

# 15

# Reservoirs Act extension

## Executive summary

This case has been driven by a planned change to the Reservoirs Act 1975 that will serve to extend the scope of the definition of statutory reservoirs – in line with provisions made in the Flood and Water Management Act 2010<sup>1</sup> – to cover the safety of all large, raised reservoirs that can hold at least 10,000m<sup>3</sup> of water above natural ground level and which are designated as ‘High Risk’. The current threshold is 25,000m<sup>3</sup>.

### Case for change

Reservoir safety is undergoing reform in response to the recommendations set out in the Independent Reservoir Safety Review Report<sup>2</sup>, led by Professor David Balmforth. In a Written Ministerial Statement<sup>3</sup> in July 2022 the Government set out its intention to reform reservoir safety management practices and to modernise the Act, including enactment of the 10,000m<sup>3</sup> threshold. Reservoir safety focuses on ensuring that the physical structure of a reservoir, its dams and embankments are safe. England has an excellent reservoir safety record. However, the Toddbrook incident in 2019, increasing demands on water supply, and the impacts of climate change, have caused the Government to re-evaluate how it regulates reservoir safety.

The changes, which are expected to take effect in AMP8 based on timescales published to date<sup>3,4</sup>, mean we have an additional 62 service reservoirs or sludge lagoons that are likely to fall under the Act. It will increase the number of Severn Trent reservoirs covered by the Act from 64 to 126 – almost doubling the scope of our obligations. We expect 45 of these are highly likely to be designated as ‘High Risk’ and we believe they will need to be inspected in AMP8. Following the inspections, we will have to carry out any remedial works to ensure these water retaining structures meet enhanced safety standards under the Act.

### AMP8 proposal

The process of preparing for the registration of our assets has already started and we have engaged fully with, and submitted our response to, the Environment Agency (EA) as it prepares to formally designate reservoirs across England. Given the scale of the increase in the number of inspections required (and any consequent additional assessment work), we cannot wait for formal designation and need to act now to take robust steps to prepare. Based on a balanced and risk-based view, this case sets out the need to tackle the highest risk assets (phase 1) at a cost of £29m, which is made up of:

- £9.26m to undertake a prioritised programme of statutory inspections on 45 of the anticipated 62 reservoirs that are expected to fall under the amended Act as potentially being ‘High Risk’ (as highlighted in detail in Appendix A and in summary in Table 1). This includes the employment of specialist staff to carry out the inspections, together with smaller investments required to monitor these sites;
- £16.1m to provide overflow upgrades at 13 distribution service reservoirs (DSRs) and five lagoons to meet the likely enhanced asset standard required under the Act;
- £3.2m for enhancements to two service reservoirs to support the structural changes required to ensure we can discharge our duties in line with the amended Act; and

<sup>1</sup> <https://www.legislation.gov.uk/ukpga/2010/29/schedule/4/crossheading/large-raised-reservoir> - points 3 and 6

<sup>2</sup> <https://www.gov.uk/government/publications/reservoir-review-part-b-2020>

<sup>3</sup> <https://questions-statements.parliament.uk/written-statements/detail/2022-07-20/hcws246>

<sup>4</sup> <https://consult.environment-agency.gov.uk/solent-and-south-downs/reservoir-safety-reform-programme/>

- £0.615m to pay for EA charges for the regulation of statutory reservoirs.

We have worked with reservoir experts at independent engineering consultancy Arup to review the current risks and potential remedial work and their report is laid out in Appendix B. We have also carried out a thorough review of these required interventions to ensure any activities that are required under the normal maintenance and operation of our assets have not been included in this proposal. As a result, we have identified an implicit allowance of £4m which has been netted off this proposal. We have proposed two price control deliverables (PCDs) which will be used to track delivery and return money to customers in the event of non-delivery.

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Note: Annexes referred to sit within separate PR24 documents whereas Appendices are contained within this document

# 1. The need for investment

## 1.1 Meeting new statutory obligations

Reservoirs in England are regulated under the Reservoirs Act 1975, as amended by the Flood and Water Management Act 2010, which is enforced by the EA. The Act covers the safety of all large, raised reservoirs that can hold at least 25,000m<sup>3</sup> of water above natural ground level. Schedule 4, para 2 A1 (3) of the Flood and Water Management Act 2010<sup>5</sup> provides the legislation to alter this volume criterion to include smaller reservoirs with an escapable volume of over 10,000m<sup>3</sup>. The proposed change was the subject of a Defra consultation, published in February 2012<sup>6</sup>, although no timescale for the adoption of this change in England has been promulgated until recently, the EA has indicated ambitions to implement reforms by 2026/27<sup>7</sup>. This change to the Reservoir Act was adopted in Wales and came into force in 2016<sup>8</sup> where the threshold of 10,000m<sup>3</sup> has been implemented. While there may be further consultation on how this is implemented in England as secondary legislation, the threshold of 10,000m<sup>3</sup> is the basis of this case. We believe this to be a reasonable assumption given the provision made in existing legislation, the adoption of this threshold in Wales and no clear proposals of any other volume between 10,000 m<sup>3</sup> and 25,000m<sup>3</sup> to be used.

This expected change significantly increases the expected construction standard and surveillance requirement of these structures, to ensure they meet modern day safety standards. This change will result in additional cost through:

- **Additional operational activities:** Introduction of new reservoir surveillance (to include maintenance and monitoring) in line with the industry best practice surveillance manual;
- **Compliance investment activities:** These assets were not built to meet this safety standard which means modifications will need to be implemented to provide new key safety infrastructure. These modifications will include safety features such as overflows and instrumentation, monitoring, and control equipment;
- **Ongoing statutory inspections:** Assets will now require statutory reservoir inspections, to include an initial inspection (known as a Section 8 inspection) by an independent All Reservoirs Panel Engineer (ARPE, often called the Inspecting Engineer), with a repeat by an ARPE every 10 years (a Section 10 inspection). Statutory reservoirs also require an annual safety assessment and statement (a Section 12), and report/certification by a panel Supervising Engineer;
- **Scoping and executing mandatory safety works:** If safety works arise because of a statutory inspection, and are stated by the independent ARPE to be required in the interest of safety, the requirement is legally binding; and
- **Increase in the standard to which such assets are characterised and managed to comply with the Act:** For example, all works affecting safety need to be overseen by an independent Qualified Civil Engineer (drawn from the All Reservoirs Panel, i.e. an ARPE).

<sup>5</sup> <https://www.legislation.gov.uk/ukpga/2010/29/schedule/4/crossheading/large-raised-reservoir>

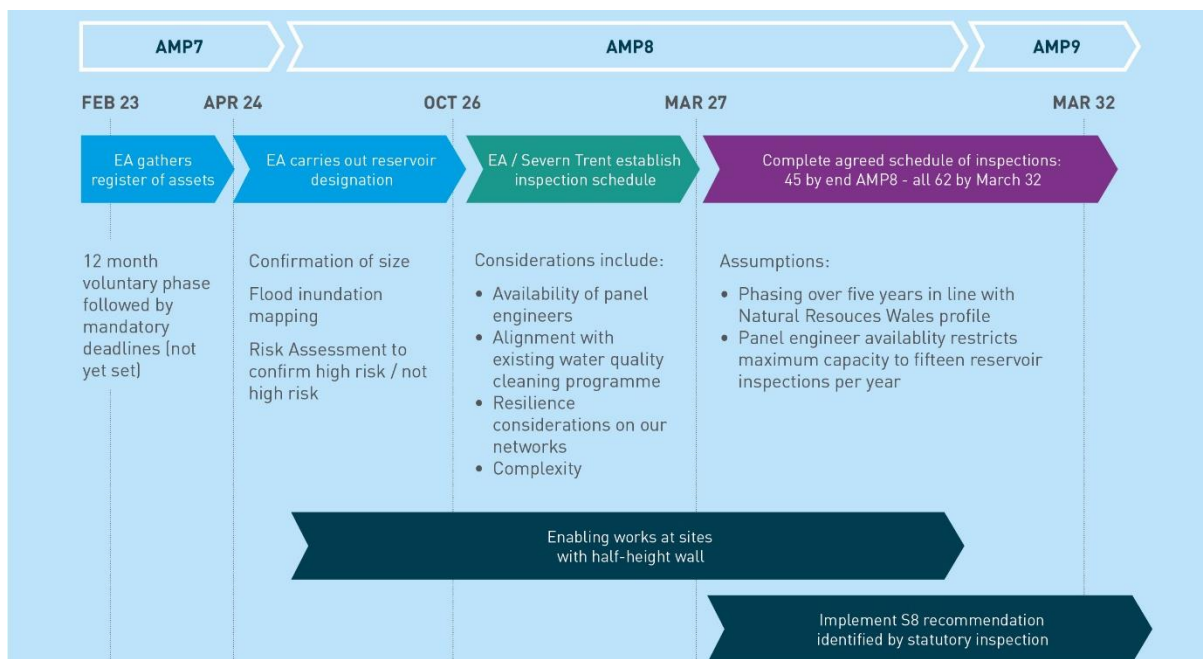
<sup>6</sup> Reservoir safety in England and Wales: implementation of amendments to the Reservoirs Act 1975

<sup>7</sup> <https://consult.environment-agency.gov.uk/solent-and-south-downs/reservoir-safety-reform-programme/> the published timescales from the EA showing reforms through existing powers as early as 2024/5 and the overall programme of reforms completing by 2026/7

<sup>8</sup> <https://britishdams.org/assets/documents/Dam%20Legislation%20-%20Wales%20-%20October%202016.pdf>

It is worth noting that certain recommendations (such as safety or monitoring measures), made by an independent panel engineer appointed to undertake an inspection under the Act of a reservoir, immediately become a statutory requirement as soon as they are made. As the Act increases its scope to include smaller reservoirs and lagoons, it will almost double the number of subject reservoirs within Severn Trent's portfolio. The EA has initiated the process for formally designating the reservoirs which we anticipate will be complete between April 2024 and October 2026, as shown in Figure 1 and based on broad timelines published by the EA<sup>9</sup>. The specific enactment timeline will be defined by the Government and the Regulator and has not been formally published. While we acknowledge there are uncertainties in the timescale of enactment – given the high-level timescales published to date and the wider political landscape – changes in AMP8 or even AMP9 will require us to be prepared for when the changes do take effect. Our assumed timeline also mirrors the process that has been applied in Wales and draws on expert advice from reservoir engineers at Arup.

**Figure 1: Expected timescales of changes under the Act**



To mitigate the uncertainty in the exact timing and designation of the assets, we engaged Arup to undertake a review of our reservoir portfolio. This review, which involved independent ARPES and reservoir engineering specialists, identified the increased number of reservoirs that would be designated under the amended Act and is shared in Appendix B.

The scope of their review included:

- Reviewing and verifying the size data of 73 assets identified by our records as falling between 8,000m<sup>3</sup> (to allow an error margin) and 25,000m<sup>3</sup>;
- Reviewing positioning to confirm that the storage above natural ground volume level exceeds 10,000m<sup>3</sup>;
- Carrying out a proxy risk assessment which considered the flood inundation route and potential to cause harm (i.e. whether each reservoir could potentially be classified as High Risk or Not High Risk, and therefore subject to the Act);
- Reviewing asset records to identify likely inspections needed to support EA designation; and
- Using all available data to cross check the assessment (e.g. flood mapping).

<sup>9</sup> <https://consult.environment-agency.gov.uk/solent-and-south-downs/reservoir-safety-reform-programme/>

**Table 1: Sites reviewed considering the proposed changes to the Act, and outcomes of those reviews**

Reservoir Type	Assets reviewed	Expected to be covered as High Risk	Potentially will be covered as possibly High Risk	Total to be covered
Service reservoir	54	34	14	48
Tank	4	2	1	3
Flood storage reservoir	5	5	0	5
Impounding reservoir	1	1	0	1
River weir	1	0	1	1
Sludge lagoon	8	3	1	4
<b>Total</b>	<b>73</b>	<b>45</b>	<b>17</b>	<b>62</b>

To note: Reservoirs marked as 'potentially' could not be assessed in enough detail to provide enough accuracy to decide on whether the site fell under the Act.

Arup's report, including tentative risk designation screening, is presented in Appendix B.

Under the Act, each reservoir should be inspected within two years of its 'High Risk' designation. This means it is possible that if all 73 assets are designated as high risk, thereby falling under the Act, all inspections would need to be completed within two years. However, based on the implementation plan executed in Wales, which was a five-year phased programme, and factors such as the limited number of Defra-appointed inspecting engineers<sup>10</sup> this proposal assumes a five-year phasing of inspections starting from 2027, which is the latest date anticipated. Based on a thorough and expert review of the assets, this case covers the inspections of the 45 assets which have been judged as expected to be covered by the Act, with the remaining 17 assets due to be inspected in AMP9 should they be confirmed as being covered by the Act. Appendix A sets out the assessment findings for all 73 assets investigated by Arup as possibly being covered by the amended Act.

As part of the preparation for the changes, we have researched the overflow capacities of the sites and have established that 18 of them (13 DSRs and five lagoons/ponds) are deemed to require upgrades to their overflows or spillways to meet the statutory safety requirements that will be recommended by inspecting engineers under the Act.

In addition to the change in the Act, as part of reservoir safety reforms the EA has indicated that charging for the regulation of statutory reservoirs is due to be introduced in April 2025. Consultation started in September 2023 and will culminate in a charging mechanism to all owners of large, raised reservoirs that fall under the new regulations. This has been proposed by the Government in a Defra press release of 20 July 2022<sup>11</sup>, which stated that:

*'In 2022/23 and 2023/24, reforms will be made through existing powers, guidance and training, including . . . developing proposals for a proportionate charging scheme to improve recovery of regulatory costs'*

## 1.2 Customers support the need for this investment

This need is driven by a new statutory obligation, and it is therefore not appropriate to ask customers if they wish to pay for the improvement. That said, we have been transparent about this requirement

<sup>10</sup> At the time of writing, there were 32 inspecting engineers, covering the whole of the UK [[All reservoir panel engineers: contact details - GOV.UK \(www.gov.uk\)](#)]

<sup>11</sup> <https://www.gov.uk/government/news/government-to-strengthen-and-modernise-reservoir-safety-regime>

and its impact on bills. There are three main ways that customer and wider societal views have been taken into consideration.

Firstly, the change in legislation has already been subject to two public consultations with a further three consultation opportunities planned over the next two years which will cover the proposed changes to the secondary legislation reforms. This is a fully open consultation process and many of the changes that are being proposed respond to high-profile incidents, such as that at Toddbrook in 2019<sup>12</sup> which has highlighted the need to ensure there are no safety concerns or risks to the public from any reservoirs and lagoons.

The media coverage of the Toddbrook incident, and the subsequent review by Professor David Balmforth, brought reservoir safety considerations into increased focus for both the public and the Government.

Secondly, our LTDS research included the costs and phasing of this investment, and we discussed bill impacts with customers over the long term and also about how we are testing whether investment is no regrets. Customers were supportive that, if an obligation is known about, then we should address it in a way that provides the smoothest bill impact possible. Some customers were concerned that waiting for certainty could lead to us being “underprepared” and could drive more volatility in bills, which is undesirable.<sup>13</sup>

Finally, in our Affordability and Acceptability testing, the proposed costs of this investment were included in the bill impacts and made clear to customers that they form part of the ‘must do’ elements of our plan and should be considered before they decide if further (discretionary) improvements are affordable and acceptable. Informed customers in the deliberative phase of the Affordability and Acceptability testing almost universally found the plan acceptable and broadly affordable. In the quantitative phase, 76% of customers found the plan acceptable. While 53% of customers said the future bill would be difficult to afford, we are proposing a comprehensive package of support worth £550m over 2025-2030 for those who are struggling. For more information on our customer engagement see Annex 3a and for our affordability strategy see Annex 3b.

We have listened to customers’ views about taking steps to minimise bill impacts as far as possible, and on their wish to share the costs over the longest possible time, which is another factor in our decision to prepare for the formal change and to spread the cost across two AMPs.

## 1.3 Management control

In this section we provide evidence that the cost is driven by factors beyond management control and that the improvements we are proposing enhance the level of service customers will receive – in this case that means an enhanced level of public safety. It should be noted that:

- The need is driven by an external factor that is outside management control;
- We have sought to control and limit the risk as far as possible before seeking enhancement investment; and
- The need has not arisen or been compounded by underinvestment, failure to deliver or poor management decisions in the past.

### 1.3.1 The introduction of new statutory obligations is outside management control

<sup>12</sup> <https://news.sky.com/video/toddbrook-reservoir-overflows-after-heavy-rain-11775086>

<sup>13</sup> Annex 3a Customer Engagement

The introduction of new legislation is clearly outside management control. We have engaged fully with the EA, starting with the voluntary submission to them of a register of assets so they can start their process towards implementing the extension of the Act. Our submission has been fully verified by independent experts at Arup.

### 1.3.2 We have sought to control the impact before seeking investment

We have proactively prepared for the changes to the Act to enable us to carry the work out efficiently and safely and have conducted a thorough review of overlap between this requirement and other obligations which are funded as part of our base plans. The evidence presented in Sections 2 to 4 shows we have considered options and have benchmarked the cost of meeting the new obligations and we present evidence to show we are efficient.

#### Base plan investments

We have ongoing maintenance and inspection programmes across our DSR and water tank asset base which includes a 10-year rolling water quality inspection programme. Table 2 shows we consistently invest around £180m every five years on this asset group. For those assets that already fall under the Act (i.e. dams, impounding reservoirs, lagoons, ponds, and WTW tanks that are more than 25,000m<sup>3</sup>) we manage their surveillance, inspection, and resulting actions through our Reservoir Safety team, supported by capital delivery teams from base plan investments.

**Table 2: 10-year base investment trend in DSRs and water tanks**

Asset group	Investment need	Totex AMP7 £m	Totex proposals AMP8 £m
Distribution Service Reservoirs (DSRs)	Rebuilding DSRs	37.0	41.0
	Remedial repairs	70.0	50.0
	Replacing short life assets (i.e. valves, sensors)	5.9	7.3
	Isolation enabling works	7.2	5.0
Tanks	Rebuilding tanks	41.0	52.0
	Remedial repairs and Isolation enabling works	18.00	26.0
<b>Total</b>		<b>179.1</b>	<b>181.3</b>

For all DSRs and tanks, we will ensure this ongoing base investment enables safe inspection in line with our commitments with the DWI to manage these assets with respect to cryptosporidium and bacteriological water quality risks. For 95% of the assets that will now fall under the amended Act, we have already, or will in AMP8, use base investment to ensure the inspections and resulting remedial work can be safely carried out. We have only identified additional investment in less than 5% of such assets where isolation requirements for a reservoir safety inspection are needed over and above a water quality inspection. We have allocated a portion of these additional costs to this new statutory driver while assuming some of the expenditure should draw from base funds. We set out the additional base plan costs we are absorbing in AMP8 as a result of this new legislation in Section 4.

Furthermore, aligning our base water quality inspection programme with this enhanced reservoir safety programme in AMP8 will enable us to reduce any potential impact on customers. This is because

it would reduce the risk of having multiple service reservoirs out of service at the same time without reducing resilience or increasing the risk of supply interruptions.

### **1.3.3 The need has not arisen due to past performance or management decisions**

As a responsible company, we have always taken the safety of our dams and reservoirs extremely seriously as we recognise the critical importance of such assets, and the consequences of a failure would be considerable. The management of our current estate of statutory reservoirs is overseen by the Dams and Reservoirs Team in accordance with the requirements of the Act, secondary legislation, and guidance from regulators and industry. In addition, the team provides assistance to colleagues in the business on matters relating to their management of non-statutory assets and has proactively reviewed our portfolio of reservoirs that may fall under the proposed changes to the Act. Our reservoirs are commonly managed on a risk basis, with additional attention paid to those where their situation, construction or history indicates that more rigorous oversight is required.

We believe our approach to reservoir safety is sector leading; we believe we were the first water company to submit our response to the EA regarding preparing for registration of assets under proposed reforms and we are the only water company that has a comprehensive training manual for reservoir surveillance. This is industry-leading and is shared both nationally and internationally. It can be found on the British Dam Society website<sup>14</sup>.

Overseeing our reservoir safety activities and reporting to the Severn Trent Chief Engineer is an independent Review Panel manned by two leading industry experts Tim Hill (Mott MacDonald) and Matt Hill (Stantec). Tim Hill reported as the 2022 chair of the panel:

*“The Review Panel consider that Severn Trent’s pro-active approach to reservoir safety is to be commended. Severn Trent continue to demonstrate an exemplary attitude to reservoir safety, commensurate with being one of the leading reservoir owners in the UK”.*

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<sup>14</sup>[https://britishdams.org/assets/documents/Web%20Ref%20Docs/2019\\_03\\_04\\_Maintaining%20Reservoirs\\_%20Redesign.pdf](https://britishdams.org/assets/documents/Web%20Ref%20Docs/2019_03_04_Maintaining%20Reservoirs_%20Redesign.pdf)

## 2. Identifying and assessing the best option for customers

In this section we set out our approach to identifying and mitigating the impact of, and formulating the optimum response to, the change in legislation. We have followed three key steps to ensure we have found the best option for our customers:

**Figure 2: process for establishing the best option for customers**



### 2.1 Identifying the optimum sequence and pace

As described in Section 1.1, we have taken every possible step to establish the impact of the change to the legislation which, based on published timelines, is due to be enacted by 2026/27<sup>15</sup>. This proposal includes the costs to carry out the reservoir safety inspection at 45 sites (rather than the expected additional 62 sites), and we will manage the risk of this being greater from our base cost allocation in AMP8.

We believe this is the optimum pace because:

- At least 45 assets have been confirmed by independent experts as meeting the criteria to be classified as high risk and therefore fall under the amended Act – this assessment mimics the EA’s designation assessment;
- From the ambitions set out by the EA and associated timelines discussed above, we believe all designations will be complete by, at the latest, October 2026, which means we are likely to have three years in AMP8 to complete the inspections;
- Based on a review of how the requirements were enforced in Wales, we believe we will be given five years to complete the full programme of inspections (i.e. we expect inspections to take place in both AMP8 and AMP9); and
- Based on a review of the availability of Inspecting Engineers, we believe an average of between 10 and 15 reservoir inspections per year is achievable.

It is possible we will have to complete more inspections in AMP8 but, for the reasons stated above, we believe the proposed pace ensures a fair balance of risk and cost efficiency for our customers. It is also possible the number of assets falling under the amended Act in AMP8 could be fewer and we have proposed a price control deliverable (PCD) which would return investment to customers if less activity is required due to delayed timing or fewer assets being designated. The PCD is described in Section 5.

With regard to the necessary work at the two reservoirs to ensure their compliance with the amended Act, we believe it is in the best interests of customers for us to progress these as soon as possible to

<sup>15</sup> See timeline on EA’s reservoir safety reform page; <https://consult.environment-agency.gov.uk/solent-and-south-downs/reservoir-safety-reform-programme/>

ensure we have resilience mitigations in place before the inspection timeline is set. This is because there are complex system risks that will need to be coordinated and managed when taking these assets offline alongside all the other maintenance and enhancement activities.

## 2.2 Establish scope

We have considered three aspects when defining the scope of work required:

- Conducting the inspection;
- No and low regrets remedial works that are highly likely to be raised as improvements required in the interest of safety in order to meet this higher structural standard under the amended Act; and
- The scope of work needed to ensure safe isolation of the reservoirs to enable the inspection to be carried out (where this isolation is over and above that required for our water quality inspection programme).

### 2.2.1 Conducting the inspections

This scope covers statutory/procedural, hydraulic, and structural investigations that will be required to meet the inspection standards required under the amended Act. We have a considerable track record and extensive knowledge of the requirements under statutory inspections across the existing 64 assets we own and operate that already fall under the regulations. Through a combination of our and Arup's experience, we have identified several work items needed as part of the inspection, including:

- Reviewing inflow, outflow and overflow provision, and capacities;
- Assessing drawdown capacity;
- Carrying out a structural assessment and flood/inundation assessment;
- Carrying out asset condition assessment, which can include non-destructive pipework testing and drainage and pipework surveys (involving CCTV); and
- Carrying out measured surveys, potentially including topographic, bathymetric, and volumetric surveys.

The total cost of this capital work is £3.25m across the new assets, which is for the inspection of 45 of the 62 sites in AMP8. The basis of this additional costing is included in section 4.1 and pro-rata-ed based on our assessment that 15 inspections per year would be the maximum achievable, and assuming inspections start in year three of AMP8.

To coordinate and undertake the inspection works, more specialist supervising engineers, technicians, and surveyors will be required. Our current team comprises 4.6 FTE Supervising Engineers, four Reservoir Technicians and three Reservoir Surveyors, who collectively manage all the required activities to comply with the Act for the existing Severn Trent estate of 64 large, raised reservoirs. We have considered the range and complexity of our potential statutory reservoirs and estimate we need to increase our team through the addition of two Supervising Engineers, two Reservoir Technicians, and a Reservoir Surveyor. The new team members would be involved in information gathering, and surveying and inspection works described elsewhere in this case to 'adopt' each newly designated statutory reservoir into our management regime. They will also assist in the supervision and monitoring of the implementation of work recommended by independent inspections.

We believe this to be proportionate to maintain the programme in a steady state condition, given the activity required for up to 62 smaller reservoirs is expected to be less resource intensive than the current estate. We have allocated £1.34m across AMP8 for these additional employees, based on employment starting in year two of AMP8 in readiness for the amended Act coming into force in year three. The total amount for the inspection work is therefore £4.59m.

### **2.2.2 Remedial works because of the inspections:**

The scope of remedial work will be specified as a result of the inspection, which is not currently known. Therefore, we have reviewed all recommendations from recent independent inspections on our designated reservoirs, and Welsh Water has shared its learnings from the first Section 8 inspections completed in Wales (which is tracking over five years ahead of the timeline in England). There are several low value remedial actions that are commonly required on the grounds of safety as a result of the statutory inspections. These include:

- Flow measurement of reservoir underdrainage or toe/embankment drainage (i.e. as might be accomplished using a V notch), as a potential indicator for leakage or atypical reservoir behaviour;
- Level sensors;
- Automated data collection from the above; and
- Real-time monitoring with alarm facility.

Across the 45 assets we are proposing to inspect over AMP8, the potential need for such remedial actions has been considered and totals £4.68m, based on experience from our current asset base that 80% of sites will require 'simple' work to be undertaken (i.e. a single flow measurement location) and 20% more 'complex' activity (i.e. two or more flow measurement locations). Including these installations in our proposal is low/no regrets because they are good practice safety measures for any water retaining structure being surveyed as part of the Act. Given the low value, we believe this inclusion is of extremely limited risk to customers and in the event of it not being mandatory it still improves the safety of the assets and reduces the risk of catastrophic failure.

The other consistently occurring improvement requirement relates to the overflow arrangements, whereby the current design standards are required to meet a greater standard than historical designs, which depending on age may have had little to no overflow provisions. Expert engineers at Arup have assessed the estate of reservoirs that would come under the extension to the Act as to the suitability of existing overflow capacity and, if an outflow is undersized relative to the inflow, it could pose a risk in the case of unmitigated over-filling. Through our independent expert assessment, we have established:

- Thirteen DSRs will require additional overflow capacity once the extended safety requirements under the Act come into force; and
- Five Lagoons and ponds will require additional spillway capacity. They currently either have no spillways or spillways which would be deemed undersized once inspected under the Act.

On the basis that inspections in AMP8 will be prioritised based on a perceived level of risk, it is likely all 18 sites requiring overflow upgrade works would be inspected as a priority.

### 2.2.3 Ensuring safe isolation of the assets

We have reviewed the isolation arrangements across all the likely newly designated assets to assess their suitability for carrying out the inspection. This included a review of the existing isolation arrangements in place for the inspection regimes we already undertake as part of water quality inspections. The options available depend on the specific system confirmation but typically rely on either a bypass arrangement or require new storage to divert the flow during the inspection and remedial work phase. We present the evidence below to show we have considered a wide range of options to enable isolation and inspection before concluding new assets will be needed.

This assessment concluded that two of our assets (less than 5%) cannot be taken out of supply for a sufficient duration to enable the necessary safety inspections and subsequent works, which will mean they cannot comply with the Act.

Each of these enabling requirements are at DSR sites with part-height division walls, where each cell either side of the dividing wall can be isolated from the other, but the combined structure cannot be isolated without compromising supply to customers. While this arrangement is adequate for the isolation of respective cells in DSRs during water quality inspections, it does not enable a full height 'drop test' to be undertaken to ascertain levels of leakage from the entire structure.

Leakage can pose risks to the structural safety of the reservoir and if leaking water were to undermine the foundations it could compromise the structure and cause a release of water. While this is monitored on all reservoirs at a high level by routine operational visual checks on the underdrains at a reservoir site, and via leakage tests during water quality inspections, an Inspecting Engineer would require more robust data regarding levels of leakage to determine potential issues and to sign off actions that might be required.

For example, at our Erdington DSR in Birmingham, which is currently covered by the Act, the site has a half height wall and cannot be isolated for a full leakage drop test. Leakage tests on the respective compartments either side of the dividing wall (i.e. only utilising half the head of water in the DSR) have been deemed unacceptable by the Inspecting Engineer and this has led to enforceable actions to enable the site to be fully isolated as per the below extract from the Section 10 inspection report:

#### **16.4 Recommendations as to Measures to be taken under Section 10(3)(b) of the Act (Maintenance)**

(These recommendations are enforceable by the Enforcement Authority but do not require Supervision by a Qualified Civil Engineer within the Meaning of the Act)

1. I recommend that Severn Trent Water initiate a review of the reservoir operation and make whatever changes are necessary to network operation to enable drop tests of both compartments in the reservoir to be undertaken at periods not exceeding once every three years.

This situation is not satisfactory. The most significant safety risk relating to this reservoir likely consists of void formation under the floor slab caused by concentrated leakage.

For sites coming under the Act with very limited historical data regarding leakage and safety of the structure, an Inspecting Engineer would require us to ensure we can provide this vital piece of data to inform their assessment of reservoir safety.

## Hagley Road DSR isolation enabling works

Hagley Road DSR in Birmingham has a capacity of [REDACTED] m<sup>3</sup> and is of reinforced concrete construction, dating from 1962. The DSR directly supplies up to [REDACTED] homes and businesses and is critical to the management of daily flow and pressure fluctuations in Birmingham.

The DSR consists of two conjoined cells with a 66% part-height wall between. The pipework exists to allow either cell to be run independently and this facility has been used to isolate the cells for water quality driven inspection works in the past. However, the part-height division walls would not allow for a leakage drop test assessing the full height of the structure which an Inspecting Engineer is likely to request as part of reservoir safety checks.

If we rely on the part-height wall, we can only perform this one cell at a time, with half the head of water, which will not give a full reflection of any leakage. We believe this arrangement will be unacceptable to an Inspecting Engineer. The age and construction of this DSR are similar to Ladderedge DSR in Staffordshire which already comes under the Act, where significant leakage was found in AMP6 as part of statutory inspection and surveillance work, and which required substantial remedial works. The reservoir at Hagley Road will need to be assessed in a similar manner to determine if similar leakage issues are present.

This DSR serves the north part of the Hagley Road Control Group in Birmingham and receives water from pumps at the Edgbaston DSR site. The control group is sensitive to low pressures and the pumps therefore run on a 'day mode' and a 'night mode' depending on levels of demand, with Hagley Road critical to managing fluctuations. These can typically be managed to be within [REDACTED] % of the reservoir volume (or 2ML) over a week. However, during peak demand periods, the fluctuations can reach as much as [REDACTED] %, or 6ML. The buffer of supply provided by the DSR, and the conjunctive operation with the Edgbaston pumps, is critical to maintaining supply to customers. With proactive management of reservoir levels, a range of [REDACTED] % is achievable, or a working volume of 2ML which requires a cell of larger volume once 'deadbands' of operating levels at high and low levels are considered.

**We are therefore proposing to build 3ML of additional storage on nearby land to ensure customers will continue to receive an uninterrupted supply during future testing.**

## Wilford DSR

Wilford DSR in Nottinghamshire has a capacity of [REDACTED] m<sup>3</sup> and is of brick construction dating from 1906 with a reinforced concrete roof added later. The DSR supplies [REDACTED] homes and businesses.

The DSR consists of two conjoined cells with a half-height wall between. The DSR has sufficient capacity in each compartment either side of the half height wall to enable it to be isolated for the purposes of water quality inspections. This has successfully been undertaken this year. However, as Wilford DSR provides the head to supply a gravity network and provides a buffer to supplies where there is a deficit between the outlet demand and inlet supply, taking the whole DSR out of supply would not be feasible. Operating the network without the storage would be extremely risky, with over-pressurisation and discolouration highly likely.

A full height leakage drop test would therefore not be feasible, and we believe this arrangement will be unacceptable to an Inspecting Engineer.

The DSR currently operates at around a [REDACTED] % operating level ([REDACTED] ML) and when operating with compartments isolated either side of the half height wall it has a capacity of [REDACTED] ML.

**We are therefore proposing to build 4ML of additional storage on nearby land to ensure customers will continue to receive an uninterrupted supply during future testing.**

## **Other DSRs reviewed for isolation enabling works**

As part of our assessment, we have established that the following four DSRs have half height walls and would also be subject to the same full height leakage drop test as the above DSRs during a Section 8 inspection. We have considered the options and established that simple additional bypass pipework and valving would be sufficient to facilitate this. We estimate this would cost around £210,000 and we are proposing to fund this from our base cost allowance and have not included any costs in this investment case. This is because the work does not enhance the safety and structural condition of the assets and, therefore, we are challenging ourselves to fund it out of base allowances. The remainder are all capable of being fully isolated without unacceptable risk to the areas and customers they serve.

The four reservoirs where improvements will be funded out of base cost allowances are:

1. **Crich DSR** in Derbyshire has a capacity of [X] m<sup>3</sup> and is of reinforced concrete construction, dating from 1970. The DSR directly supplies [X] homes and businesses, and a further [X] indirectly. To facilitate a drop test, we need to provide a bypass around Crich DSR and add two new variable speed drives to the pumps at Coddington booster pumping station, with a new programmable logic controller at the existing motor control centre;
2. **Kelham DSR** in Nottinghamshire has a capacity of [X] m<sup>3</sup> and is of reinforced concrete construction, dating from 1960. The DSR directly supplies [X] homes and businesses and is critical to managing pressures in the downstream network and trunk mains. Its criticality will be reduced during AMP8 by the installation of a new main to increase supply capacity to the area. To enable full isolation for a drop test, we will therefore only need to provide a new bypass at the DSR using 15 metres of 300mm pipework;
3. **Minchinhampton DSR** in Gloucestershire has a capacity of [X] m<sup>3</sup> and is of reinforced concrete construction, dating from 1953. The DSR supplies [X] homes and businesses. To enable full isolation to facilitate a drop test, we will be building a new bypass using 100 metres of 300mm pipework; and
4. **Evington DSR** in Leicestershire has a capacity of [X] m<sup>3</sup> and is of reinforced concrete construction, dating from around 1930. It supplies [X] homes and businesses. To enable full isolation of Evington, to facilitate a drop test, we will build a new bypass using 100 metres of 300mm pipework.

Other DSRs we investigated but which require no additional work:

- **Radbourne DSR** in Nottingham: Half height wall between two cells. We are currently progressing plans to enable full isolation of this asset in AMP7 as part of our water quality inspection programme;
- **Barby DSR** in Warwickshire: Half height wall between cells 1 and 2. Barby 1 and 2 are part of a wider complex of DSRs which can respectively support isolation of the others, and 1 and 2 were taken out together in 2019 with no issues;
- **Colwick DSR 1** in Nottinghamshire: Half height wall between two cells, but a separate DSR on site (Colwick 2) is of sufficient size to enable full isolation of one cell;
- **Edgbaston (Monument Road) DSR** in Birmingham: Has an 85% height wall. A project is underway in AMP7 to enable full isolation of this DSR;
- **Hartshorne DSR** in Derbyshire: Has a 33% height wall. The whole site was isolated from supply in 2021 for its last water quality inspection; and

- **Kings Drive DSR** in Derbyshire: Half height wall. This site is one of three serving this area and any one of the three can be out of supply, with customers supported by the other two.

### 2.2.4 Regulation charges

The EA has indicated that charging for regulation of statutory reservoirs is due to be introduced in April 2025, this is part of reforms to be made through existing powers for implementation as early as 2023/24<sup>16</sup>.

As a minimum, a straight charging mechanism would impose an annual charge per reservoir that is subject to regulation. We have 64 Large Raised Reservoirs in England, with a further 45 to 62 once the threshold change comes into force under the amended Act.

However, the EA is looking at other options which would be more expensive for large operators to avoid undue impact on smaller entities that own reservoirs based on:

1. Ability to pay, with rail industry models being considered; and
2. Charge by risk presented, with the nuclear industry being studied.

Based on preliminary discussions with the regulator, direct charges of £1,500 to £2,000 per reservoir would apply. We are therefore proposing to use the lower range of this for an inclusion of £615,000 in this investment case for this new requirement, based on £96,000 for each of the first three years of AMP8 for the current statutory reservoir estate and £163,500 for each of the final two years for the extended estate, including the additional 45 sites. As Severn Trent is a larger operator of reservoirs there is a risk charging mechanisms will lead to higher charges than this. There is also the risk that more than the 45 sites will be designated under the amended Act, which we are prepared to fund from our base cost allowance. Given the low value, and the clear intention to bring in charging for regulation, we believe this inclusion is of extremely limited risk to customers.

## 2.3 Considering costs and benefits

Given there is no option as to whether we comply with the proposed statutory change, and that the solutions presented are necessarily site-specific, it is not appropriate at this point to fully consider the costs and benefits of our proposal. This is not to say that no cost/benefit appraisals will be carried out, as our established project controls require that costs and benefits are considered as part of the project optioneering stage, once necessary safety improvements are better defined.

There is limited scope to drive wider benefits, but it is worth noting that the aim of the Act is to protect lives and property, so the investment would make safety improvements and reduce risk on the reservoir estate which could be understood as being 'wider benefits' but it is not part of the investment case consideration. For context, we can qualitatively appreciate costs and benefits at Toddbrook, which ultimately did not fully fail but which did require extensive remedial work, and so it is a useful test case to illustrate the impact of preventing failure compared to the costs/disbenefits of response and recovery after a failure. The key points from this example are:

- The capital cost of the remediation project to the Canals & Rivers Trust is currently stated to be £15m<sup>17</sup>; and

<sup>16</sup> <https://www.gov.uk/government/news/government-to-strengthen-and-modernise-reservoir-safety-regime>

<sup>17</sup> <https://canalrivertrust.org.uk/news-and-views/news/work-starts-on-permanent-restoration-of-toddbrook-reservoir>

- The November 2021 Restoring Toddbrook Reservoir, Environmental Statement Volume IV: Non-Technical Summary<sup>18</sup> qualitatively describes short-, medium- and long-term significant effects on various receptors (visual, noise/vibration and the water environment) from the dam remediation and spillway replacement project;

It could be argued that the above impacts would have been mitigated by an improved surveillance approach.

A good example in the UK context is associated with the 2007 Ulley incident. Nationally, the floods associated with a particular weather event that year have been assessed to have cost of the order of £3bn<sup>19</sup>, while the direct costs of the flooding in the Rotherham area have been assessed as £14.5m (presumed 2007 prices)<sup>20</sup>. However, this is the flood response and recovery cost in general, as opposed to the cost of flooding associated with a release of water from the reservoir. It is nonetheless indicative of the order of magnitude of cost associated with a flood.

Providing substantial additional referenceable context in terms of avoided impact is difficult, as it is highly dependent on the publication of necessarily specific case studies of dam failures. An example of this is the failure of the Brazilian SAMARCO tailings dam. A paper published by Nature<sup>21</sup> illustrates the impact on the downstream environment in terms of toxic metals deposition along 650km of river environment, and the potential for this to impact, and continue for a long time to impact, environments and communities in this area. This is somewhat higher than the magnitude and toxicity hazard posed by a typical UK reservoir.

## 2.4 Seeking independent challenge and robust assurance

We have sought independent challenge by engaging Arup for research and technical reporting throughout the development of this case. Specifically, Arup has been tasked to help identify sites which are likely to come under the extension to the Act to test the rigour of our assessment and the prioritisation of our AMP8 activities.

We have also responded to our Expert Challenge Panel about the level of uncertainty of the remedial works and whether they could be more fairly treated through an uncertainty mechanism and costs recovered when the action is known. The guidance on PCDs issued in July this year suggested that using them as an uncertainty mechanism is unacceptable to Ofwat. Therefore, we have reduced the remedial works to low value, highly likely interventions and we will manage any further remedial work by appropriate sequencing and agreement with the EA or through cost sharing of any overspend through the normal totex incentives.

This business case has also been through our well-established three lines of assurance to ensure appropriate checks and independent reviews have been completed.

<sup>18</sup> [planning.highpeak.gov.uk/portal/servlets/AttachmentShowServlet?ImageName=486870](http://planning.highpeak.gov.uk/portal/servlets/AttachmentShowServlet?ImageName=486870)

<sup>19</sup> <https://environmentagency.blog.gov.uk/2022/06/24/15-years-of-technological-advances-since-the-2007-floods/>

<sup>20</sup>

[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/86529/ImpactAssessmentsIncidentYorkshireandHumberFloodingRotherhamJune2007\\_0.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/86529/ImpactAssessmentsIncidentYorkshireandHumberFloodingRotherhamJune2007_0.pdf)

<sup>21</sup>

[https://www.nature.com/articles/s41598-017-11143-x.epdf?sharing\\_token=ubr8TcDFI84arArbhwtuZdRgN0jAjWel9jnR3ZoTv0OwgY\\_AhSVN\\_0GX0gzilSywfnKiiN4FvL7NXJvcF97PBsGkmZOuWLG9ghGKvdzH9XDan9MI\\_n3Qt4jo3FnZNuiG3vxzPzIU7wc3ePypn97sV9U2lyW3vQPt5okwlcx8SEU%3D](https://www.nature.com/articles/s41598-017-11143-x.epdf?sharing_token=ubr8TcDFI84arArbhwtuZdRgN0jAjWel9jnR3ZoTv0OwgY_AhSVN_0GX0gzilSywfnKiiN4FvL7NXJvcF97PBsGkmZOuWLG9ghGKvdzH9XDan9MI_n3Qt4jo3FnZNuiG3vxzPzIU7wc3ePypn97sV9U2lyW3vQPt5okwlcx8SEU%3D)

### 3. A ‘no- and/or low-regrets’ strategy for the long term

#### 3.1 Our core pathway is no regrets

1. This is statutory and therefore no regrets; and
2. We acknowledge there is some uncertainty about when the designation will be implemented, and therefore about the timescales for completing the statutory inspections, but the EA has confirmed it agrees with our assumptions and it is a matter of ‘when’ and not ‘if’.

Our no-regrets core pathway to 2050 includes the investment set out in this case and makes provision for repeating the inspections every 10 years in line with the Act. We have not made any assumptions about enabling works at the other reservoirs that could potentially fall under the Act or made assumptions about larger remedial works which may be necessary as a result of the inspections because there is too much uncertainty to define that as no-regrets investment. We have considered alternative programmes under different future pathways (see below).

#### 3.2 Ofwat Common Reference Scenarios

We have considered the eight common reference scenarios (CRS) and consider that this investment is not directly sensitive to any of them, as described below.

- **Environment scenario – impact of abstraction licence capping:** None of the reservoirs which will newly come under the amended Act are on groundwater sites and, therefore, are not subject to licence or source losses because of the Water Industry National Environment Programme (WINEP) plans do not change the requirement to keep maintaining these reservoirs. Under WINEP plans, we have licence losses in most counties<sup>22</sup>, and therefore the areas supplied by the reservoirs will be affected by reduced abstraction and supply availability by 2030-2035, when licence reductions come into effect. These losses are primarily mitigated by our investment plans for WINEP and our Water Resource Management Plan (WRMP), as well as demand side reductions through leakage and per capita consumption reductions;
- **Demand scenario – growth forecasts:** Where we are proposing a new structure to enable isolation of existing assets, we have demand forecasts based on the water resource zone (WRZ). All these assets are in our Strategic Grid WRZ, and this zone has a demand forecast change by 2035 of -5% as our core assumption, with a worst case of +3%. This forecast does not impact the need to provide new structures to enable isolation of the DSRs as outlined, and growth assumptions will be factored into the design of the supporting structures;
- **Climate change:** the EA cites climate change as one of the reasons for requiring the new standard as shown by the quote below. But climate change does not change the legal requirement or the size of the existing asset and therefore it is not a relevant driver of uncertainty (although it may impact on the size of spillways required for impounding reservoirs).

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<sup>22</sup> Notably Derbyshire and Leicestershire do not have licence losses as they are supplied from surface WTWs only, all other counties in Severn Trent do have licence losses under WINEP in the 2030-2035 time window.

*'We have an excellent reservoir safety record. However, the Toddbrook incident in 2019, increasing demands on water supply, and the impacts of climate change, are all reasons to re-evaluate how we regulate the reservoir safety.'*<sup>23</sup>

- **Technology** – the CRS does not include any technology specifically related to reservoir safety.

### 3.2.1 Additional alternative scenarios

We have carried out the following sensitivity testing on the key assumptions to stress test our view that this represents no regrets investment.

- **The timeline of designation:** As discussed above, we will not have control of the timeline but, essentially, that does not change the proposal as we remain confident the changes to the Act will be brought in during AMP8. The only activity that may not be needed is the £4m to carry out the inspections. While the pre-emptive remedial work will improve the safety of the tanks and will be needed when the designation is complete and is therefore no regrets over the longer term; and
- **Changes to the water system:** As discussed above, we require enabling works at some of our sites, as well as intervention planning in our network as numerous reservoirs are taken out of service. We will ensure we can continue to meet the supply-demand balance, so ensuring customers see no change to their service. We have an interventions planning function to risk assess, manage, and prioritise work required to take assets out of use for planned maintenance or inspection purposes. We will align inspections under the amended Act with water quality driven reservoir inspections as much as possible to ensure the change in the Act does not adversely affect our ability to carry out other planned interventions and maintenance works on our network.

## 3.3 Adaptive pathways

An adaptive planning approach allows us to make better long-term investment decisions on behalf of our customers by ensuring we have a broad monitoring plan that gives us early indication of a need to adapt our plans to respond to change. Annex 2 of the LTDS describes how we have identified and created the adaptive pathways and our monitoring plan. Of our three adaptive pathways, the only one influenced by this enhancement driver is the government-led pathway. The table below explains what we have assumed for this investment in this alternative pathway.

### Government Led Legislative Future Pathway

	By 2030	By 2035	By 2040	By 2045	By 2050
<b>Assumptions</b>	The minimum likely statutory requirements have been identified for AMP8 and no changes are expected	The remaining 17 structures (greater than 10,000m <sup>3</sup> ) need to be inspected (no additional remedial works have been assumed)	Section 10 inspections due for assts brought under the act during AMP8	Section 10 inspections due for assets brought under the Act in AMP9	Section 10 inspections due for assets brought under the act during AMP8

<sup>23</sup> <https://consult.environment-agency.gov.uk/solent-and-south-downs/reservoir-safety-reform-programme/>

<b>Monitoring</b>	Through full engagement with the EA and Defra we will monitor potential changes in legislation, and  We will continue to look for innovative condition monitoring technology that will help us monitor the structural integrity of these assets at lower cost
<b>Trigger/Decision Points</b>	The designation of assets falling under the act will inform our PR24 plan delivery; and  The results of the statutory inspections will inform our AMP8 base plan (as we must respond within two years of the inspection) and also inform our PR29 plan as we complete the phased delivery of the statutory requirement.
<b>Enabling Investment within this case</b>	The case includes enabling activity to discharge our duties under the Act but this is not enabling activity to inform our adaptive pathways.

## 4. Robust and efficient costs

Given the scope of this proposal is statutory, demonstrating our costs are robust and efficient is critical to make sure our customers get the best possible deal.

Our estimates are based on a relevant bank of data of our own completed projects over the last five years, as well as on consultant-derived estimates. These have been used and combined with market testing and third-party benchmarking to challenge ourselves to be efficient in our delivery of these works. This section sets out the key evidence to demonstrate this. Full details of our costing methodology and overall efficiency can be found in Annex 4a Costs, efficiency and stretch.

Table 3 below shows the costs required in AMP8 for the activity required on the 45 tanks/reservoirs. In this section we provide more detail of the cost derivation for each element of this case.

**Table 3: Inspection costs**

Activity	Cost in AMP8 £m	
Statutory inspections and low value remedial work (£9.26m)	Statutory Inspections of 45 of the 62 tanks/reservoirs	3.25
	Employees to manage inspections and surveillance programme of additional sites	1.30
	Low value high likelihood remedial actions and monitoring installations required under the grounds of safety as a result of the statutory inspections	4.68
Anticipated matters in the interest of safety	DSR and Lagoon overflow/Spillway upgrades	16.10
Safe isolation to enable statutory inspections	Enabling works to allow safe access to the tanks	3.20
	Regulation charging	0.60
<b>Total</b>		<b>29.13</b>

### 4.1 Statutory Inspection works

Our independent consultant has studied each of our candidate reservoirs, and recommended the necessary activity at each one, as well as providing pricing for the works. With reference to section 2.4 above, this work is shown in Table 4 below.

**Table 4: Cost of works to inspect reservoirs**

	Estimated cost of work item £	Quantity of work item to be delivered (Likely sites shown in brackets)	Total £
Review inflow, outflow and overflow	5,000	60 (42)	300,000
Collate available design records	5,000	60 (42)	300,000
Structural assessment	5,000	17 (14)	85,000
Asset condition surveys	10,000	52 (36)	520,000
Assess drawdown capacity	5,000	58 (41)	290,000
Surveys – topographical/bathymetry /volumetric	10,000	48 (32)	480,000
S8/S10 inspection	10,000	59 (42)	590,000

Flood/inundation assessment (DSR)	5,000	51 (36)	255,000
Flood/inundation assessment (Open)	15,000	11 (8)	165,000
Check previous work undertaken	5,000	8 (7)	40,000
Regular or S12 inspections	10,000	62 (45)	620,000
Recommended repairs	20,000	43 (34)	860,000
<b>Total expenditure (for 62 sites)</b>			<b>4,505,000</b>
<b>Total expenditure (for 45 sites likely to require work under the Act)</b>			<b>3,250,000</b>

The work item unit cost is based on our independent consultant's estimate. It is unlikely there would be any economies of scale for this work, as each item involves a separate scope at individual site s. Other companies have previously published their own cost assessments for similar activities (e.g. Welsh Water/Dwr Cymru Ref 5.8B.3 *Dam Safety & Reservoirs – Cost Modelling [for PR19] September 2018*)<sup>24</sup>, which are higher, once inflation is allowed for, than those proposed above. The sites at which we are proposing to carry out work are detailed in Appendix A.

The cost of additional employees to manage the inspection and surveillance programme is outlined in section 2.2.1 and totals £1.34m. This cost is broken down per year in Table 5 below, which is then applied over the final four years of AMP8 on the assumption that recruitment and upskilling are required prior to the extended Act coming into force and statutory inspections commencing in year 3 of AMP8. This gives a total £1.336m in AMP8.

Based on current average salary costs for 23-24 for level 1/2 employees in the Dams and Reservoir team for those positions it's as follows for annual costs:

**Table 5: Inspection costs**

	Level assumption	FTEs	Total employment costs per year (Gross Salary + NI + Pension + Bonus + £5k per FTE assumption for travel, training, mobile phone, PPE)
Reservoir Technicians	1	2	£100,000
Reservoir Surveyor	2	1	£78,000
Supervising Engineers	2	2	£156,000
<b>TOTAL</b>		<b>5</b>	<b>£334,000</b>

## 4.2 Low value high likelihood remedial actions

For all 45 sites we intend to inspect in AMP8, we have included the following costs:

- Installation of underdrainage/leakage flow measurement infrastructure (e.g. a 'V' notch);
- Level sensors;

<sup>24</sup> <https://corporate.dwrcymru.com/-/media/Project/Files/Page-Documents/Corporate/Library/PR19-Reports/Supporting-Details/58B3-Dam-Safety--Reservoirs--Cost-Modelling-WSH.ashx>

- Automated data collection from the above; and
- Real-time monitoring with alarm facility.

Based on recent contract experience of the design and installation of this type of works at other sites we estimate we require a total of £4.68m for the 45 sites:

- For the assumed 36 'simple' sites, we estimate a cost of £2.92m for the installation of a single weir at each one; and
- For the assumed nine 'complex' sites, we estimate a cost of £1.76m for the installation of two weirs at each one.

The rates used are based on contracted works carried out at other sites to establish unit costs for both 'simple' and 'complex' sites, costing £81,000 and £196,000 per site respectively. Using quotations and purchase orders raised across 11 sites in 2022 and 2023 for specific packages of work directly relating to this scope, we have created a unit cost per site. We have then applied standard design and project management uplifts to these. We therefore believe this represents a robust estimate for the work. Based on experience of our current asset base, 80% of sites will require 'simple' (single flow measurement location) and 20% 'complex' (two or more flow measurement locations) installations.

### 4.3 Overflow upgrades

For the 13 DSRs and five lagoons that would require increased overflow capacity, we have estimated costs for the provision of upgrades, totalling **£16.1m**.

#### DSR Overflows – £12.3m

The scope to provide additional overflow capacity at DSRs would be similar on all sites but needs to be tailored based on where overflowing water could be discharged to. We have therefore assumed the following scope for each site:

- Run to waste pipe provision (length dependent on distance to appropriate water course);
- Cut through existing tank and installation of new overflow pipework (500mm); and
- Cleaning and chlorination of tank following installation.

We have generated cost estimates for these based on our standard cost curves and benchmarked against a supplier estimate for a 700-metre overflow pipe option. The benchmark from Stonbury, one of our framework contractors, was for £[ ] for the above scope against our standard cost curve estimate contract cost of £[ ]. This equates to a total project cost of £1.34m once internal design and project management fees are included, as well as a 25% optimism bias, which we believe appropriate given the high-level scope at this stage and exclusion in these estimates of ancillary items for the work, such as additional discharge arrangements into watercourses. We therefore believe these represent efficient, benchmarked estimates.

The 13 DSRs that would require increased overflow capacity, as highlighted by Arup, are outlined below, with their respective cost estimates. Where two DSRs are on the same site, we have generated a single project cost with associated economies of scale:

- Barby (Warwickshire, rural, 500m to canal or watercourse): £1.1m;
- Bushbury 2 and 3 (Wolverhampton, urban, 700m to watercourse): £2.58m for 2 DSRs;
- Churchdown 1, 2 and 6 (Gloucestershire, rural, 200-700m to watercourse): £3m for 3 DSRs;
- Crich (Derbyshire, rural, 700m to watercourse): £1.34m;
- Frankley PWR2 (Birmingham, urban, 50m to watercourse): £0.54m;

- Highters Heath (Birmingham, urban, 500m to canal or watercourse) : £1.1m;
- Nedge Hill (Shropshire, rural, 500m to watercourse) : £1.1m;
- Oxtou 1 and 2 (Nottingham, rural, 10m to watercourse) : £0.95m for 2 DSRs; and
- Stoughton (Leicestershire, rural, 100m to watercourse) : £0.61m.

### Lagoon spillways – £3.8m

Lagoons are water retaining reservoirs for waste waters (i.e. for purposes other than raw water storage for subsequent treatment). These are generally of similar construction with sloped embankments around the open reservoir, and spillways can be built on the external face of these embankments. We have therefore derived a standard ‘unit cost’ for the construction of such spillways. Our estimate of £690,000 is based on a recently delivered contract price of £407,000 for a new spillway on an AMP7 project. When project management, design, overhead, and optimism bias are applied, we have established the £690,000 figure. We have had this benchmarked by Aqua Consultants, which has determined (from their cost models) a benchmark value of £ 1,063,674 for contract costs. This is substantially higher than our estimate but, given we have based this on a recently delivered scheme, we are proceeding with our estimate and believe this to be a robust and efficient cost to apply to this scope of work.

Five lagoons at an estimate of c.£690,000 per site:

- We anticipate that the sites at Newlands Farm Pond, Newstead sludge lagoon, Wedges Mill effluent lagoons, and Hartshill STW sludge lagoon may require the addition of a simple additional spillway capacity such as might be provided by a sectional concrete block (i.e. Dycell or similar) spillway over the existing embankment. Based on our recent experience of spillway construction, we have budgeted for £690,000 per site which leads to a total of £2.76m for these works; and
- Curdworth Western lagoon is a slightly different case, in that it is likely that an improved overflow capacity will be required and so it will also require substantial enabling works. The embankment was built of variable material of unknown quality to an unknown standard, starting around 1900, and is now populated with mature vegetation and trees. We have therefore increased the optimism bias on this scheme to the HM Treasury Green Book starting point for civil schemes of 44%, such that an estimated budget of £1m is proposed to address localised ground improvements, vegetation management, and spillway construction at this site.

**We have therefore included a total of £16.1m for the provision of overflow upgrades at DSR and lagoon sites that will be required under the extended Act.**

## 4.4 New assets for isolation enabling works

### 4.4.1 Cost derivation

*Table 6: Breakdown of construction costs for new asset*

Scheme	Detail	Pre efficiency Total £m	Post efficiency Total £m	Post Implicit Allowance reduction £m
Hagley Road	New 3ML cell	5.4	3.4	1.4

Wilford	New cell	4ML	6.0	3.8	1.8
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To generate the above estimates, we have used Severn Trent’s historic delivery costs for projects of a similar nature, which are stored in our Severn Trent Unit Cost Assessment tool. This enables us to apply appropriate rates to different high level scope items, apply internal design and project management costs and generate a project total estimate.

For further comparison, Table 7 below summarises recent activity we have carried out for isolation enabling works at five DSRs and for WTW tanks to enable water quality driven inspections and activities, the range of which is broadly in line with the estimates we are putting forward for this work, further demonstrating the costs are robust and based on recent actuals. We acknowledge a proportion of these estimates should draw from our base plan as there may be future additional benefits from the additional network storage being provided, and therefore propose £2m per site, in line with recent major isolation activities in table 7, should draw from base plan funds as an ‘implicit allowance’ and costs over and above this we are putting forward as enhancement expenditure in this case.

**Table 7: Recent isolation enabling works at comparably sized DSRs and WTW tanks to enable inspections**

	Unit cost	Scope
Small scale DSR isolation enabling works (AMP7)	£130,000/site	Varies: from a small number of hydrant installs for overpumps/overland PRVs up to several kilometres of distribution mains renewals and large pumping station rebuilds
Major isolation enabling schemes at DSRs and WTWs	£2m/site	4 x new tanks 1 x new pumping station
All major DSR and WTW tank schemes, including rebuilds of DSRs, which have some proportion of the benefit as isolation enabling	£5.5m/site	Average of 10 sites, including those five in the enabling line above. The remaining five are for major rebuilds of DSRs at four sites, and significant remedial works at one WTW’s tank which also included isolation enabling work

#### 4.4.2 Benchmarking tank rebuild costs

Aqua Consultants has provided a detailed benchmark report on the proposed costs for each of the new structures proposed, which we have used to inform this case. They have three datasets using historical costs collected across the UK water industry to provide the three benchmark figures. These benchmarks are based on the asset level outturn costs which means no project risk items (as covered by optimism bias) are included and are price base adjusted to 2022/23 prices using CPI-H.

The following section outlines the detailed breakdown and benchmarking of the three sites where we are proposing new structures are required to enable isolation.

#### Hagley Road

The project scope consists of:

- 3ML service reservoir;
- 50m of 800mm diameter pressure mains;
- 50m of 600mm diameter pressure mains;
- 200m of 450mm diameter pressure mains;
- Four manholes; and

- Associated connections and monitoring equipment.

**Table 8: Benchmark of Hagley Road**

Assets	Severn Trent estimate		Benchmark	
	Design and build cost	Upper quartile	Mean	Lower quartile
Service reservoir 3,000m3	2,397,257	1,392,328	2,149,244	2,490,670
800mm pressure mains	39,722	46,199	79,173	114,145
600mm pressure mains	30,735	40,679	60,920	85,609
450mm pressure mains	95,123	121,624	182,792	256,827
Manhole – fields and verges	61,426	76,133	107,886	188,148
Non-standard items	244,679	172,101	280,465	351,531
Programme level non-standard allowance	163,440	299,007	309,644	324,594
D&B construction cost	2,787,703	2,148,071	2,538,061	3,811,524
Project Oncosts	1,017,147	399,303	524,537	601,964
<b>Total project cost</b>	<b>4,302,616</b>	<b>2,547,374</b>	<b>4,033,240</b>	<b>4,826,164</b>
<b>Optimism bias and Severn Trent overheads</b>	<b>1,328,751</b>			
		<b>3,383,231</b>		
<b>Total project cost (including optimism bias)</b>	<b>5,378,278</b>	<b>(of which £2m proposed as base plan contribution)</b>		

The Severn Trent estimate for the total project cost is 10% above the average of the benchmarks. We accept that customers should only fund efficient costs and therefore we are reducing our estimate by £2m.

## Wilford

The project scope consists of:

- 4ML service reservoir;
- 50m of 800mm diameter pressure mains;
- 50m of 600mm diameter pressure mains;
- 200m of 450mm diameter pressure mains;
- Four manholes; and
- Associated connections and monitoring equipment.

Table 9: Benchmark of Wilford

Assets	Severn Trent estimate		Benchmark	
	Design and build cost	Upper quartile	Mean	Lower quartile
Service reservoir 4,000m3	2,751,093	1,621,204	2,487,524	2,902,147
800mm pressure mains	39,722	46,199	79,173	114,145
600mm pressure mains	30,735	40,679	60,920	85,609
450mm pressure mains	95,123	121,624	182,792	256,827
Manhole – fields and verges	61,426	75,678	107,886	188,148
Non-standard items	243,373	172,101	280,465	351,531
Programme level non-standard allowance	183,523	334,822	347,321	364,480
D&B construction cost	3,404,994	2,412,276	2,914,018	4,262,887
Project Oncosts	1,142,133	443,907	590,580	690,076
<b>Total project cost</b>	<b>4,547,127</b>	<b>2,856,184</b>	<b>3,504,598</b>	<b>4,952,963</b>
<b>Optimism bias and Severn Trent overheads</b>	<b>1,492,026</b>			
		<b>3,793,369</b>		
<b>Total project cost (including optimism bias)</b>	<b>6,039,151</b>	<b>(of which £2m proposed as base plan contribution)</b>		

The Severn Trent estimate for the total project cost is 10% above the average of the benchmarks, and 4% below the average construction cost. We accept that customers should only fund efficient costs and therefore we are reducing our estimate by £2.2m.

**Conclusion:**

We have drawn on recent outturn costs to build the estimates. We have sought challenge and benchmarking from cost consultants and, as a result, we have added an efficiency challenge to our costs to bring them in line with upper quartile efficiency, and we have assumed a based contribution to the works given potential future benefits of additional storage. This equates to a £4.2m self-imposed efficiency challenge and a £4m base contribution.

## 4.5 Direct procurement for customers (DPC)

To ensure we satisfy Ofwat's 'Minimum Expectation' of 'considering DPC by default', we have considered if this investment case satisfies the criteria. Even when considering whole life costs this

enhancement case does not meet the size threshold of £200m and therefore we are not proposing this investment be delivered through DPC.

## 4.6 Data table mapping

We have added an additional line for this activity as it does not relate to any of the existing AMP8 enhancement drivers stated in this tables CW3 or CWW3.

Line title	CW3/CWW3 Reference	Capex/Opex	AMP8 £m
Additional Line 1	CW3.130	Capex	27.15
	CW3.131	Opex	1.14
	CWW3.181	Capex	0.65
	CWW3.182	Opex	0.19

## 5. Customer protection

We have been careful to protect customers from:

- **Paying twice.** The investment presented in this case only relates to enhancement activity. We have challenged ourselves to ensure that activity that could be expected through normal asset management is paid for through base expenditure. We have extended this in principle to capture any additional costs outside of our assumptions for AMP8; and
- **Paying for an unfair share compared to future customers.** Customers expect us to anticipate and prepare for changes in legislation and this has been under discussion since 2022. We have proactively engaged with the EA to give us the maximum possible time to deliver efficiently and to share the costs over the longest possible time period. The legislation has already been passed and so the only question is the timing, so this investment is no-regrets.

### 5.1 Proposed price control deliverable

We have developed a price control deliverable which shows the outcomes customers can expect as a result of this enhancement expenditure, and we have taken into account an outcome delivery incentive where appropriate.

Our aim is to ensure customers are protected from under or late delivery through easy to measure, track and verify deliverables.

We have taken account of existing regulatory reporting mechanisms and have aligned our deliverables with these mechanisms where appropriate.

We will continue to develop the detailed measurement methodology which will include third line assurance review to ensure there is sufficient specificity in the definition to meet the repeatability and reporting accuracy required as part of the APR requirements.

PCD1	<b>% of newly designated reservoirs compliant with the Reservoirs Act 1975</b>
<b>Description</b>	<p>A planned change to the Reservoirs Act (1975) (the Act) will extend the scope of the definition of statutory reservoirs to include those &gt;10,000m<sup>3</sup>. This will bring at least 45 reservoirs under the Act in AMP8. Each site will be inspected on a schedule agreed with the regulator, and measures in the interest of safety identified by the inspecting engineer become legally binding under the Act. A programme of work to deliver these measures within prescribed dates will be required to ensure compliance with our legal duties under the Act.</p>
	<p><b>Measure</b> Percentage (%) of newly designated reservoirs where measures in the interest of safety, identified by an Independent All Reservoir Panel Engineer (ARPE) under the Act, have been completed by the statutory delivery date.</p> <p><b>Measurement</b> Each year we will confirm the percentage (%) of newly designated reservoirs where measures in the interest of safety have been completed or remain on track to be completed in line with the dates in the statutory notices issued by the ARPE.</p>

The number of reservoirs to be improved in the current scheme is conditional on the legal enactment of the amendments to the Reservoirs Act (1975) expected in financial year 2026/27.

The number of sites where measures in the interests of safety are required will be identified by an -ARPE following a statutory inspection.

We have identified likely improvement actions but the ultimate scope will be confirmed following ARPE inspections.

**Conditions on scheme** Measures required at each reservoir may have due dates spanning typically up to two years. The annual assessment of compliance will be based on the Supervising Engineer’s annual statement to confirm all actions are on track. This assessment is required to be submitted to the ARPE and this process is subject to assurance. Once the final action has been completed, compliance will be evidenced by written certification from the ARPE to the regulator.

Until the newly designated reservoir has been inspected it will not be assessed for compliance nor included in the percentage compliance calculation.

**Assurance**

Independent third-party assessment and assurance of measures completed at reservoirs within agreed statutory milestones. The regulator will track compliance with the measures in the interest of safety and communicates with the undertaker until these are complete typically every six months.

**Cost sharing incentive payments**

Cost Sharing incentive rates have been calculated using the Ofwat PCD payments model using the following assumptions:

- A cost-sharing rate of 50/50 is used for underspends and overspends
- WACC = 3.23%
- The time incentive rate is set at 3.5% of totex
- Totex = £23.3m
- Deliverable = % of reservoirs where measures in interest of safety have been completed by the date in the statutory notices

*PCD rate = 3.88m / year at 100%*

*Time Incentive rate = 0.27m / year at 100%*

**Impacts on performance in relation to performance commitments**

*None*

Deliverable	Unit	25/26	26/27	27/28	28/29	29/30	Total
Identified actions in the interest of safety have been completed on time	% complete			100	100	100	100

PCD2	Additional Reservoir Inspections
<b>Description</b>	A planned change to the Reservoirs Act 1975 that has extended the scope of the definition of statutory reservoirs and means we will need to deliver 45 additional inspections
	<p><b>Measure</b> Number of inspections delivered.</p> <p><b>Measurement</b> Inspections will be delivered through a regulatory inspection plan and be evidenced by statutory report.</p>
<b>Conditions on scheme</b>	The number of reservoirs to be inspected in the current scheme is conditional on the legal enactment of the amendments to the Reservoirs Act (1975) expected in financial year 2026/27, and covers sites coming within the new threshold (>10,000m <sup>3</sup> ), previously not covered by the Act .
<b>Assurance</b>	The company will commission an Independent third-party party All Reservoirs Panel Engineer to complete assessment and assurance, of the inspection schedule (prior to initiation of the schedule), inspection milestones, and forecast of likely outturn position at 31 March 2030
<b>Cost sharing incentive payments</b>	<p>Cost Sharing incentive rates have been calculated using the Ofwat PCD payments model using the following assumptions:</p> <ul style="list-style-type: none"> <li>• A cost-sharing rate of 50/50 is used for underspends and overspends</li> <li>• WACC = 3.23%</li> <li>• The time incentive rate is set at 3.5% of totex</li> <li>• Totex = £5.8m</li> <li>• Deliverable = Inspections (45)</li> </ul> <p><i>PCD rate = £0.065m / scheme</i> <i>Time Incentive rate = £0.005m / scheme</i></p>
<b>Impacts on performance in relation to performance commitments</b>	<i>None</i>

Deliverable	Unit	25/26	26/27	27/28	28/29	29/30	Total
Number of inspections delivered	Number			10	15	20	45

## 5.2 Overlap with other statutory instruments

This outcome will also be regulated by the EA under very strict guidelines and timelines once the reservoirs have been designated. In addition to any penalties paid through the PCD for non-delivery, we would also face enforcement by the EA.

If the EA timeline proceeds at a faster pace than we have assumed the phasing of new sites increases through AMP8, we will find the additional cost through our base cost allowance to ensure we remain fully compliant with our statutory obligations.

### **5.3 Deliverability**

Our plans for AMP8 across the entire Severn Trent portfolio are ambitious and will be challenging but we believe we are in a unique situation in terms of deliverability of additional statutory works resulting from the extension of the Reservoir Act. We have strong in-house capabilities with a proven track record of delivering statutory schemes under the Act over several AMPs together with contract partners in place for works of this nature.

Our assessment of internal capability is such that we would require an overall increase of five full-time employees to coordinate and undertake the additional activity required for the inspection and surveillance activities for the additional sites. This would be made up of an additional two Supervising Engineers, two Reservoir Technicians, and a Reservoir Surveyor.

Our assessment is this would be broadly proportionate to manage this programme in a steady state condition. Our current Reservoir Safety team consists of four Supervising Engineers, four Reservoir Technicians, and three Reservoir Surveyors managing an estate of 64 reservoirs which are larger than the 25,000m<sup>3</sup> threshold, including major impounding reservoirs and their associated dam structures. Our assessment of resource requirements is based on the activity required for 62 smaller reservoirs being less resource intensive.

The additional isolation enabling structures will be delivered through our business-as-usual design and delivery processes and supply chain for AMP8.

The network intervention requirements for all reservoir inspections are discussed in section 2.2; we will seek to align inspections under the Act with water quality driven inspections which are managed through our intervention planning process.

The work we have done with experts at consultancy Arup and through engagement with the asset operators gives us confidence that we have the skills and capacity to deliver this enhancement.

## Appendix A

Table A: Result of Arup survey into Severn Trent assets likely to fall under the new Act

Reservoir Name	Reservoir Type	In/Out of Arup independent study scope	Arup conclusion on High Risk/Not High Risk	Likely to fall under amended Act?
Barby	DSR	In	High Risk	Y
Beacon Hill (Beacon Heights)	DSR	In	High Risk	Possibly
Berry Hill 1	DSR	In	High Risk	Possibly
Blackshaw Moor Lower	IR	In	High Risk	Y
Bushbury Nr.2	DSR	In	High Risk	Y
Bushbury Nr.3	DSR	In	High Risk	Possibly
Butterhill 2	DSR	In	N/A	N
Campion Hills Treated Water Reservoir Compartments 1 and 2	DSR	In	N/A	N
Campion Hills Treated Water Reservoir Compartment 3	DSR	In	N/A	N
Castle Pools Middle (The Dandy)	FSR	In	High Risk	Y
Castle Pools Upper	FSR	In	High Risk	Y
Church Wilne Contact Tank	Tank	In	High Risk	Y
Churchdown No.1	DSR	In	High Risk	Y
Churchdown No.2	DSR	In	High Risk	Possibly
Churchdown No.6	DSR	In	High Risk	Y
Cluddley	DSR	In	High Risk	Y
Colwick No.1	DSR	In	High Risk	Y
Colwick No.2	DSR	In	High Risk	Y
Coundon	DSR	In	High Risk	Y
Cowleigh	DSR	In	N/A	N
Crich	DSR	In	High Risk	Y
Edgbaston (Monument Road)	DSR	In	High Risk	Y
Elbury No.3	DSR	In	High Risk	Possibly
Evington	DSR	In	High Risk	Y
Frankley Pure Water Tank No.2	DSR	In	High Risk	Possibly
Goldthorn Hill Nr.1	DSR	In	High Risk	Possibly
Goldthorn Hill Nr.2	DSR	In	High Risk	Y
Hady No.1	DSR	In	N/A	N
Hagley Road	DSR	In	High Risk	Y
Hallgates No.3	DSR	In	High Risk	Y
Hartshorne	DSR	In	High Risk	Y
Headless Cross No.2	DSR	In	High Risk	Y
High Tor	DSR	In	High Risk	Y
Highters Heath	DSR	In	High Risk	Y
Kelham	DSR	In	High Risk	Possibly
Kings Drive	DSR	In	High Risk	Y

Little Eaton Middle Works No.1 (Low SR No.1)	DSR	In	High Risk	Y
Madeley Court Pool (Lower & Upper)	FSR	In	High Risk	Y
Meir Waterhead No.1	DSR	In	High Risk	Y
Minchinhampton	DSR	In	High Risk	Possibly
Curdworth Western Lagoon	Sludge	In	Not High Risk	Y
Misk Hill	DSR	In	High Risk	Y
Mitcheldean	Tank	In	High Risk	Possibly
Monkmoor WWTW	Sludge	In	N/A	N
Nedge Hill	DSR	In	High Risk	Y
Newlands Farm Pond	FSR	In	High Risk	Y
Newstead Sludge	Sludge	In	High Risk	Y
Noe Diversion	Riv. Weir	In	High Risk	Possibly
Norton	DSR	In	High Risk	Possibly
Nurton 1	DSR	In	High Risk	Possibly
Oxton 1	DSR	In	High Risk	Possibly
Oxton 2	DSR	In	High Risk	Y
Peasley Bank	DSR	In	High Risk	Possibly
Radbourne	DSR	In	High Risk	Y
Ramsdale 2	DSR	In	High Risk	Possibly
Redhill (Shropshire)	DSR	In	High Risk	Y
Redhill No.2 (Notts)	DSR	In	High Risk	Y
Shelton Treated Water Reservoir	DSR	In	High Risk	Y
Spernal WWTW	Sludge	In	N/A	N
Stoughton	DSR	In	High Risk	Y
Strensham - Tank	Tank	In	Not High Risk	Y
Strensham WTW	Sludge	In	N/A	N
Sunnyside 3 (Notts)	DSR	In	N/A	N
Swingate	DSR	In	High Risk	Y
Trimpley - Tank	Tank	In	N/A	N
Trimpley Top	DSR	In	High Risk	Y
Tuttle Hill No.2	DSR	In	High Risk	Y
Wedges Mill Effluent Lagoons	Sludge	In	High Risk	Y
Westrip	DSR	In	High Risk	Y
Whitacre WTW Lagoon	Sludge	In	N/A	N
Whiteborough 10	DSR	In	High Risk	Y
Wilford	DSR	Out	High Risk	Y
Langley Mill Pool/Pond	FSR	Out	-	Y
Hartshill STW Sludge Lagoon	Sludge	Out	-	Possibly

To note: The reservoirs in the study currently defined as 'possibly' were those where, in many cases, the only source of level data was Google Earth Pro which, in some locations, is not defined to a suitable accuracy to confirm whether the site does or does not fall under the Act.

## Appendix B

*Arup Summary Report, June 2023 (minus appendices which give details of locations only)*

Severn Trent Water

# Non-Statutory Reservoirs

## Summary Report

Reference:

P2 ST Classification: OFFICIAL PERSONAL | 6 June 2023



This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 289639-00

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## Executive Summary

The Non-Statutory Reservoir project was carried out by Arup on behalf of Severn Trent Water / Hafren Dyfrdwy (ST/HD) to help understand the reservoir safety risks posed by reservoir sites with capacities identified in the range 10,000 to 25,000m<sup>3</sup>. These reservoirs would likely be brought into the Reservoirs Act 1975 if the threshold is amended to 10,000m<sup>3</sup>. This change would increase the number of reservoirs within ST/HD's portfolio that fall under the Reservoirs Act 1975 (the 'Act'). By studying each reservoir, the project aims to help ST/HD to understand the increase in portfolio risk which could occur as a result of additional operational requirements and capital works to ensure the reservoir safety risks posed by the reservoirs are minimised.

The study was led by 2 No. Arup All Reservoir Panel Engineers and considered 15 No. open reservoir sites and 59 No. service reservoirs and tanks. ST/HD provided available information about the sites to allow desk studies to be carried out. The desk studies were augmented by site visits to 13 No. open reservoir sites.

A report was produced for each reservoir, to collate information about the reservoir; describe the current condition; identify key risks and mitigation; make recommendations; and indicate the magnitude cost of these and any operational constraints. The reports were created as Excel workbooks and have been issued independently of this summary report.

ST/HD experienced difficulties in providing historical data about their assets. The availability and quality of data has impacted on the preparation of the reports. A number of the service reservoir and tank reports have been prepared on very limited data which has meant that findings and recommendations are limited to generic concerns.

For each reservoir the total capacity and capacity above natural surrounding ground level volume were estimated to identify whether the reservoir is likely to fall under an amended Reservoirs Act. For the majority of sites, Google Earth Pro was used to inform the natural surrounding ground level. 4 No. reservoirs were estimated to have volumes in excess of the capacities stated within current legislation. ST/HD are in the process of registering these reservoirs with the relevant enforcement authority.

Common reservoir safety risks identified at the studied reservoirs included: lack of data about reservoir design and current condition; unknown or insufficient overflow capacity; deterioration of reservoir structure; pressurised pipe failure; unknown or insufficient drawdown capacity; and deterioration of underdrainage system.

Based on the key themes from the risk and mitigation assessment, we recommend ST/HD consider using the results of this study to carry out additional studies on their reservoir portfolio. These are listed in this report and include: analysis of data from this study to understand portfolio wide risks and likely cost of mitigation; topographical surveys to confirm capacity assessment; collection of additional asset data; internal inspections and pipework surveys; overflow capacity assessments; drawdown capacity assessments; and study to confirm operational issues. The completion of additional studies may result in recommendations for remedial works which can be costed to help ST/HD better understand investment needs.

In addition to capital works, we recommend that operational input is increased, with a reservoir safety focus, for those reservoirs that are found to be likely to fall under an amended Act. This includes: regular surveillance visits; internal inspection programme; and CCTV surveys of pipework and drains.

# 1. Introduction

## 1.1 Background

Reservoirs in the UK are regulated under the Reservoirs Act 1975, as amended by the Flood and Water Management Act 2010, which is enforced by the EA in England and Natural Resources Wales in Wales. The Act covers the safety of all large raised reservoirs that can hold at least 25,000m<sup>3</sup> of water above natural surrounding ground level. The Flood and Water Management Act 2010 makes provision to alter this to include smaller reservoirs with a volume of between 10,000m<sup>3</sup> and 25,000m<sup>3</sup>. When this change is enacted, it would increase the number of reservoirs covered by the Act and potentially increase operational and maintenance activities for Undertakers.

It is not currently known when the change may occur. If the change is made, it will increase the number of reservoirs within Severn Trent Water / Hafren Dyfrdwy's (ST/HD) portfolio that fall under the Reservoirs Act. ST/HD are keen to understand the implications of this potential change, particularly in relation to reservoir portfolio risk position and associated costs. The project was commissioned to help inform ST/HD's asset planning processes, in particular, for planning investment needs for AMP 8 and beyond.

## 1.2 Objectives and Scope

The main objective of the project was to help ST/HD to understand the reservoir safety risks posed by a number of their reservoir sites with capacities identified in the range 10,000 to 25,000m<sup>3</sup>.

ST/HD carried out initial screening of their sites to provide a list of sites where the reservoir assets could fall within that range. The list of sites and location plan is included in Appendix A. The sites comprised of 15 open reservoirs and 59 service reservoirs/tanks.

The agreed Arup scope included the following tasks for each site:

1. Verify the reservoir capacity (and escapable volume), associated uncertainties and confidence levels, and whether it is likely to fall within the ambit of a changed Act;
2. Carry out a desk study, visit the reservoir (for open reservoirs and any service reservoirs/tanks agreed with ST/HD), and advise, from an All Reservoirs Panel Engineer's standpoint, on any potential matters which may become safety matters should it become subject to the Act;
3. Advise on the potential risks of identified issues, and whether there are operational issues (e.g. isolation) that would affect remedial work; and
4. Advise on the likely magnitude of cost associated with any identified measures.

The deliverables for the project comprise of this summary report and a spreadsheet proforma report for each reservoir to include the information described above.

The scope was extended to include a high-level screening review of whether each site that may fall under the amended Act would be designated as a high risk reservoir as defined in the Reservoirs Act 1975 i.e. in the event of an uncontrolled release of water from the reservoir, human life could be endangered.

### 1.3 Limitations

Due to the screening nature of the study, in-depth inspections and reporting for each site was not required. The following are the main limitations to the assessments:

1. The reports and recommendations made are based on the information supplied by ST/HD and visual observations made during the site visits. No external sources of information were consulted.
2. The availability and quality of historical data about the reservoirs was limited, in particular for the service reservoirs and tanks.
3. Site visits were only undertaken to the open reservoir sites and were of the external areas of sites only. No internal inspections or confined space entries were undertaken.
4. The review relates to reservoir safety risks only and is not intended to cover other risks at the sites such as water quality, public safety, and environmental.
5. The timescales provided for the recommendations were generic for each type of recommendation to assist with understanding the urgency and likely scale of work resulting. There was no assessment of operational constraints on any individual site that may affect timings (e.g. cleaning programmes), or a wider assessment of how the recommendations may be programmed across the portfolio to suit ST/HD's operational requirements.
6. The high level screening of whether the sites would be designated as high risk reservoirs was based on available mapping and satellite imagery information. No assessment of the likelihood or type of breach was undertaken. No modelling of peak flows, volumes, velocities or extents of inundation was carried out.

The following were not included in the scope of the study:

7. Any calculations or assessments for the sites such as stability checks, overflow capacity, or drawdown rates.
8. Listing of possible follow-on works after the recommendations were complete, e.g. the stated recommendation in the proforma report would be to undertake a drawdown assessment only. Any works that may result from that such as increasing drawdown capacity are not listed as the result of the initial assessment is not known.
9. Cost estimation by a Quantity Surveyor or similar for remedial works. The provided estimates of magnitudes of costs were based on prior experience of Arup and ST/HD teams of similar works.
10. In-person meetings with ST/HD operational staff and Dams and Reservoirs Staff other than during the site visits.
11. Portfolio wide analysis of results, including programming of recommendations or summary of costs.

## 2. Methodology

### 2.1 General

The study used the list of reservoirs provided by ST/HD as a starting point. Site visits were arranged and undertaken to the open reservoir sites. These sites were batched geographically for efficiency of completing the visits. Each site visit was carried out by either David Neeve or Darren Shaw, both are engineers appointed to the All Reservoirs Panel (ARP). The ARP Engineers were accompanied on the site visits by members of the ST/HD Reservoirs team.

A ST/HD Sharepoint site was used to securely transfer data and deliverables for the project.

Available data was requested by Arup and provided by ST/HD. This was collated by ST/HD Operational staff and members of the Dams and Reservoirs team and included where available:

1. A key reservoir data sheet
2. Design and construction drawings and reports
3. Monitoring data and operations site visit reports
4. Any available internal inspection reports (for service reservoirs/tanks)
5. Schematics and information about the operation of the assets

### 2.2 Report templates

A standard proforma report template was developed by Arup and agreed with ST/HD and utilised for all sites for consistency. ST/HD requested the use of Microsoft Excel to present the findings, to allow for ease of transfer of information in the future, for example to a Prescribed Form of Record.

The report proforma includes the following sheets:

1. Summary – to set out the scope of the report plus key findings and recommendations
2. Data – to list the information that has been used to prepare the report
3. Reservoir Information:
  - o Reservoir capacity and capacity above natural surrounding ground level volume, calculated using available data, plus a statement as to whether the reservoir is likely to be classed as Large Raised Reservoir under an amended Reservoirs Act 1975
  - o Reservoir Description (covering key elements such as dam, overflow, inlets/outlets, etc)
4. Reservoir Condition – to include information from any available reports and/or observations of a site visit (for open reservoirs)
5. Findings and Recommendations to include:
  - o Risks and Mitigation table to summarise key potential failure modes
  - o Recommendations table to summarise recommended work, the magnitude of cost of any remedial work and whether there are any operational issues that could affect this work • Site Visit Notes (for SR/Tanks only – to be populated in the event of a site visit)
6. Site Visit Photos

Draft reports were submitted for each site to ST/HD for comment, with a final version of each report being issued which addressed any comments.

### 2.3 Volume estimation

For each reservoir the total capacity and capacity above natural surrounding ground level volume were estimated. If drawings were available for the reservoir, these were used to calculate the volume figures. For the majority of sites, ST/HD provided a key reservoir information sheet which generally included a Top Water Level (TWL) and Bottom Water Level (BWL) figure. These could be used to calculate a depth of the reservoir. If drawings were not available, the reservoir area could sometimes

be calculated from measurements from internal inspections. If that information was not available, area was estimated using Google Earth Pro. The depth and area measurements were used to estimate total volume. Where a natural surrounding ground level figure was not available, this was estimated using Google Earth Pro and together with the TWL and area figures, was used to calculate the capacity above natural surrounding ground. In some instances, for the open reservoirs, LIDAR data were used to better understand the natural surrounding ground level.

The report includes a statement as to whether each reservoir is likely to be classed as Large Raised Reservoir under an amended Reservoirs Act 1975 on the basis:

1. Capacity above natural surrounding ground > 10,000m<sup>3</sup> = Yes
2. Capacity above natural surrounding ground < 10,000m<sup>3</sup> & total capacity >10,000 m<sup>3</sup> = Possible as if the scour or washout are considered as lowest surrounding ground, the reservoir may be classed as Large Raised Reservoir
3. Capacity above natural surrounding ground level < 10,000m<sup>3</sup> & total capacity <10,000 m<sup>3</sup> = No

The limitations of these methods include:

4. Uncertainty as to whether the stated TWL in the records is operational 'TWL' or the overflow level. This is a terminology issue as operational staff often refer to 'TWL' as the normal operating level in a reservoir whereas from a dam safety perspective, 'TWL' is a defined term and relates to the level of any overflow.
5. Uncertainty as to whether the stated BWL is the operational BWL or the floor of the SR / outlet sump.
6. Accuracy of using Google Earth Pro to measure areas and ground levels.
7. Availability of data to establish where the washout/bottom outlet is for each reservoir.

No breach mapping was available. The scope was amended to include for Arup to carry out a high level screening to determine if reservoirs would be classified as high risk or not high risk under the Reservoirs Act 1975.

## 2.4 Risks, mitigation and recommendations

Following a review of the intrinsic and current condition of the reservoir assets, key risks were determined and recorded. The Risk Assessment for Reservoir Safety 2013 guidance was used to help identify key threats and risks. Methods to mitigate each of the risks was recorded, together with resultant recommendations to minimise or better understand the risks.

The likely cost of each recommendation was estimated based on the categories shown in Table 1.

Category	Magnitude of cost
Low	< £5,000
Medium	£5,000 -£10,000
High	>£10,000

Table 1 – Cost categories

Operational issues that could affect the implementation of each recommendation were noted in the reports.

Each recommendation was assigned a risk rating and for the reservoirs that would possibly or definitely fall under an amended Reservoirs Act 1975 (the Act), a timescale for carrying out the recommendation. These are categorised as shown in Table 2. The timescales are those which would

typically apply from the date of issue of any Section 8 or Section 10 first inspection report completed after designation of the reservoir by the Enforcement Authority.

Whilst the reservoirs that were considered not likely to fall under an amended Act were not given timescales, a risk rating was assigned as ideally the recommendations would still be implemented, to reduce the risks identified.

Risk Rating	Expected Timescale *
Red	< 1 year
Amber	1-2 years
Green	3 years or more

\*Expected timescale from first Inspection under Section 8 or 10 of the Reservoirs Act 1975

Table 2 – Risk ratings, timescales and criticality

## 2.5 High Risk Reservoir Screening

A high-level screening to help understand likely implications of a change in the Reservoirs Act 1975 was carried out. The classification as high risk or not high risk for any individual reservoir would need to be confirmed at the time of designation once a suitable level of breach modelling/analysis has been completed.

The sites identified as ‘Possible’ or ‘Yes’ to falling under an amended Reservoirs Act 1975 were assessed. Those which were ‘No’ were not considered (but are listed in the workbook for completeness). OS contour maps were inspected to understand the likely direction of flow in the event of a breach. In some cases, the topography was uncertain (e.g. urban areas) so a conservative approach was taken to possible flowpath identification. Those maps and satellite imagery (Google Earth or similar) were inspected to identify possible receptors along those flowpaths. A Yes/No approach was used for potential impacts of a breach on different categories of receptor such as residential properties, community facilities and roads. Where a ‘Yes’ was identified in any category, the reservoir was categorised as ‘high risk’. If the answer was ‘No’ for all categories then it was classified as ‘not high risk’.

Greater scrutiny was placed in the assessment of the open reservoirs as there was more site-specific information from the visits. In some cases, whilst receptors were present downstream, the reservoirs were categorised as ‘not high risk’. This was due to any breach being into a major river with significant capacity and therefore the impact on receptors was considered to be negligible.

## 3. Programme

Site visits were carried out between October 2022 and January 2023 to 13 No. open reservoir sites. Of the open reservoir sites, ST/HD confirmed Dinnington Lagoon could be removed from the scope and that the Noe Diversion Weir did not need to be visited. From the inspections and data, it was found that 8 No. of the sites contained more than one potential reservoir. These were all inspected and included in the reports for the sites:

1. Blackshaw Moor – 2 No. reservoirs - Lower and Upper
2. Madeley Court Pools – 2 No. reservoirs – Lower and Upper

3. Monkmoor WWTW Sludge Lagoons – 3 No. reservoirs – A, B and C
4. Newstead Sludge Lagoons – 2 No. reservoirs – No.1 North and No.2 South
5. Newtown STW – 2 No. lagoons
6. Stensham WTW Lagoons – 14 No. lagoons
7. Wedges Mill Effluent Lagoons – 3 No. lagoons – A, B and C
8. Whitacre WTW Lagoons – 4 No. lagoons

Information about the open reservoirs, service reservoirs and tanks was provided by ST/HD over the period November 2022 to March 2023.

Draft reports for the 73 No. reservoir sites were prepared and issued via the ST/HD Sharepoint site over the period December 2022 to April 2023.

Final versions of the reports for each of the reservoir sites were prepared on receipt of comments from ST/HD and were issued between February and June 2023.

The screening exercise carried out on the sites to determine which of the reservoirs could be classified as 'high risk' under an amended Reservoirs Act 1975 was completed in May 2023.

## 4. Findings

### 4.1 Data Limitations

ST/HD experienced difficulties in locating data for some of their assets, we understand this is due to the nature in which it has been collected and stored historically. The availability and quality of data has impacted on the preparation of the reports, for example a number of the service reservoir (SR) and tank reports have been prepared on very limited data which has meant that findings and recommendations are limited to generic concerns.

There were instances where there was conflicting data about a reservoir, for example the capacity of a SR may be stated differently on a key information sheet and an internal inspection record. Where available drawings were used to confirm information but otherwise the differences were noted in the reports.

### 4.2 Key themes

#### 4.2.1 Reservoir volume estimation and registration under the Reservoirs Act

4 No. Reservoirs were estimated to have volumes such that they may fall under the current Reservoirs Act 1975 as detailed below. It is understood that ST/HD are in the process of checking the escapable volumes of these and if required, registering these with the Environment Agency and/or Natural Resources Wales.

1. Blackshaw Moor Lower – estimated volume >25,000m<sup>3</sup>
2. Curdworth Western Lagoon – estimated volume >25,000m<sup>3</sup> (likely to be Not High Risk) – ST/HD to confirm if silt is escapable
3. Newtown STW lagoons (2No.) – estimated volume of each lagoon >10,000m<sup>3</sup> (site within Wales where reduced volume has already been enacted) (likely to be Not High Risk)

Each reservoir has been assessed to determine whether it is likely to fall under an amended Reservoirs Act 1975, if a large raised reservoir is defined as having an escapable volume in excess of 10,000m<sup>3</sup>. There are a number of reservoirs in the study where this is currently defined as 'possible'. In many cases

this was due to the only source of level data being Google Earth Pro which in some locations is not to a suitable accuracy.

#### 4.2.2 High risk reservoir screening

The summary table of the high level screening exercise to determine which reservoirs are likely to be classified as high risk (in the event of an uncontrolled release of water from the reservoir, human life could be endangered) are included as Appendix B. Of the 62 No. reservoirs that were assessed as likely or possible to fall under an amended Reservoirs Act, 59 No. are considered likely to be classified as high risk.

#### 4.2.3 Risks, mitigation and recommendations

The key reservoir safety risks, potential mitigations and recommendations were included in the Risk and Mitigation sheet for each reservoir. Common and key themes are included in Table 3.

Risk Mitigation / Recommendation		
1	Lack of data about reservoir design, construction, or current condition.	Collate available records and/or carry out surveys and inspections.
2	Overfilling due to unknown or insufficient overflow capacity leading to pressurisation of roof, structural damage and erosion of fill. Available information is not sufficient to confirm if the existing overflow is adequate.	Collect information about overflow arrangement and confirm or assess adequacy of overflow capacity.
3	Deterioration of reservoir structure - floor and/or wall plus joints leading to leakage and erosion of supporting fill.	Regular internal inspection; "drop" tests; monitor for seepage; surveillance visits.
4	Pressurised pipe failure leads to loss of supporting fill – extent of risk depends on type of inflow and position of the inlet / outlet valves.	Confirm route / condition of pipework / valves; monitor for leakage; surveillance visits.
5	Inability to lower the reservoir level in an emergency due to insufficient drawdown capacity. Available information is not sufficient to determine drawdown provision.	Collect information about draw-off/scour arrangements and confirm or assess adequacy of drawdown capacity.
6	Deterioration of underdrainage leading to washout of fill under perimeter walls, or blockage of drainage system. Available information is not sufficient to confirm drainage layout and condition.	Confirmation of washout / underdrain route; internal inspection (CCTV) of underdrains; monitor for seepage; surveillance visits.

Table 3 – Common and key risks, mitigations and recommendations

One risk which was not specifically highlighted in the study workbooks but applies to most service reservoirs and tanks relates to excessive pressure variations due to rapid filling or emptying. Rapid filling is usually less of a risk as air can escape via the overflow (if there is an overflow and it is big enough). The greater risk is rapid emptying due to burst of an outlet pipe creating a negative pressure in the compartment. This can be mitigated through the provision of vents. It is recommended that a

review of ventilation provision is undertaken for any enclosed service reservoir or tank. This may require an assessment of capacity following the method given in CIRIA 138.

#### 4.2.4 *Magnitude of cost*

For the open reservoirs there were some recommendations for remedial works. However, due to the level of detail of the available data, the recommendations for the open reservoirs, service reservoirs and tanks are generally for additional studies or information gathering. High-level estimates of the costs are included in the individual reports.

It is likely that when the recommended studies are completed, they will result in additional recommendations for remedial works to reduce risks at a portion of the sites, for example overflow or drawdown capacity improvements. Those follow on costs are not currently included due to the uncertainty as to the nature and extent of any works.

It is recognised that whilst most of the resultant recommendations will result in a one-off capital cost, all sites will require regular operational costs which would apply to any reservoir which is newly registered under the Reservoirs Act 1975. These costs are not listed on the individual report forms but would need to be considered in any budget estimates for management. As well as general surveillance and maintenance activities, these reservoir-specific activities include:

1. Breach assessment to confirm High Risk/Not High Risk and inform the On Site Plan (if this is not carried out by the Enforcement Authority)
2. Supervising Engineer appointments (annual cost)
3. Appointment of ARPE to carry out Section 10 inspections (generally once every 10 years)
4. Preparation of an On Site Plan
5. Preparation of Prescribed Form of Record
6. Possible Risk Assessment for Reservoirs Safety assessment if ST/HD are operating a portfolio RARS assessment management programme

#### 4.2.5 *Operational issues*

Operational issues generally related to the ability to reduce the water level in the reservoirs to be able to carry out internal inspection and/or maintenance works. For the majority of the service reservoirs and tanks, information was provided about whether there was a bypass to the tank, but it was generally not possible to tell from the information whether water supplies could be maintained whilst a cell was taken out of service. These arrangements will need to be confirmed as they may impact on the ability to be able to carry out regular internal inspections of a reservoir.

#### 4.2.6 *Risk ratings and timescales*

The timescales assigned to each recommendation are intended to be applied from the date at which the reservoirs are first inspected following a decision that the reservoirs fall under the Act, if that is confirmed to be the case. The timescales can therefore be used to help ST/HD to prioritise investigations and works to their portfolio of reservoirs in the interim period before the changes to the Act are enacted. There are a number of recommendations that have been assigned critical ratings that it would be prudent for ST/HD to carry out now to reduce reservoir safety risk, plus a number of reservoirs where it would be beneficial to carry out surveys to confirm whether they are likely to fall under the revised Act.

## 5. Recommendations and next steps

4 No. Reservoirs were found to potentially fall under the current Reservoirs Act and it is understood that ST/HD are in the process of confirming the escapable volume of these. If they are found to exceed the current volume thresholds then the next step would be registering them with the Environment Agency and Natural Resources Wales as applicable.

For the reservoirs where it has been identified it is possible that they may fall under an amended Reservoir Act, the estimation as to whether the volume above natural ground is greater than 10,000m<sup>3</sup> will need confirming for all sites where the reservoir can hold more than 10,000m<sup>3</sup>. The most effective way to do this would be to carry out a topographical survey at these sites. We consider it would be prudent for ST/HD to assume that any reservoir with a capacity in excess of 10,000m<sup>3</sup> has a high likelihood of falling under the amended Act until a topographical survey proves otherwise.

As highlighted in Table 1 a key recommendation relates to further data collection for the majority of the sites studied. The understanding of the key risks for each site can be improved when better data is available to support the assessment. Based on the key themes from the risk and mitigation assessment, we recommend ST/HD considering batching the reservoirs and carrying out relevant studies on them to better understand risks:

1. Further analysis of data from this study to understand portfolio wide risks and likely cost of mitigation
2. Further analysis of data from this study to highlight any critical specific risks at reservoirs
3. Topographical surveys to inform capacity assessment
4. Collection of any additional asset information and data
5. Internal structural surveys and pipework surveys to inform overflow and drawdown capacity assessments
6. Overflow capacity assessments
7. Drawdown capacity assessments
8. Study to confirm operational issues, e.g. ability to bypass reservoirs

Consideration could also be given to undertaking breach assessments to understand if the reservoirs would be designated as High Risk or Not High Risk, and to provide breach maps for emergency planning.

The completion of these studies will likely result in additional recommendations for remedial works. The cost of these recommendations can only really be understood on completion of the studies.

Evidence of threats and risks developing can be more easily noticed and mitigated through regular surveillance, inspection and maintenance. It is therefore recommended that operational input is increased, with a reservoir safety focus, for the reservoirs that are found to be likely to fall under an amended Act:

1. Regular surveillance visits
2. Internal inspection programme
3. CCTV of pipework and drains programme