consequences but has limited regard for affordability. Our decision to designate a reservoir as a high-risk reservoir must therefore be robust because it triggers a need for investment of time, resource and money by the undertakers.

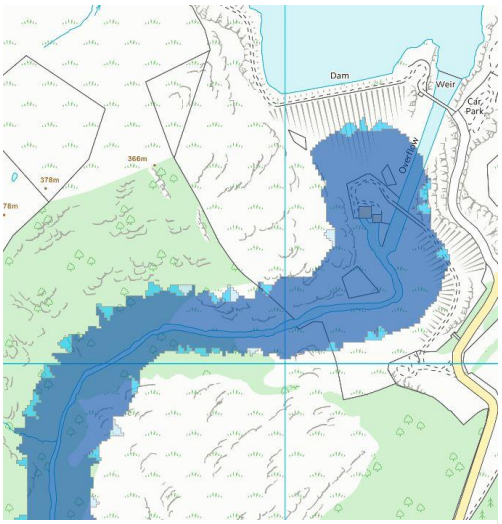


Figure 4-1: Excerpt of a reservoir flood map.

Our designation process has two initial phases:

- Phase 1: designation of reservoir regulated prior to the 2016 Regulations;
- Phase 2: designation of reservoirs registered since 2016.

Phase 1 was completed during 2017 with 88% of pre-2016 reservoirs being designated as high-risk reservoirs, and 12% of these reservoirs shown to pose a lower hazard and released from the burden of engineers' inspections, etc.

The Phase 2 designation process began in 2018 with our procurement of a consultant to help us produce reservoir flood maps. These maps will identify the properties and populations at risk of flooding in the event of a dam failure. We will review the maps along with any other data we hold to produce a Provisional Designation. We anticipate the first maps will be available at the end of 2019-20 and the designation project will last until the end of 2020-21.

As a result of the flood maps, we will have better knowledge of reservoir flood consequences in Wales. The mapping will inform our designations and enable emergency responders to understand the scale of flooding so that response plans can be reviewed and tested.

4 A high-risk reservoir is defined by the Reservoirs Act 1975 as one where we think an uncontrolled release of water could endanger human life. The designation does not confer any likelihood on an escape of water occuring.

5. Incident Reporting

Since 2016, reservoir undertakers must report any incidents to us that may affect the safety of their reservoir. We were notified and received reports of two incidents. In both cases precautionary draw down of the reservoir took place under controlled circumstances to reduce risks and enable proper investigation and remediation. Reports of the incidents are shared with other regulators and engineering professionals to collect lessons learnt.

6. Reservoirs managed by NRW

We own or manage 39 large raised reservoirs, including those within the Welsh Government Woodland Estate. This section reports on the steps we have taken to manage these reservoirs in accordance with the Reservoirs Act 1975 and includes our work monitoring two orphan reservoirs where there is no known undertaker.

Our portfolio of reservoirs

The management of our reservoirs fall into three broad areas:

- Flood Risk Management (FRM)
- Conservation
- Public Amenity through Welsh Government Woodland Estate (WGWE)

In accordance with the Sustainable Management of Natural Resources and our Wellbeing Goals, we are widening our focus to bring these principal uses together. Table 6-1 shows how the reservoirs are currently distributed by their uses.

Table 6-1: The number of reservoirs managed by NRW, showing their primary use and risk designation.

	WGWE	FRM	Conservation	
High-Risk Reservoirs	8	11	3	*22*
Large Raised Reservoir (undesignated)	8	1	5	*14*
Designated Not High-Risk	2	1	0	*3*
	18	*13*	*8*	***39***

Reservoirs under construction

We have one reservoir registered as under construction. The flood storage reservoir at Graig Merthyr (Figure 6-1) is designed to protect 246 properties in Pontarddulais. The construction work, has been overseen by an independent Construction Engineer and we expect to receive a Preliminary Certificate for this soon. We were pleased to host the First Minister and the Minister for Environment, Energy and Rural Affairs here in March 2019. Details of the scheme can be viewed on our website.

Figure 6-1: Pontarddulais Flood Storage Reservoir protects 246 properties

Inspection

During the reporting period, 13 of our large raised reservoirs were inspected by an independent Inspecting Engineer. All inspections were carried out within the timeframe specified, and all our large raised reservoirs have a valid inspection report available. In some instances, we have also arranged for reservoir inspections, where these are not a statutory requirement, to help manage future liabilities, including one reservoir which is too small to be regulated under the Reservoirs Act but holds a raised level of hazard. The range of inspections carried out is shown in Table 6-2.

Table 6-2: Number of reservoir inspections carried out at our reservoirs April 2017 – March 2019

Large Raised Reservoir (undesignated)	6
Not Regulated under the Reservoirs Act 1975	1

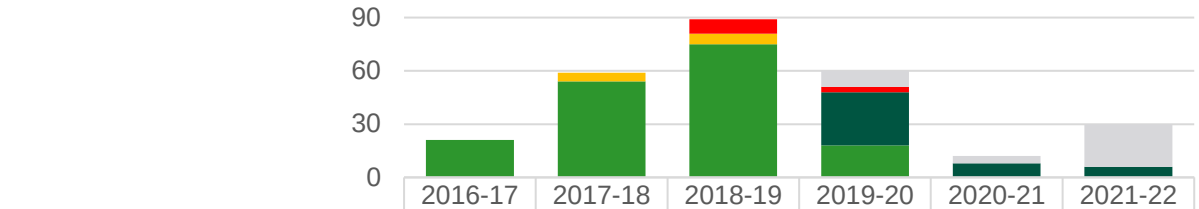
Safety measures

From the inspection reports above, and those provided prior to 2017, several recommendations as to measures to be taken in the interests of safety have been made by the inspecting engineer.

Since NRW's creation in 2013, we have had 246 individual measures recommended by our Inspecting Engineer. Figure 6-2 shows how this created a spike in the number of safety measures. These inspections and resulting measures were the result of numerous additional inspections commissioned in the early years of NRW's creation. These inspections were carried out in response to the challenge of bringing the legacy body reservoirs up to standard in preparation for the change in legislation.

As described above, some of the inspections leading to these measures were arranged as a matter of good practice rather than statutory requirement.

Figure 6-2: Completion of safety measures and predicted future measures.



	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Assumed MITIOS arising from future inspection	0	0	0	9	4	24
Overdue (High-Risk Designation)	0	0	8	3	0	0
Overdue (not designated High-Risk)	0	5	6	0	0	0
Current	0	0	0	30	8	6
Completed	21	54	75	18	0	0

A small number of safety measures were overdue completion at the end of the reporting period. The delays have been regrettable, caused in the main by slow procurement of specialist consultants and contractors; further exacerbated by one of our framework contractors going into administration early in 2019.

All statutory measures are being progressed, and non-statutory measures are being progressed on a risk basis. A scheme of works is in place and new contracts have been awarded. Some delay will be experienced due to minimising site work during the winter period 2019-20 when the risks of flooding are greater. The Inspecting Engineer is kept informed of the delays, with additional advice sought in the interim period.

Wellbeing and the Sustainable Management of Natural Resources

We have been reviewing the management of our reservoirs in line with our other duties under the Environment (Wales) and Wellbeing of Future Generations Acts. Some examples of how we have modified our approach are listed below:

- Bwlch Nant-yr-Arian. The replacement of the spillway has looked beyond a simple engineering solution to encompass habitat creation and enhancement for water voles;
- Llyn Tegid. Collaboration with a multitude of stakeholders to address amenity improvements; including: Bala Light Railway, Snowdonia National Park Authority, Gwynedd Council, Bala Town Council, local businesses, Assembly Members, local councillors, The Woodland Trust, Women's Institute and our own teams;
- Workshops carried out to establish the value and purpose of reservoirs to guide decision making, including consideration of: risk to people, water supply, water quality, amenity, habitat, heritage conservation, flood attenuation and mining risks;
- Llyn Llaeron. Long term consideration of risks, costs and benefits have led us to remove this 200-year-old redundant reservoir and we are taking similar steps at other sites;
- Local Resilience Fora. Sharing of reservoir flood information to enhance emergency planning.

Orphans

There are currently two reservoirs considered to be 'orphans' because either we have confirmed there is no owner, or we have not been able to identify the owner, despite extensive searching. The Reservoirs Act 1975 is silent on how orphan reservoirs are to

be treated but provides us with step-in powers to ensure safety is maintained. For these two reservoirs we have acted in the interests of public safety, to:

- Maintain the appointment of Supervising Engineers;
- Provide staff to visit and report back to the Supervising Engineer;
- Arrange for periodic inspections as prescribed by the last Inspecting Engineer, or as required by the Supervising Engineer;
- Implement safety measures.

We consider it plausible that further orphans may come to light and we will engage with professional partners and Welsh Government to establish sensible steps to manage the risks they pose.

7. Summary

Wales is a land famous for its reservoirs, the safety of which ultimately falls to the undertakers who own, manage or operate them. It is our duty to make sure these undertakers observe and comply with the Reservoirs Act 1975.

The 2016 amendments brought about the most significant change in reservoir safety legislation for decades, with more people brought into regulation balanced against a risk-based regulatory approach. The new requirement for the submission of all Supervising Engineer statements has highlighted additional issues and breaches of the law about which we were not previously aware and are now able to respond to.

As we proceed through the risk designation of newly registered reservoirs we will develop a regulatory approach appropriate to those new to regulation; helping them understand the need for regulation, how this can help protect their liability and understand the consequences of failing to do so.

In the next two years, we seek to further embed the SMNR principles and Wellbeing objectives into our regulatory and operational work with reservoirs, specifically:

- Seek increased engagement with reservoir undertakers and engineers to understand the challenges of compliance and of seeking appropriate improvements to reservoir safety;
- Adapt our approach to providing advice and guidance by seeking the views of undertakers on their preferences, especially geared towards “new” customers;
- Provide clear advice to undertakers of newly registered reservoirs for their first-time inspection following designation as high-risk reservoirs. It is likely that these will contain substantial safety measures for aging structures that have not previously been maintained to an adequate standard.
- Enforce the Reservoirs Act so that high-risk reservoirs are inspected, supervised and maintained to minimum standards;
- Promote collaboration within the reservoir community to share good practice;
- Provide sound information about the risks from reservoirs to those who need it or request it.

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