Department for Environment, Food and Rural Affairs

The future supply of panel engineers

By The Institution of Civil Engineers

December 2022

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1. Chairs forward

Reservoirs are a vital part of the UK's infrastructure but, as the 2019 Toddbrook incident (see section 3.1) demonstrated, they can also represent a major hazard to human life. Reservoir owners quite rightly have the primary responsibility for managing the hazards created by their assets, but they cannot discharge their duties alone. The UK reservoir safety regime also relies on the availability, competence and independence of Reservoir panel engineers.

In his post-Toddbrook review of the regime, Professor David Balmforth examined long-running concerns about the supply of these panel engineers and drew the following stark conclusion:

> "The number of qualified reservoir engineers has been dropping in recent years whilst the number of regulated reservoirs is growing. This is especially a problem with the number of inspecting engineers (one of the statutory roles carried out by panel engineers). The current trend is likely to result in the assurance of reservoir safety becoming unsustainable in the long term".[1]

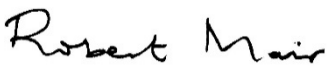
In response, Defra and the Institution of Civil Engineers asked me to chair an independent review to examine what should be done to tackle this problem. Our review confirms that Professor Balmforth was right to sound the alarm. On the supply side, the total number of panel engineers is stagnating, the amount of time each engineer is willing and able to dedicate to reservoir safety work is highly variable and some smaller reservoir owners are clearly already struggling to access those engineers who are theoretically available. At the same time, demand for panel engineers is set to rise. The government's commitment to implement the findings of Professor Balmforth's review in full will bring many more reservoirs into the regulatory system and, in the case of the highest-risk assets, increase the volume of work that panel engineers must deliver per reservoir. Demand for panel engineers is also being driven up by the need to respond to accelerating climate change and manage an ageing asset base; we may also be on the cusp of a large programme of new reservoir construction.

Many of these challenges are long-standing and I believe that the reservoir community has known for some time the broad shape of the action that is needed to improve the supply of engineers. Few of our conclusions and recommendations are therefore entirely new. The UK must ensure that the benefits of supplying panel engineers through the private sector are not undermined by a chase to the bottom on fees that leaves insufficient profit (and incentive) to develop the next generation. Smaller owners must be better supported. We need to make better use of the panel engineers we have and provide more effective structure and support for those who want to advance their career. While panel engineers know that dams and reservoirs offer an exciting, varied and rewarding career path, they are also aware

[1] Balmforth, D (2021) *Independent Reservoir Safety Review Report*, page 96

that this message has not been sold as effectively as it could be to a wide and diverse audience of potential new recruits.

The forthcoming implementation of the Balmforth Review can be a catalyst for breaking this inertia. The work needed to reform the reservoir safety regime to reflect the lessons from Toddbrook does run the risk of generating intense short-term pressure on panel engineer capacity. That outcome is not, however, inevitable. We have time to make changes that will improve the supply of panel engineers over the short and long term. Government, reservoir owners, engineering consultancies and the trade and professional bodies active in the sector need to embrace this opportunity and convert our recommendations into a collaborative change programme that puts the supply of panel engineers on a sustainable footing for the 2020s and beyond.



Professor Lord Robert Mair CBE FREng FICE FRS

Chair, ICE Review of the Future Supply of panel engineers

2. Executive summary

In January 2022, the Department for Environment, Food and Rural Affairs (Defra) commissioned the Institution of Civil Engineers to undertake a review of the future supply of Reservoir panel engineers. This was a response to Professor David Balmforth's Independent Reservoir Safety Review of March 2021, which found that a long-term decline in the number of panel engineers, particularly inspecting engineers (one of the roles carried out by members of the three higher panels, namely the All Reservoirs Panel, the Service Reservoir Panel and the Non-Impounding Reservoir Panel) threatened the long-term sustainability of the current reservoir safety regime.

Section 4 of this report sets out our analysis of the current supply and demand of Reservoir panel engineers in the UK. Our evidence corroborates Professor Balmforth's findings that the total number of panel engineers is set to stagnate, with membership of the All Reservoirs Panel likely to continue at around 33 for the next five years.[2] We also present evidence that the ability of all reservoir owners to access those panel engineers is constrained by other factors. First, the amount of their working lives that individual members of the Panels dedicate to reservoir safety work varies considerably, with some holding many commissions and others very few or even none. Second, larger engineering consultancies, which employ the majority of all reservoirs panel engineers (ARPEs), can also be unwilling or unable for a variety of commercial reasons to service some owners. Finally, the geographical distribution of panel engineers across the UK is also uneven. Two areas, East Anglia and Scotland, were reported as being particularly poorly served. This presents a greater issue for the supply of supervising engineers, who are effectively on call and should be able to reach an owner's reservoir within hours.

We also agree with Professor Balmforth's findings that demand is rising. In part this is due to long-term trends, including climate change and an ageing asset base. It is also probable that the level of reservoir construction in the UK will increase considerably over the next decade, placing additional demands on ARPEs, who must deliver the statutory construction engineer role for these assets. More importantly, the government has indicated that it accepts in principle all of Professor Balmforth's recommendations. While this is important for managing safety, it will bring many more reservoirs under regulation for the first time. This will generate a short-term spike in demand for initial inspections by ARPEs, the appointment of supervising engineers, and the delivery of a range of associated documents to which panel engineers must contribute.

There are significant uncertainties around the size and persistence of this spike in demand. The ICE has commissioned work from Mott MacDonald (see Annex B) that, when completed, will provide the sector with scenarios that it can use to generate a shared understanding of the scale of this issue and the options available to deal with it. At this

[2] This figure refers to the members of the All Reservoirs Panel for England and Wales. Scottish ministers appoint engineers to the All Reservoirs Panel for Scotland. In November 2021 (the last update available on the Scottish Government website), there were 31 members of the Scottish Panel. The vast majority of ARPEs hold appointments to both Panels.

stage, the most important message from these scenarios is however that government and regulators do have the ability to take decisions that can minimise and smooth the impact of these changes.

The implementation of the Balmforth Review can also act as a positive catalyst for wider change in the sector. We recommend that governments, regulators, owners, engineering consultancies and sector bodies grasp the opportunity to collaborate on a programme of action that can increase the availability of panel engineers in all four nations of the UK. This will help deal with any spike in demand and place the regime on a more sustainable footing for the coming decades.

Section 5 of the report identifies six overarching actions that we recommend should form the basis of this programme:

- unlock capacity in the existing panel engineer community
- grow ARPE numbers in the short to medium term
- Reform the Panel structure to align it to any new risk/hazard classification for UK reservoirs and create a stepping stone between the supervising engineers Panel and All Reservoirs Panel
- deliver a step change in the Learning and Development support available to panel engineers
- improve the commercial environment in which panel engineer services are delivered.
- promote panel engineer careers to a wide and diverse range of audiences

panel engineers and their employers work across England, Wales, Scotland and Northern Ireland. We have therefore identified detailed recommendations under each of these six headings that we believe can contribute to securing a more sustainable supply of panel engineers in all four nations of the UK.

Finally, in carrying out the review it became increasingly clear that many of the drivers affecting the supply and demand of panel engineers are characterised by a high degree of uncertainty. In this environment, organisations with convening power, including Defra, the devolved administrations, the ICE and the British Dam Society (BDS), have an important role in supporting an iterative approach to implementing our recommendations, including ensuring that feedback is gathered on their effectiveness and used as a guide for further action.

2.1 Summary of review recommendations

Recommendation 1: Unlock capacity in the existing panel engineer community.

a) Regulators should work with the sector to deliver a permanent improvement in the quality and transparency of data on the distribution of panel engineer commissions, while respecting commercial and professional confidentiality.
b) Defra, the devolved administrations and the Reservoirs Committee should review whether extending panel engineer appointments from five to ten years or making renewal automatic in the absence of concerns from owners or the regulator could provide a level of security that will encourage engineers to dedicate more of their working lives to reservoir safety activity.
c) The Reservoirs Committee should ask its New Panel Engineer Committee to work with the regulators to identify inefficient process and unnecessary panel engineer tasks that could be reformed or eliminated, consistent with moving to a more proportionate, risk-based approach to reservoir safety.
d) The ICE should convene a task and finish group, including representation from the UK government, devolved administrations and the regulators, to identify further actions that can unlock capacity in the existing panel engineer community, with a particular focus on meeting the spike in demand that will occur during the implementation period of the Balmforth Review.

Recommendation 2: Grow ARPE numbers in the short to medium term.

(a) The Reservoirs Committee should develop better data on the potential pipeline of ARPEs and identify candidates for targeted support. Existing ARPEs considering retirement should be asked if they would be willing to mentor supervising engineers seeking to progress to the All Reservoirs Panel as a pilot for a wider scheme.
(b) Defra and the devolved administration should commission the Reservoirs Committee, the ICE and BDS to deliver a pilot scheme to provide targeted support and mentoring to future ARPEs as part of efforts to mitigate the short-term pressure created by the implementation of the Balmforth Review.
(c) The Reservoirs Committee should explore the offers made to the review by reservoir owners to open up their capital programme to engineers in other organisations seeking design and construction experience. The potential for scaling any initiative to a sector-wide scheme involving other owners should be assessed.
(d) The Reservoirs Committee should invite the relevant owners to share their proposals to exploit Shadow Arrangements for reservoirs between 10,000 and 25,000 metres cubed (m^3) to grow the experience of prospective ARPEs and supervising engineers. The potential for scaling to an industry-wide initiative should be assessed.

Recommendation 3: Reform the Panel structure to align it to any new risk/hazard classification for UK reservoirs and create a stepping stone between the supervising engineers Panel and All Reservoirs Panel.

(a) The Reservoirs Committee should initiate a project to allow a reformed Panel Structure to be created in parallel with Defra's work on a new risk/hazard classification for high-risk reservoirs.
(b) Defra and the devolved administrations should commission the Reservoirs Committee to review the future of the Service Reservoirs Panel and the Non-Impounding Reservoirs

Panel, including their potential to support promotion of reservoir engineering careers to structural and geotechnical engineers.

Recommendation 4: Deliver a step change in the Learning and Development support available to panel engineers.

(a) The Reservoirs Committee, the ICE and BDS should lead the scoping and development of a structured career development pathway that supports:
- a smoother transition from the supervising engineers Panel to the All Reservoirs Panel
- entry to the reservoirs sector for non-UK engineers
- entry to the reservoirs sector from adjacent areas of civil engineering

This work should engage the Environment Agency (in its new role of providing training and development support to panel engineers and owners) and other trade and professional bodies relevant to the sector, including the Chartered Institution of Water and Environmental Management, the Institution of Structural Engineers and the British Geotechnical Society.

(b) The Reservoirs Committee and the ICE should assess the feasibility of a progressive assurance system, allowing prospective supervising engineers and ARPEs to demonstrate their achievement of the necessary attributes over an extended period of time.

(c) Defra and the devolved administrations should commission the ICE to develop a proposal for a training course to support supervising engineers seeking to advance to the All Reservoirs Panel. In parallel, Defra and the devolved administrations should consider appropriate funding arrangements for the creation and delivery of the course as a contribution to the public good of reservoir safety.

(d) Defra and the devolved administrations should convene a stakeholder working group to review the wider financial model for training and development of panel engineers covering:
- burden-sharing between businesses, government, owners and regulators
- reducing reliance on pro-bono contributions from the Reservoirs Committee and other panel engineers.

Recommendation 5: Improve the commercial environment in which panel engineer services are delivered.

(a) The ICE should create best practice guidance on the procurement of panel engineer services and review the case for creating a new standard contract.

(b) The Environment Agency should review if and how its new role in promoting best practice among panel engineers and asset owners can be used to improve procurement practice among owners.

(c) The ICE should convene a stakeholder task and finish group to remove barriers to smaller owners accessing panel engineer services. This should include the creation of frameworks or other ways for smaller owners to pool their demand and resources.

(d) Defra should facilitate a dialogue between reservoir sector stakeholders and the insurance industry with a view to identifying opportunities to reduce or slow the rise of Professional Indemnity Insurance premiums.

(e) Defra should, as a contingency measure, consider including the capacity to introduce an independent inspectorate into the revised legal framework it will need to introduce to implement the Balmforth Review.

Recommendation 6: Promote panel engineer careers to a wide and diverse range of audiences.

(a) The ICE and the Reservoirs Committee should engage with the British Geotechnical Association, the Institution of Structural Engineers, the Chartered Institution of Water and Environmental Management and other relevant bodies, to inform a plan that will support engineers in adjacent sectors to pursue membership of the Panels.
(b) The Reservoirs Committee should review whether more weight could be given to overseas experience and issue new guidance as appropriate.
(c) Defra, the ICE, BDS, the devolved administrations, OFWAT, water companies and consultancy businesses should develop a shared plan to exploit the opportunities for increasing the supply of panel engineers created by the likely increase in water supply reservoir projects over the next decade. This should include engaging with universities to identify opportunities for increasing research and teaching on dams and reservoirs.
(d) The ICE, BDS and the Reservoirs Committee should review existing diversity initiatives and identify opportunities to fill any gaps or consolidate activity to improve their impact.

3. Introduction

3.1 Background to the review

In March 2021, the final report was published from Professor David Balmforth's Independent Reservoir Safety Review (the Balmforth Review). The review was commissioned by the Secretary of State for Environment, Food and Rural Affairs following an incident in August 2019 in which heavy rainfall caused serious damage to the spillway at Toddbrook reservoir in Whaley Bridge, Derbyshire. Around 1,500 people were temporarily evacuated, and an immediate drawdown of the water level was instigated, together with urgent engineering measures to shore up and stabilise the spillway.

In light of this incident, Professor Balmforth was asked to review the application of current legislation for reservoir safety and report on whether the regulation of reservoirs remained effective and robust in securing the ongoing safety of this critical infrastructure.

The UK's current reservoir safety regime relies on the availability, competence and independence of specialist reservoir engineers appointed to a series of panels by the Secretary of State on the advice of the Institution of Civil Engineers (ICE). These engineers are known generically in the sector as panel engineers. A summary of the relevant aspects of reservoir safety legislation and the roles of different categories of panel engineers is set out in section 3.2 below.

In his review (p87), Professor Balmforth concluded:

> "The current supply of reservoir engineers, especially of inspecting engineers (one of the statutory roles carried out by members of the All Reservoirs Panel), is insufficient to meet likely future demand. This has been a long-standing problem. There is a real danger that the current system for managing reservoir safety could break down in the future if a sufficient supply of reservoir engineers cannot be maintained".

He recommended (p96):

> "Defra and the Environment Agency, working with their counterparts in the other administrations of the UK, owners and employers should commission the ICE to undertake a thorough review of the supply and development of supervising (a role carried out by members of the supervising engineers Panel) and inspecting engineers to ensure future supply".

In January 2022, Defra commissioned the ICE to undertake a review and take forward this recommendation made by Professor Balmforth in the Independent Reservoir Safety Review. Professor Lord Robert Mair, past ICE President (2017–2018), agreed to chair the review, and Andrew Crudgington (former Policy Director at the ICE) was appointed as a technical researcher and author of this report. The permanent ICE staff who support the Reservoirs Committee also formed part of the review team.

The review team has gathered evidence via a literature review, more than 30 interviews with stakeholders, a call for evidence (which generated more than 40 written responses from across the sector) and a consultation webinar attended by 70 stakeholders. Initial conclusions and recommendations were tested at a workshop on 15 September 2022 which formed part of the British Dam Society's biennial conference. In the early stages of the review, the team also engaged with the rail sector, an area of UK infrastructure that is also subject to high levels of safety regulation. The difficulty in drawing useful comparisons between these two sectors resulted in this line of enquiry not being prioritised.

3.2 The roles of panel engineers under current reservoir safety legislation

Reservoir safety in England and Wales is managed under the Reservoirs Act 1975 as subsequently amended by the Water Act 2003 and the Floods and Water Management Act 2010. Similar provisions exist in Scotland under the Reservoirs (Scotland) Act 2011. In Northern Ireland, the Reservoirs (NI) Act 2015 provides for the regulation of reservoir safety. The Act has not yet fully commenced and will require secondary legislation in the form of Commencement Orders and associated regulations.

In summary, at the time of writing, for all raised reservoirs greater than 25,000m³ in capacity in England and 10,000m³ in Wales and designated by the Enforcement Authority (the Environment Agency or National Resources Wales) as high risk, the legislation requires that:

- a qualified **construction engineer** is appointed to certify all work associated with construction of a new reservoir or alterations to the capacity of an existing reservoir (this applies also to reservoirs that are not designated as high risk)
- a qualified **inspecting engineer** is appointed to inspect the reservoir at least every 10 years (known as Section 10 inspections as they refer to Section 10 of the Reservoirs Act 1975) and to require the owner to implement Measures in the Interests of Safety (MIOS) and/or specific maintenance (known as statutory maintenance)
- a qualified **supervising engineer** is appointed to oversee the reservoir and its surveillance, monitoring, operation and maintenance, and to be available at all times to advise the owner over its safety

The **reservoir owner** is responsible for appointing reservoir engineers in accordance with the legislation.[3] The owner must provide details of the appointment of qualified engineers to the regulator (the Environment Agency or devolved nation equivalent) at the times specified in the legislation. Failure to do so is a criminal offence.

construction engineers must issue certificates to the owner when works at a reservoir are completed to their satisfaction.

[3] Legally in England, the responsibility for the safety of a reservoir lies with the **undertaker**, the entity who undertakes to operate the reservoir. In most cases, the undertaker is the **reservoir owner**. In this report, the term "reservoir owner" is exclusively used to mean the **undertaker**, or **reservoir manager** in Scotland.

Inspecting engineers must issue their inspection reports to the owner as soon as practicable. When an inspecting engineer requires Measures in the Interests of Safety (MIOS), a mandatory completion date must be specified. These works must be overseen by a **Qualified Civil Engineer (QCE)**, who must certify the work once completed. In most cases, the QCE role will be carried out by a member of the All Reservoirs Panel. This can be the same engineer who has carried out the Section 10 inspection.

Supervising engineers must visit the reservoir at least once per annum, report to the owner on their visit(s) and issue an annual statement of the reservoir's condition to the owner.

Following a ministerial direction in April 2021, the owners of all large raised reservoirs in England (both high risk and non-high risk) must prepare an on-site flood plan. This plan must be signed off by the reservoir's **supervising engineer** who should also review it as part of their annual inspection (the Section 12 inspection). Owners and supervising engineers are expected to carry out testing of the plan in a manner proportionate to each reservoir's risk of flooding.

A summary of the statutory roles that may be discharged by members of the All Reservoirs Panel and supervising engineer Panel is shown in table 1 below.

Summary of statutory roles that may be discharged by members of the panels

All reservoirs panel

- supervising engineer
- inspecting engineer
- construction engineer
- Qualified Civil Engineer overseeing measures in the interests of safety

Supervising engineers panel

- supervising engineer

Note: Members of the Service Reservoirs Panel and Non-Impounding Reservoirs Panel can discharge the same roles as members of the All Reservoirs Panel but for a limited category of reservoirs.

Appointment of panel engineers

Defra and the Welsh Government formally appoint reservoir engineers to joint panels for England and Wales and Scottish ministers carry out the same role for the equivalent panels in Scotland. Northern Ireland reservoir safety legislation is yet to be fully commenced.

There are four Panels, specified by the ministers, whose members are those engineers qualified to act as reservoir engineers. These are:

- the **All Reservoirs Panel** (engineers qualified to undertake the duties of inspecting engineer, Qualified Civil Engineer and construction engineer for all reservoirs, and also to act as supervising engineers)
- the **Non-Impounding Reservoirs Panel**

- the **Service Reservoirs Panel**
- the **supervising engineers Panel**

Members of the Non-Impounding Reservoirs Panel and the Service Reservoirs Panel can fulfil all four panel engineer roles (construction engineer, inspecting engineer, qualified civil engineer and supervising engineer) but only for a limited category of reservoirs.

In practice, the vast majority of panel engineers are appointed to either the All Reservoirs Panel and are known as all reservoirs panel engineers (ARPEs) or the supervising engineers Panel and are known as supervising engineers.

Appointments are made following recommendation by the ICE Reservoirs Committee, which has been established to advise ministers on the suitability of candidates.

Appointments are for five years, and engineers may apply for reappointment for a further term. There are no limits to the number of terms served on successful application.

Applicants are examined on their professional qualifications, experience of work on dams and reservoirs, related knowledge such as hydraulics, hydrology, geotechnics and structures, their knowledge of reservoir legislation and their continuous professional development.

The assessment for suitability is based on the competence of the individual to carry out the tasks required of the respective panel engineer. Competence is assessed on the basis of satisfying a set of required attributes for each Panel. The applicant is interviewed and tested against these attributes by a subcommittee comprising three members of the ICE Reservoirs Committee, who are themselves practising panel engineers, often accompanied by an independent observer from the Environment Agency, the Scottish Environmental Protection Agency or Natural Resources Wales. Engineers applying for renewal of their appointment are not routinely called for interview, however such interviews are conducted where they are considered necessary following a review of their application.

The ICE Reservoirs Committee includes a representative of the governments of England, Wales, Scotland and Northern Ireland, and their respective regulators (as observers), as set out in the Reservoirs Act 1975 as amended, and equivalent legislation in Scotland.

3.3 Forthcoming changes to the regulation and classification of reservoirs

Current situation

England

In England, only Large Raised Reservoirs (those with a capacity greater than 25,000m³) are currently regulated under the Reservoirs Act 1975 (as amended) and of these, only those designated as high risk by the Environment Agency in its roles as a regulator are subject to regular inspection and supervision. The current legislation requires that a reservoir be designated as high risk unless it can be shown that it does not endanger human life.

Scotland

Reservoir safety management in Scotland is governed by the Reservoirs (Scotland) Act 2011 which shares many of the features of the Reservoirs Act 1975. The Act is being implemented in a phased approach and currently the regulatory regime applies only to reservoirs with a capacity over 25,000m³. Smaller reservoirs with a capacity of between 10,000m³ and 25,000m³ will be brought under the new regime at a later date.

The Scottish Environmental Protection Agency (SEPA) categorises reservoirs as High, Medium or Low Risk based on the consequences of an uncontrolled release of water on seven receptors (human health – people; human health – community; economic activity – businesses; economic activity – transport; economic activity – agriculture; the environment; and cultural heritage).

Reservoirs in Scotland's high-risk category have the same requirements for Inspecting and supervising engineers as their English counterparts. Owners of Medium Risk reservoirs must appoint a supervising engineer but need to appoint an inspecting engineer only if this is recommended by the supervising engineer. Owners of low-risk reservoirs have no statutory requirements to appoint either a supervising engineer or an inspecting engineer.

Wales

The responsibility for the regulation of reservoirs in Wales lies with Natural Resources Wales (NRW). Although the legislation and much of the regulations are the same as in England, Wales has already enacted a lower threshold of 10,000m³.

Northern Ireland

The Reservoirs Act (Northern Ireland) 2015 provides for the regulation of reservoir safety in Northern Ireland. The Act has not yet been implemented but will introduce a regulatory framework for the management and maintenance of reservoirs capable of holding 10,000m³, or more, of water above the natural level of the surrounding land. These will be known as controlled reservoirs.

The Act places a requirement on the Northern Ireland Department for Infrastructure to give each controlled reservoir a designation that will inform the required level of regulation and maintenance. Similar to the Scottish regime, each reservoir will receive a designation of

High Consequence, Medium Consequence or Low Consequence, depending on the impact that a catastrophic failure of the dam would have on human life or health, economic activity, the environment and cultural heritage. High Consequence reservoirs will require the greatest degree of regulation and maintenance, while Low Consequence reservoirs will require minimal regulation.

Forthcoming changes

Ministers have indicated that they intend to implement in England the recommendations of Professor Balmforth's Independent Reservoir Safety Review (2021) in full. The recommendations include reducing the threshold at which regulation is applied from 25,000m³ to 10,000m³ in line with current arrangements in Wales and those planned in Scotland.

Professor Balmforth has also proposed that future assurance of reservoir safety should be managed on the basis of risk and that the amount of effort (and cost) associated with that process should be in proportion to that risk.

Under his proposal, high-risk reservoirs in England will be divided into three classes:

- **Class 3**: Reservoirs at the lower end of the range of risk, where an uncontrolled release of water would be likely to result in a very low loss of life. These would require a level of supervision and inspection similar to that which exists at present
- **Class 2**: Reservoirs where the loss of life following an uncontrolled release of water would be significant but not large. In addition to current arrangements for supervision and inspection, a qualitative risk assessment would be required as a minimum, along with the inspection
- **Class 1**: Reservoirs with a potential high loss of life following an uncontrolled release of water. Visits to the reservoir for supervision would be increased from the current minimum of one per annum to a minimum of three per annum, and the interval for periodic inspection would be set at a maximum of five years. A quantitative risk assessment would be required along with the inspection. In addition to the periodic inspection, a design safety review would be required every 20 years, involving one or more specialists in addition to the inspecting engineer

The Balmforth Review has also proposed that the threshold for categorising reservoirs as high risk or not high risk should be revisited to remove those assets that present an insignificant level of risk and focus more resources on the reservoirs posing the greatest hazard.

The number of reservoirs that may be removed from the high-risk category and thus require fewer panel engineer inputs could be considerable. The Balmforth Review (p79) suggests this could be as high as 32% of the existing high-risk reservoirs, depending on the method used by policymakers to assess risk and set the thresholds.

4. The supply and demand of panel engineers

4.1 Introduction

The reservoir safety regime relies on all owners being able to commission the panel engineers they need to discharge their duties.

Owners, regulators and government all need to be confident that the engineering profession, larger owners and the consultancy market will ensure that sufficient numbers of panel engineers are trained, developed and made available to carry out the roles defined in legislation and regulation (see section 3.2).

There is strong evidence that the supply of panel engineer services is stagnating, while demand is increasing. This is a long-term trend that as Professor Balmforth argued threatens the proper functioning of the reservoir safety regime. The sector also faces a challenge on a shorter time horizon to ensure that there are sufficient panel engineers to cope with the significant one-off spike in demand that it will experience during the implementation of the Balmforth Review as a large group of new reservoirs are brought under the regulatory regime for the first time.

To help us better understand the potential scale of the changes to demand and its impact on the sector, we have commissioned Mott MacDonald to develop a demand model and a set of scenarios. These scenarios cover both the potential peak demand during Balmforth implementation and the subsequent increase to ongoing base workload to be delivered by panel engineers. At the time of writing, the first iteration of this model has been developed, with input from the review team and panel engineers employed by Mott MacDonald.

The first iteration of the scenarios are:

- during the Balmforth Review implementation period, demand for ARPEs may be between 2.1 and 7.1 times higher than current base demand. Demand for supervising engineers may be between 1.3 and 2.3 times higher than current base demand
- the long-term impact of the Balmforth Review may be to increase demand for ARPEs to between 1.0 and 1.6 times the current base demand. Demand for supervising engineers may be between 1.0and 1.8 times higher than current demand. This is before other factors, such as the impact of climate change and increased reservoir construction, are taken into account

The model suggests that the variable with the greatest impact on the size of the short-term spike in demand will be policymakers' decisions on the number of years within which initial inspections must be carried out for reservoirs falling under the regulatory regime for the first time.

Annex B includes further details of the scenarios and the underpinning methodology.

There is a high level of uncertainty around many of the variables that underpin the model so the initial results should be treated with a high level of caution. We hope that following the completion of the review, the ICE and the Reservoirs Committee will work with Defra, the

devolved administrations and other stakeholders to refine the scenarios further as a tool to guide action.

4.2 Why is the supply of the services provided by panel engineers stagnating?

Our conclusion that the supply of panel engineer services is stagnating has three components:

(i) Absolute numbers of panel engineers

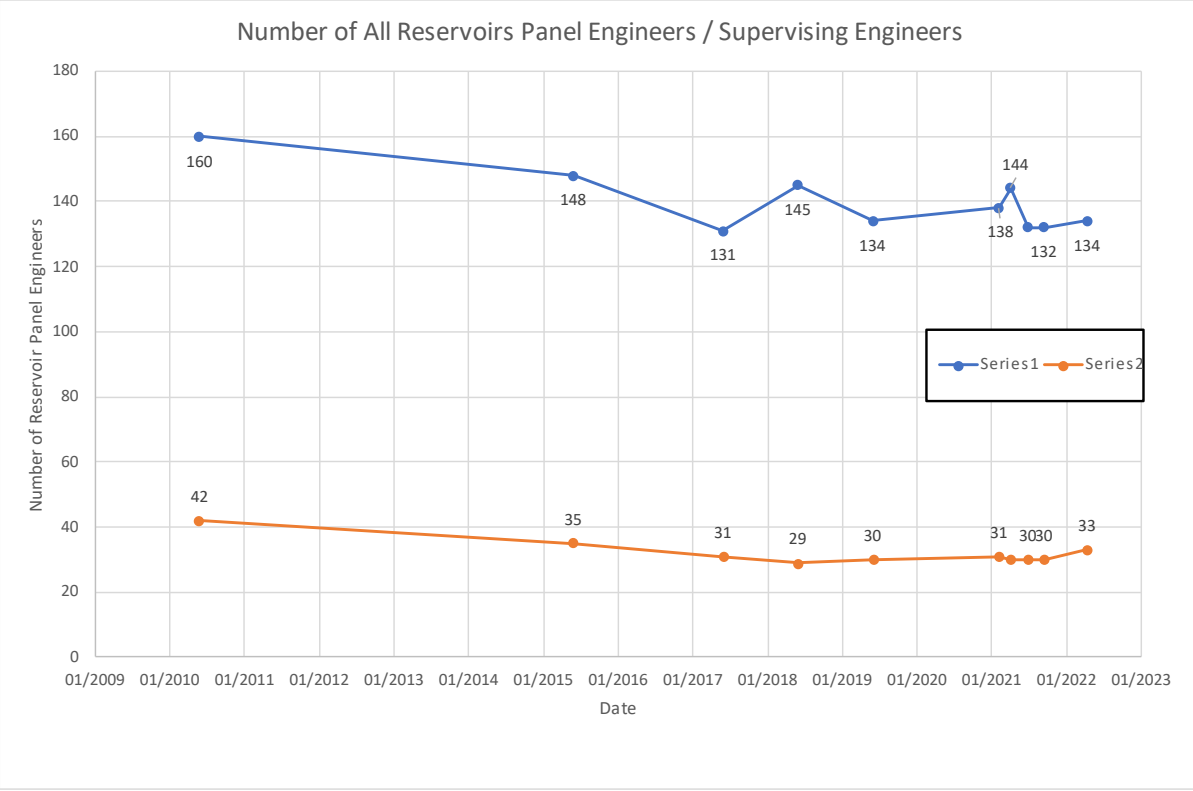
The steady decline in panel engineer numbers is not a new phenomenon. Figure 1 shows data prepared by the current Chair of the British Dam Society demonstrating the decline of both supervising engineer and all reservoirs panel engineer numbers over the last ten years.

Figure 1: 'panel engineer numbers since 2010. Source: David Littlemore, Stillwater Associates'

Figure 1 shows the drop in panel engineer numbers from 2010 until 2022.

Series 1 shows supervising engineer numbers dropping from 160 in 2010 to 131 in 2017. Numbers of supervising engineers recovered slightly with peaks of 145 in 2018 and 144 in 2021 but have fallen back to 134 in 2022

Series 2 shows all reservoirs engineer numbers dropping from 42 in 2010 to a low of 29 in 2018 and recovering slightly to 33 in 2022



In his review, Professor Balmforth expressed particular concern that "the current supply of reservoir engineers, especially of inspecting engineers (one of the statutory roles carried out by members of the All Reservoirs Panel), is insufficient to meet likely future demand".

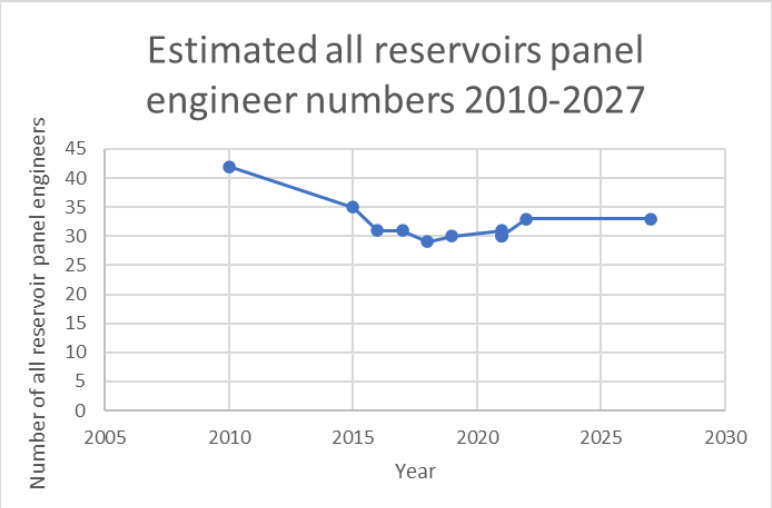
As figure 1 shows, the number of ARPEs did in fact increase slightly in 2021–22, rising from a low of 30 to the current total of 33.

This increase is, however, unlikely to be sustained. We surveyed members of both the All Reservoirs Panel and supervising engineers Panel about their future career plans, covering both retirements and intentions to seek appointment or reappointment to the All Reservoirs Panel. Our analysis of the results of the survey suggests that between 2022 and 2027 membership of the All Reservoirs Panel will stagnate, with 10–11 retirements being balanced by 10–11 new appointments (see figure 2, below; see Annex C for full survey results and analysis).

This finding is more positive than a similar exercise carried out in 2016 by the Reservoirs Committee which concluded that "numbers of inspecting panel engineers will continue to decline. By 2022 we expect the number of inspecting engineers to have reduced to a total of between 21 (most realistic case) and 30 (best case)."[4] The committee's worst-case scenario has been avoided due to an increased pass rate at ARPE interview, which is likely to be the result of improved guidance on the attributes required for appointment. Our analysis shows, however, that there is no room for complacency, particularly in light of the probable significant increase in demand we describe later in this section.

Figure 2: 'Estimated all reservoirs panel engineer numbers 2010 to 2027 – based on a survey of panel engineer intentions carried out in August 2022'

Figure 2 shows the drop in all reservoirs engineers from 42 in 2010 to 33 in 2022 and based on the survey of panel engineer intentions carried out in August 2022 projects that numbers are unlikely to rise above 33 from 2022 to 2027.



[4] Peters A, Goff C, Littlemore D and Williamson T (2018) Inspecting engineer succession planning – plain sailing or choppy waters? *Dams and Reservoirs* **28(2)**: 54–61

(ii) The activity level of each panel engineer

Information shared with the review by the Environment Agency has given us an insight into the very uneven distribution of workload between the members of the All Reservoirs Panel. Some of this data may be commercially sensitive so is not reproduced in full but as an illustrative example, in September 2022:

- 20% of the ARPE membership held 60% of inspecting engineer appointments in England
- 12% of the ARPE membership held 60% of construction engineer appointments in England
- 23% (388) of supervising engineer appointments in England were held by ARPEs
- 10 of the (then) 31 members of the All Reservoirs Panel held no appointments in England

Great care needs to be taken when interpreting this data. The figures relate only to work carried out in England and represent a snapshot in time. panel engineers also carry out other formal and informal reservoir safety roles, for example oversight of the delivery of Measures in the Interests of Safety (MIOS).

In addition, in relation to supervising engineer appointments held by ARPEs, while it is true these tasks can be carried out by members of the supervising engineers Panel, panel engineers and owners can benefit from the continuity, knowledge sharing and understanding of statutory roles that ARPEs can bring. This is reflected in the legal and regulatory regime which is clear that ARPEs can carry out the supervising engineer role.

These figures do, however, suggest that there may be an opportunity to unlock capacity in the existing community to support reservoir owners.

This is discussed further in our conclusions and recommendations. It is, however, important to stress that the amount of time a member of one of the panels dedicates to panel engineer activity reflects the commercial and professional decisions of the individual engineers and their employer. It is also influenced by owners' preferences for working with individual panel engineers or their procurement strategy.

ARPEs and supervising engineers will typically have many other competing duties and opportunities within their employers' businesses. Very few members of the Panels are full-time panel engineers (or would want to be so).

All of these points mean it would be a fundamental misunderstanding to think of the uneven distribution of Panel Commissions in the same way as we would think of the relative workload of specialist engineers employed directly by a regulatory body.

(iii) Are panel engineers willing and able to accept commissions from all owners?

Larger owner organisations with multiple reservoirs (hereafter larger owners), for example water companies, told us that they increasingly meet their needs for supervising engineers in-house. ARPEs are typically secured as part of longer-term framework contracts and larger owners did not report difficulties in accessing their services.

In contrast, smaller owner organisations (hereafter smaller owners), for example farmers, local authorities or owners of heritage assets, told us that they face a much more challenging environment. They rarely have the resources to employ their own supervising engineers. In

the context of the specific challenges facing smaller owners, it is important to understand that 51 of the 134 current supervising engineers are employed by reservoir owners, restricting the engineers available to be engaged by smaller owners. Similarly, the nature of the supervising engineer role means that the role holder is effectively on-call and is expected to be able to reach a reservoir relatively quickly if required. This places a further, geographical, limit on the pool of supervising engineers a smaller owner can draw on. Written submissions suggest this is a growing problem in some areas of the UK, including East Anglia and Scotland.

Some smaller owners told the review that they are struggling to secure the panel engineers they need to discharge their duties. This may in part be a consequence of the timing of our call for evidence, which was issued during a period when the sector was struggling with a significant short-term spike caused by a ministerial direction of April 2021 requiring all reservoirs to prepare an on-site flood plan.

Smaller owners' problems may, however, be more systematic and profound. Several consultancy businesses told the review that they are unable or unwilling to bid for work or accept commissions from some smaller owners due to a combination of factors including fees, volume of work involved, payment risk, liabilities and insurances, and the set-up costs related to servicing a new client.

A small number of independent ARPEs are also available to service the market but it is important that government and regulators understand the extent to which ARPEs in particular are increasingly concentrated in a small number of larger consultancies. In their submission to the review, JBA Consulting provided data that shows that the number of consultancies employing an ARPE has declined from 15 in 1990 to 9 today. In addition, half of the current 33 ARPEs are employed by only three consultancies.

4.3 The drivers of increased demand

Our conclusion that demand is rising also has three components:

(i) A large, short-term spike in demand during the implementation phase of the Balmforth Review

In July 2022, ministers announced that they intend to implement the recommendations of the Balmforth Review in full, when parliamentary time allows.[5] As discussed previously this has the potential to create a significant spike in demand for panel engineers during the implementation period.

The size of this spike is uncertain and will depend on decisions made by policymakers and the ongoing work of regulators to identify all of the relevant reservoirs in their areas. In his review, Professor Balmforth drew a broad conclusion that his recommendations would increase the number of reservoirs in England, Wales and Scotland requiring inspection by circa 500 to roughly 4,000. Professor Balmforth's baseline figure for this increase includes Welsh reservoirs between 10,000m³ and 25,000m³ that have only relatively recently been brought under the regulatory regime. Professor Balmforth's figure does not, however, include Northern Ireland, which is yet to commence its reservoir safety legislation. In their submission to this review, the Northern Ireland Department for Infrastructure told us that

[5] Hansard (2022) Reservoir Safety: Reforming the Safety Regime and Modernising Legislation for England

they expect to add a further 197 reservoirs to the total number in the UK requiring the appointment of an inspecting engineer and a supervising engineer.

Each newly designated reservoir brought into the safety regime for the first time will require:

- a Section 10 inspection by an ARPE (under current regulations, within one year)
- the appointment of a supervising engineer
- input from supervising engineers and potentially ARPEs into on-site flood plans and reservoir safety management plans
- Measures in the Interests of Safety: it is reasonable to assume that reservoirs entering the system for the first time, often with smaller, less-experienced owners, will generate a significant number of Measures in the Interests of Safety. This will require inputs from ARPEs in their roles as construction engineers and Qualified Civil Engineers.

In addition, the Balmforth Review recommends that all existing regulated reservoirs also create and maintain reservoir safety management plans. This will require inputs from panel engineers.

On a smaller scale, some panel engineer expertise will be required to support the tasks that government and regulators will need to deliver, including:

- risk classification for all reservoirs between 10,000m³ and 25,000m³: These assets will need to be designated either high risk or not high risk
- designation of high-risk reservoirs into categories: High-risk reservoirs will need to be subdivided into risk classes. Professor Balmforth has recommended three classes based on the potential loss of life in the event of an uncontrolled release of water
- reclassification of some high-risk reservoirs as not high risk: Professor Balmforth recommended revisiting the basis for the existing high-risk/not-high-risk classification to allow resources to be better concentrated on those reservoirs posing the greatest risk to human life. This will have an important impact on future demand as evidence presented in the Balmforth Review suggests that this could result in 25–32% of existing high-risk reservoirs being re-categorised into the lower category

To help us better understand the potential size of the spike in demand for ARPE and supervising engineer services during the implementation of Professor Balmforth's recommendations, the review has been working with Mott MacDonald to build some indicative scenarios. This work is based on a range of variables including:

- number of reservoirs designated as high risk/not high risk
- number of class 1, 2 and 3 reservoirs within the high-risk category
- number of Measures in the Interests of Safety (MIOS) identified by the initial Section 10 inspections
- average days required to carry out different panel engineer activities
- time allowed to carry out first inspections and other activity for newly designated reservoirs

The scenarios and the methodology used are summarised in Annex B. Further challenge and refinement of the scenarios is needed before they can be used to support detailed decision-making but at this stage we believe it is possible to draw some broad conclusions:

- the spike in demand may be large enough to place significant workload stress on the panel engineer community
- this stress will be much higher for ARPEs than supervising engineers

- decision-makers have options that can manage down the size of peak demand. In this context the number of years to perform the initial inspections for newly designated reservoirs is the variable with the greatest impact on the size of demand in any single year

Our confidence in these conclusions is enhanced by several of the submissions to the call for evidence, for example:

- one major asset owner with multiple reservoirs reports that they are planning for a short-term peak of 10–20% caused by the need for new registrations and inspections
- the National Trust told us that an initial review of the likely impact across their properties suggests a demand equal to one full-time-equivalent ARPE for this relatively minor asset owner
- the Environment Agency, one of the largest owners of statutory reservoirs in the UK with 218, expects its stock of reservoirs requiring panel engineer support to rise by 25%
- in Northern Ireland, the Department for Infrastructure expects 179 reservoirs to be registered when it introduces parallel legislation and will need to draw upon the same pool of panel engineers as other parts of the UK

(ii) A permanent increase in baseload demand following the implementation of the Balmforth Review

The scenarios also model the permanent impact of these measures. As discussed above, further work is required to refine the scenarios but as an initial conclusion the model suggests a smaller but not insignificant permanent increase to baseload demand for ARPEs.

The most important variables driving the size of this permanent increase are:

- the number of reservoirs classified as high risk or non-high risk
- the number of high-risk reservoirs placed in the two highest classes of the proposed new three subdivisions of the high-risk category

The increase in inspection visits and additional scrutiny of reports by the regulator recommended by Professor Balmforth for the higher classes of high-risk reservoirs may also lead to an increase in Measures in the Interests of Safety (MIOS) and thus demand for ARPEs in the Qualified Civil Engineer role.

(iii) Other factors driving demand for panel engineer services

Reservoir construction

Evidence submitted to the review highlighted a likely increase in reservoir construction over the next 5–10 years. Sources of this potential demand include:

- Water companies: A paper submitted to the British Dam Society Conference in September 2022 indicated that up to 10 major water supply reservoirs may be constructed by water companies over the next 20 years[6]
- Flood Relief: The Environment Agency told us that they expect to continue building two to three flood storage reservoirs per year
- Farming: The National Farmers Union explained that as part of the Government Food Strategy, funding for reservoir construction is available under the Farming Transformation Fund Water Management Grant. We have no visibility of the number of new reservoir construction projects that this may generate
- Energy: Russia's invasion of Ukraine is focusing attention on domestic energy security, while the Net Zero imperative can be expected to increase demand for renewables. Again, we have no systematic visibility of the potential impact on reservoir construction. We did receive one submission from a business in the hydro-power sector, who reported that they have seven new dams under construction, but we are unclear on the size of these assets
- Overseas dam construction: Several respondents suggested that dam construction in the international market may increase over the coming decade. We were not able to identify any quantifiable evidence of the potential impact on capacity in the UK market, though any such projects will be attractive to the international, multi-disciplinary consultancies that employ the majority of ARPEs

In the light of this evidence, it would be prudent to work on the assumption that over the next 10 years the demand for construction engineer services will be higher than the recent trend. This is likely to include some projects of a scale that will demand both a construction engineer and an expert design Panel, which will normally include at least one other ARPE.

This is an important conclusion because Professor Balmforth has confirmed to us that his assessment of a need for ARPE numbers to rise from the current 33 to circa 40 was based solely on his calculation of demand for the inspecting engineer role. Informal soundings with a number of senior panel engineers suggest it would not be unreasonable to expect some ARPEs to be dedicating 20–40% of their effort to delivering the construction engineer role.

The impact of Toddbrook, the long-term impact of climate change and an ageing reservoir stock

Figures provided to the review by the Environment Agency show that the number of Measures in the Interests of Safety identified at Section 10 inspection have been rising since the Toddbrook incident. In 2018, the last year before Toddbrook, 10% of the 204 Section 10 inspections carried out resulted in MIOS; this rose to 37% in 2020 (from 207 inspections) and 49% in 2021 (from 155 inspections). This may be a short-term peak reflecting a more cautious approach by ARPEs and regulators but it seems reasonable to assume that, as the industry, government and regulators absorb the lessons from Toddbrook, numbers of required MIOS will not return to their previous levels. Similarly, many contributors to the review have indicated that the sector should assume an increase in demand for design,

[6] Welbank J (2022) *Best Value Planning of Strategic Water Supply Reservoirs in England,* Paper to British Dam Society Biennial Conference

construction and maintenance work as the sector adapts to the long-term impact of climate change and the needs generated by an ageing asset base.

5. Conclusions and recommendations

The need for action is clear. The review has identified that supply of panel engineers is likely to stagnate at a time when demand for their services will grow. If left unchecked, this will threaten the integrity of the reservoir safety regime due to an increased risk that owners will not be able to access the panel engineers they need to discharge their responsibilities.

The most pressing challenge is to ensure that the system can cope with the pressures that will be placed on it during the implementation of the recommendations of the Balmforth Review. Professor Balmforth calculated that the implementation would lead to circa 500 additional reservoirs being brought into the safety regime for the first time, an increase of 14%. As the Balmforth Review acknowledged, there are significant uncertainties affecting this figure and it does not include reservoirs in Northern Ireland. The final figure may therefore be higher. This will generate a high demand for panel engineers to deliver initial Section 10 inspections, take up supervising engineer appointments and contribute to the creation of reservoir safety management plans and on-site flood plans. It is also reasonable to assume these assets, many of which are older and have not previously been managed actively, will generate a high number of Measures in the Interests of Safety requiring supervision and certification.

The implementation of the Balmforth Review also, however, presents an opportunity. Many of our recommendations have been discussed by sector stakeholders for many years but the absence of a burning platform has reduced the will to drive forward change. The Balmforth Review provides that catalyst and it is important that all the sector stakeholders make good use of the time available before primary legislation is introduced. This may be as much as two to three years, so there remains sufficient time to deliver meaningful action.

We have identified six overarching recommendations. There are many links and interdependencies between these recommendations and we suggest that they are treated as a collaborative programme of work delivered by sector stakeholders and overseen by Defra.

In addition, while we are confident that our recommendations can help secure a more sustainable supply of panel engineers, we are also conscious that there is a high level of uncertainty around many of the key drivers behind our conclusions. These uncertainties include: the number of reservoirs coming under regulation, the number of reservoirs in each risk class, the amount of time required for different panel engineer inputs, the wide diversity of UK reservoirs and the demands they place on panel engineers, levels of future reservoir construction in all parts of the UK and overseas, future levels of Professional Indemnity Insurance premiums, the retirement plans of panel engineers and the impact of the trend towards foreign ownership of consultancy businesses on the future appetite of the sector for providing panel engineer services.

In these circumstances it would be prudent for the programme to take an iterative approach to developing robust solutions. We hope that Defra can provide the structure through which

stakeholders can work together as they trial solutions, gather feedback on their effectiveness and make course corrections as required.

5.1 Unlocking capacity in the existing panel engineer community

The UK needs to recruit and retain more panel engineers but there may also be opportunities to support the existing panel engineer community to carry out more reservoir safety work.

In September 2022, the All Reservoirs Panel had 33 members and the supervising engineers Panel 134 members. Data shared with the review by the Environment Agency (see section 4.2(ii)) shows that the distribution of activity among the members of the All Reservoirs Panel is extremely uneven, for example:

- 20% of the ARPE membership held 60% of inspecting engineer appointments in England
- 12% of the ARPE membership held 60% of construction engineer appointments in England
- 23% (388) of supervising engineer appointments in England are held by All Reservoirs panel engineers
- 10 members of the All Reservoirs Panel held no appointments in England (though may have held appointments elsewhere in the UK)

We do not have similar figures for the members of the supervising engineers Panel. The call for evidence has, however, provided some useful insight into how much time they are able to dedicate to the role. As an example, one major consultant told us that their supervising engineers may spend as little as 10% of working life on panel engineer duties as these are one relatively small element in a wider portfolio of activity delivered by these members of staff.

A smaller cohort of independent panel engineers also exists, offering both ARPE and supervising engineer services. Some of these engineers are extremely busy and are an important element of the system, particularly for smaller owners. Others are, however, semi-retired and only service a small number of clients.

There may therefore be scope to draw on capacity from within the existing panel engineer community. This could be particularly helpful to manage the short-term peak in demand for Inspecting and supervising engineers that will be generated during the implementation of the Balmforth Review. Improving the quality and transparency of the data on panel engineer workload is likely to be an important enabler of this work.

Understanding the drivers of panel engineer activity levels

Any effort to unlock capacity from the existing panel engineer community does, however, need to start from the understanding that very few panel engineers carry out the role full time and few would currently want to do so. Many panel engineers have told the review that concentrating solely on the statutory duties under the Reservoir Act would be career limiting and for some intellectually unappealing. It is also risky as Panel membership must be renewed every five years, leaving a full-time panel engineer at risk of losing the basis of their

livelihood if they cannot secure renewal. In this context there may be some value in reviewing the case for automatic renewal in the absence of the regulator or owners raising concerns about a panel engineer's work. This may provide an incentive for existing panel engineers to dedicate more time to reservoir safety activity, though the impact of such a move on standard of work would need to be carefully monitored.

Other contributors to the review took the more positive view that their ability to combine panel engineer duties with other work as part of a broad portfolio is one of the things that attracts them to retaining Panel membership, and that this is a benefit that the sector undersells.

Inside consultancy businesses, senior supervising engineers and ARPEs often hold leadership positions, while younger engineers who are developing their careers will normally be engaged in a wide portfolio of activity. All engineers working in consultancy will ultimately have the shape of their workload defined by the wider commercial and strategic decisions of their employers. Bidding and accepting ARPE or supervising engineer commissions must compete alongside other potentially more financially attractive uses of these highly skilled professionals' time.

The commercial and procurement models prevalent in the sector also have an important influence on the activity level of any individual panel engineer. The Procurement Frameworks used by many larger owners are typically tied to individual consultancies or groups of consultancies, reducing the pool of engineers able to take on the client's ARPE and supervising engineer commissions.

Nonetheless it should still be possible and desirable to design a set of incentives that will encourage panel engineers and their employers to dedicate more time to statutory reservoir safety work. The foreseeable spike in workload that is on the horizon with the implementation of the Balmforth Review is an opportunity to appeal to owners, consultants, government and regulators to collaborate to make changes that will unlock extra capacity during this period. The ICE is well placed to act as a convener for this exercise.

Eliminating panel engineer activity that is not adding value

The pressure on resources created by the implementation of the Balmforth Review is also an opportunity to eliminate or reform activities and processes that are not adding value. This should be seen as part of the implementation of Professor Balmforth's recommendation that the sector fully embraces a proportionate, risk-based approach to reservoir safety. As an example, several contributors have suggested that the requirement for both high-risk and non-high-risk reservoirs to prepare and periodically review on-site flood plans has in practice led to supervising engineers becoming significantly more involved with the safety management of non-high-risk reservoirs. It is at least questionable as to whether this is consistent with a proportionate, risk-based approach. As a more radical proposal, some contributors have suggested that Service Reservoirs could be removed from regulation as the Drinking Water Inspectorate's role in monitoring these assets and their strong enforcement powers ensures that these assets are well managed.

Distribution of supervising engineer workload

There may also be value in reviewing the role of ARPEs in delivering the supervising engineer role. As noted above, this is permitted under the legislation and many contributors to the review noted that there is value to an APRE understanding the supervising engineer perspective, while owners can clearly benefit from a senior engineer's expertise. Professor Balmforth has already recommended that in the interests of independence an ARPE should not be able to act as inspecting engineer for a reservoir where they are the supervising engineer. We are now entering a period in which demand for the services of ARPEs will grow significantly and there may be a case for a deeper examination of how the supervising engineer workload is delivered in future.

supervising engineers employed by reservoir owners

The 51 supervising engineers employed by reservoir owners are not currently available to service the assets of other owners. Submissions to the review suggest that in addition to the formal supervising engineer role, these engineers are often also engaged in a range of activities related to their employer's capital programmes, enterprise risk management, data reporting, emergency planning and general provision of engineering expertise. This level of activity, combined with the difficulties an economically regulated water company would have in charging out staff to third parties, leads us to conclude that exploring the potential for water company panel engineers to service other owners should not be a priority.

Recommendation 1: Unlock capacity in the existing panel engineer community.

a) Regulators should work with the sector to deliver a permanent improvement in the quality and transparency of data on the distribution of panel engineer commissions, while respecting commercial and professional confidentiality.
b) Defra, the devolved administrations and the Reservoirs Committee should review whether extending panel engineer appointments from five to ten years or making renewal automatic in the absence of concerns from owners or the regulator could provide a level of security that will encourage engineers to dedicate more of their working lives to reservoir safety activity.
c) The Reservoirs Committee should ask its New Panel Engineer Committee to work with the regulators to identify inefficient process and unnecessary panel engineer tasks that could be reformed or eliminated, consistent with moving to a more proportionate, risk-based approach to reservoir safety.
d) The ICE should convene a task and finish group, including representation from the UK government, devolved administrations and the regulators, to identify further actions that can unlock capacity in the existing panel engineer community, with a particular focus on meeting the spike in demand that will occur during the implementation period of the Balmforth Review.

5.2 Growing ARPE numbers in the short to medium term (one to five years)

In his review, Professor Balmforth expressed particular concern about the increasing pressure on ARPE capacity. Our analysis of the impact of the implementation of his recommendations supports this view that ARPE capacity is the sector's greatest challenge.

Our recommendations 3 to 6 (see sections 5.3 to 5.6) are aimed at improving the supply of all panel engineers over the medium to long term (we would expect these measures to bear fruit over a period of five to ten years). There are, however, opportunities to grow ARPE numbers that could show results over the short to medium term (one to five years).

Targeted support for potential ARPEs

Annex C describes the results of a survey carried out by this review into the future intentions of the current cohort of ARPEs and supervising engineers. Our analysis of the results suggests that between 2022 and 2027 there is an opportunity to support circa 10 supervising engineers to achieve APRE membership. Unfortunately, the results also suggest this will be offset by circa 11 retirements of ARPEs. The responses of existing ARPEs suggest an unwillingness to reconsider their retirement plans, so it is likely to be more productive to focus on supporting supervising engineers with ambitions to secure appointment to the All Reservoirs Panel than incentivising existing ARPEs to continue in the role. There would, however, be value in sounding out the willingness of these ARPEs to contribute their expertise and experience to a programme of targeted support for their potential successors. In addition to the immediate benefits for ARPE numbers, this would provide valuable insight for the creation of an enhanced training and development package (see recommendation 4 below).

The responses to our call for evidence indicate two other potential quick(er) wins, both of which turn elements of the challenging environment the sector is facing into opportunities.

Design and construction experience

The attributes required for membership of the All Reservoirs Panel demand that applicants have significant design and construction experience. Acquiring this experience has been problematic due to the low level of UK reservoir construction in recent decades. The Reservoirs Committee has in recent years clarified how experience gained overseas, overseeing major remedial works and of the construction of flood relief reservoirs can potentially qualify as relevant experience.

The potential increase in UK reservoir construction (see section 4.3(iii)) is a further opportunity for more engineers to gain this experience. In their response to our call for evidence, two major reservoir owners indicated that in principle they were open to discussions around opening up access to their planned capital programmes to provide more engineers with some form of design and construction experience. We imagine this could be achieved in various ways, including secondments and shadowing.

Voluntary registration and inspection of reservoirs between 10,000m³ and 25,000m³

A second opportunity relates to the Shadow Arrangements for reservoirs between 10,000m³ and 25,000m³ that many owners are already putting in place to prepare for the lowering of the threshold when the Balmforth Review is implemented. One respondent to our call for evidence has described how their organisation intends to use this interim period to develop the capabilities of their panel engineers in the wider interests of the sector. Their suggestion is to encourage owners to register voluntarily their reservoirs between 10,000m³ and 25,000m³. In advance of formal designation, owners can make a judgement as to whether a reservoir is likely to be classified high risk or not high risk. If the owner considers a reservoir is likely to be classified as high risk then an experienced supervising engineer could be deployed to carry out a non-statutory Section 10 inspection (normally carried out by APREs) and trainee reservoir engineers could carry out non-statutory annual Section 12 inspections (normally carried out by supervising engineers). This will provide both cohorts with valuable experience to support their career progression. This model is predicated on owners accepting that they are likely to lose experienced supervising engineers to consultancy when they seek ARPE status but they would also have a cohort of experienced engineers well placed to replace them. In principle, engineering consultancies could also offer a similar service during the transition period.

Recommendation 2: Grow ARPE numbers in the short to medium term.

a) The Reservoirs Committee should develop better data on the potential pipeline of ARPEs and identify candidates for targeted support. Existing ARPEs considering retirement should be asked if they would be willing to mentor supervising engineers seeking to progress to the All Reservoirs Panel as a pilot for a wider scheme.
b) Defra and the devolved administration should commission the Reservoirs Committee, the ICE and BDS to deliver a pilot scheme to provide targeted support and mentoring to future ARPEs as part of efforts to mitigate the short-term pressure created by the implementation of the Balmforth Review.
c) The Reservoirs Committee should explore the offers made to the review by reservoir owners to open up their capital programme to engineers in other organisations seeking design and construction experience. The potential for scaling any initiative to a sector-wide scheme involving other owners should be assessed.
d) The Reservoirs Committee should invite the relevant owners to share their proposals to exploit Shadow Arrangements for reservoirs between 10,000m³ and 25,000m³ to grow the experience of prospective ARPEs and supervising engineers. The potential for scaling to an industry-wide initiative should be assessed.

5.3 Reforming the Panel structure

Ideas for reforming the current Panel structure and in particular the introduction of an intermediate Panel between the supervising engineers Panel and the All Reservoirs Panel have been under discussion in the sector for many years. In response to this lengthy debate, the Balmforth Review (p83) set out a case for change:

> As the risk posed by reservoirs varies considerably across the range of reservoirs, it is arguable whether the attributes needed for inspection or supervision of reservoirs should be the same across the whole of that range. Indeed, since many supervising engineers are very experienced, there is an argument for considering the progression through to inspecting engineer and then to construction engineer in a number of stages rather than the current leap.

The responses to our call for evidence revealed significant (but not universal) support for bringing forward changes to the Panel structure. A range of different models was proposed, including the inspecting engineer Panel described by Professor Balmforth alongside other options based on combinations of the type of reservoir, its height or volume, and the consequence of failure.

The role of an interim Panel in encouraging engineers to progress beyond supervising engineer

Our survey of the future intentions of supervising engineers suggests that reform to the Panel structure can also have a positive impact on increasing the number of future ARPEs (or any renamed higher Panel or Panels).

We asked respondents which of a list of actions would be most likely to encourage them to seek progression beyond the supervising engineers Panel. The results are summarised in table 2 below.

Table 2: Survey of supervising engineers to the question: "Which if any of the following actions would encourage you to apply to the All Reservoirs Panel (tick all that apply)?"

Action	Would encourage me to apply to the All Reservoirs Panel
An Intermediate Panel that reduced the size of the jump from the supervising engineers Panel to the All Reservoirs Panel	57%
A clearer, structured pathway to help you move from supervising engineer to ARPE	46%
Greater access to design and construction experience	33%

Action	Would encourage me to apply to the All Reservoirs Panel
Other	29%
Greater access to training and mentoring	20%

A similar survey of supervising engineers conducted by the Reservoirs Committee in 2016 also suggested that an intermediate panel would be the intervention with the greatest impact on progression.

Aligning any new Panel(s) to a reformed risk/hazard classification for high-risk reservoirs

There is a strong dependency between any move to introduce new Panels and Defra's planned reform of the risk/hazard classifications for high-risk reservoirs. Professor Balmforth has proposed subdividing high-risk reservoirs into three classes, with greater requirements for panel engineer involvement in the management of assets in the two higher-risk classes. There is a compelling logic to align any new Panels to this reformed risk categorisation which can then also form the backbone of a structured career pathway and support training and development (see recommendation 4).

The Reservoirs Committee will need to advise ministers on how the Panel structure should be reformed. Preparatory work to align this activity with Defra's work on risk classification can begin now. The committee should begin to work through the issues that have been raised during previous discussions of reform to the Panel structure; these include the level of construction experience required for different panels and any constraints or risk mitigation measures that should be placed on members of an interim Panel, for example probationary periods or some form of light-touch check by an ARPE. The committee could also usefully consider more radical proposals such as allowing members of any Panel aligned to the lower or lowest classes of the new tripartite risk classification to inspect their employers' reservoirs. This would create a stepping stone for a supervising engineer working for an owner who wishes to progress but at that stage of their career does not wish to move to a consultancy business.

Service Reservoirs Panel and Non-Impounding Reservoirs Panel

The Reservoirs Committee can also take this opportunity to review the future of the Service Reservoirs Panel and Non-Impounding Reservoirs Panel which currently have three and one members respectively. The committee may conclude that these Panels do not serve a useful function. We do, however, urge the committee to consider if these Panels may have an underexploited role as potential pathways into the sector for structural and geotechnical engineers and could thus form part of a plan to promote reservoir engineering careers to a broad and diverse audience (see recommendation 6).

Recommendation 3: Reform the Panel structure to align it to any new risk/hazard classification for UK reservoirs and create a stepping stone between the supervising engineers Panel and All Reservoirs Panel.

a) The Reservoirs Committee should initiate a project to allow a reformed Panel Structure to be created in parallel with Defra's work on a new risk/hazard classification for high-risk reservoirs.
b) Defra and the devolved administrations should commission the Reservoirs Committee to review the future of the Service Reservoirs Panel and the Non-Impounding Reservoirs Panel, including their potential to support promotion of reservoir engineering careers to structural and geotechnical engineers.

5.4 Enhancing support for training and development

A structured career pathway

A reformed Panel structure aligned to a new risk classification for high-risk reservoirs can form the basis for a more structured career pathway for panel engineers. The need for such a pathway was a recurring theme in the responses to our call for evidence and our survey of supervising engineers (see table 2 above).

The benefits of a pathway have been described to us in several ways.

Several experienced supervising engineers told us that they feel that the only means they currently have to assess their readiness for progression to the All Reservoirs Panel is to submit an application and sit an interview. Others, while welcoming the Reservoirs Committee's definition of panel engineer attributes, called for further guidance to provide "greater understanding of the journey to ARPE and not just the end point". This difficulty in assessing progress appears to us to be a particular problem for engineers working in consultancies who do not employ an ARPE and thus find it harder to access mentoring and advice.

Other contributors have suggested that a career pathway could be designed to increase the understanding among young engineers and engineers in adjacent sectors of how to access and progress a career as a panel engineer.

We believe that, if combined with a reformed Panel structure, a career pathway can support these goals and help to tackle any impression that the Reservoir Engineering sector is somewhat closed and inflexible. Pathways should demonstrate how to enter the sector at different stages of a career and from a variety of backgrounds. They should also break down the action required to progress into more manageable and measurable steps. Communications around the pathway can also stress how panel engineering can be combined with other technical and leadership activities to create a varied and rewarding career.

Progressive assurance or interim peer review

Contributors to the review suggested that these benefits could be heightened by introducing some form of progressive assurance of an engineer's acquisition of the attributes required for membership of the supervising engineers Panel or All Reservoirs Panel. These contributors argued that the current system, in which an application form and an interview with existing panel engineers is used to determine entry to the Panel, is too all or nothing and is not an effective way of assessing knowledge, skills and experience gained over many years. A progressive assurance approach would reduce but not eliminate the importance of the interview by introducing a modular system that allowed engineers to bank their acquisition of attributes over a period of years. Contributors also argued that this approach can contribute to improving the sector's diversity, for example by providing more flexibility for engineers who take career breaks.

The idea of a pathway, matched with progressive assurance of progress, has similarities with the system of Initial Professional Development operated by the ICE and other professional institutions in which a mentor (in the ICE's case called a Supervising Civil Engineer) is assigned to support an engineer working towards chartered status. This is very time and resource intensive, and a lighter-touch approach could be to create a system of intermediate peer review to provide engineers with a periodic check on their progress and advice on their next steps.

Reducing the reliance on pro-bono contributions to support the training and development of future panel engineers

Progressive assurance is, however, one of several proposals in this review that would place further pressure on panel engineers and particularly the Reservoirs Committee to provide support to the sector on a pro-bono basis.

In his review (p34), Professor Balmforth noted, "It should be remembered that much of the time spent on assessing the competence of reservoir engineers, writing guidance and producing articles and papers is done on a pro bono basis, perhaps more than in other sectors. This may prove to be unsustainable in the future at current levels."

This conclusion was echoed repeatedly by contributors to this review. It is not in the interests of reservoir safety to drift into a situation where panel engineers are unable or unwilling to carry out roles vital to the functioning of the current system and it would be wise for government to take the opportunity of the implementation of the Balmforth Review to work with the panel engineer community to find a solution acceptable to all sides.

Training courses

The role of formal training courses in the development of supervising engineers and ARPEs can be overstated. Many of the attributes required, particularly for ARPEs, need to be acquired through practice and experience.

It is therefore not altogether surprising that our survey of supervising engineers shows that greater access to formal training is a priority for only 20% of respondents seeking to progress to ARPE.

This does not, however, mean that formal training has no role in a rounded learning and development package for panel engineers. Several responses to the call for evidence observed that while several commercial providers deliver training to prospective supervising engineers, there is no similar support for supervising engineers seeking to progress to ARPE. These responses suggested that training would be particularly valuable for potential ARPEs currently working for smaller consultancies who, as discussed above, can struggle to access the support and mentoring of existing ARPEs. Responses also suggested that the most valuable content to be covered by a formal training course would be the legal and regulatory basis of the three elements of the ARPE role (inspecting engineer, construction engineer and Qualified Civil Engineer) and training to develop the core skills of producing and communicating clear, actionable and well-justified recommendations for owners.

The small numbers of potential ARPEs mean that such a course is unlikely to be attractive as a commercial offering for either a university or a commercial training provider. Defra, working with the devolved administrations, will therefore have to collaborate with sector stakeholders to develop a sustainable funding model. ICE has a well-established and respected training function and, in consultation with the British Dam Society, should be asked to develop a proposal for a training course to support potential ARPEs. It may also be possible to design this course to appeal to a wider cohort of professionals in the reservoirs sector, including overseas engineers seeking to work in the UK. This could reduce, if not eliminate, the need for further support.

Sharing the cost of training and development

More broadly, the cost of training and development of future panel engineers available to the open market currently falls largely on consultancy businesses.

The review has been told by several consultancies that the upfront cost of training a supervising engineer is circa £10,000–15,000, with a similar cost again to support an engineer up to membership of the All Reservoirs Panel. This is set against relatively low fees for much of the work delivered (see recommendation 5). One consultant calculated that it will typically take 133 commissions, probably over a decade or more, to recoup the investment in supervising engineer training, although if the engineer is ultimately able to proceed to ARPE they will become more valuable to the business.

Consultants do benefit commercially from developing panel engineers but these benefits are shared by regulators, owners and ultimately the public. The cost of training is not the most significant element of the challenging commercial environment facing consultancy businesses but has the potential to undermine business leaders' enthusiasm for continued investment in panel engineers at a time when the UK needs to increase their numbers. Sharing some of the financial burden of training may also help reduce the advantage that larger players with more resources currently have in the market. This could help medium-sized consultancies bring through more ARPEs.

Co-ordinating training and development effort

Finally, the Balmforth Review recommended that the Environment Agency should work with owners and panel engineers to help them grow capability and foster continuous improvement. We understand the Agency is currently creating a Standards team to be led by an in-house ARPE whose role will include delivering targeted training and support to owners and panel engineers. There is an obvious opportunity for this activity to be co-ordinated with the long-standing training and development role of the ICE, the British Dam Society and other trade and professional bodies active in the sector.

Recommendation 4: Deliver a step change in the Learning and Development support available to panel engineers.

a) The Reservoirs Committee, the ICE and BDS should lead the scoping and development of a structured career development pathway that supports:
   - a smoother transition from the supervising engineers Panel to the All Reservoirs Panel
   - entry to the reservoirs sector for non-UK engineers
   - entry to the reservoirs sector from adjacent areas of civil engineering

   This work should engage the Environment Agency (in its new role of providing training and development support to panel engineers and owners) and other trade and professional bodies relevant to the sector, including the Chartered Institution of Water and Environmental Management, the Institution of Structural Engineers and the British Geotechnical Society.
b) The Reservoirs Committee and the ICE should assess the feasibility of a progressive assurance system, allowing prospective supervising engineers and ARPEs to demonstrate their achievement of the necessary attributes over an extended period of time.
c) Defra and the devolved administrations should commission the ICE to develop a proposal for a training course to support supervising engineers seeking to advance to the All Reservoirs Panel. In parallel, Defra and the regulators should consider appropriate funding arrangements for the creation and delivery of the course as a contribution to the public good of reservoir safety.
d) Defra and the devolved administrations should convene a stakeholder working group to review the wider financial model for training and development of panel engineers covering:
   - burden-sharing between businesses, government, owners and regulators
   - reducing reliance on pro-bono contributions from the Reservoirs Committee and other panel engineers.

5.5 Improve the commercial environment for consultancy businesses and reservoir owners

Understanding the commercial proposition from both sides

The review has found a widespread (though not universal) view among consultancy businesses and independent panel engineers that current low fee levels form a significant barrier to achieving a more sustainable supply of panel engineers. This is a very important

challenge as the current regime will not be sustainable unless commercial organisations feel they are able to command fees that cover salaries, overheads, Professional Indemnity Insurance and the cost of training and development of panel engineers, while still making an acceptable level of profit.

The commercial environment is also important for reservoir owners, who must be able to procure panel engineer services at a cost that is manageable for their organisation. The size and financial capacity of reservoir owners varies considerably, ranging from large utility companies through to small farmers, angling clubs and individual property owners with a reservoir in their grounds.

Consultancies large and small paint a mixed picture of owner behaviour in relation to fees. Some owners are reported to recognise the value of high-quality panel engineer work and are willing to see fees rise. As an example, one large owner reported in their submission to the review that they have been willing to see a 30% rise in fees for their Section 10 inspections from ARPEs. Other owners are, however, reported to be encouraging a race to the bottom on fees, showing no interest in doing more than the minimum required to achieve compliance with legislation and regulation.

Fees are, however, only one part of an overall commercial proposition. Consultancies need to consider a range of issues, including risk allocation, limits of liability, cost of Professional Indemnity Insurance, payment risk, size of assignment and opportunities for follow-up work. Larger consultancies also report that they face significant internal costs to begin servicing a new client. As an example, one major consultancy reported that any new commission below £25,000 is subject to additional commercial scrutiny and is often not approved. This, in principle, creates opportunities for smaller consultancies with lower overheads but, as discussed above (see section 4.2), ARPEs are currently heavily concentrated in a small number of larger businesses.

The evidence we have gathered suggests very strongly that smaller and less well-resourced owners face greater difficulties in putting together attractive propositions than large utility businesses. Several submissions from bodies representing smaller owners warn that some of their members are already struggling to access both ARPEs and supervising engineers. Submissions from a number of smaller owners also stated that they do not always see the value to them of the reports they receive from panel engineers and that they would struggle to pay higher fees while also maintaining a viable business.

Establishing best practice for the procurement of panel engineer services

This discussion suggests to us that there would be value in codifying and promoting best practice for the procurement of panel engineer services. The ICE has a long history of supporting best procurement practice for the construction industry and already publishes other key guidance used in the sector, such as its Guide to the Reservoirs Act 1975. It would be well placed to scope and produce procurement guidance that establishes best practice for the engagement of panel engineers. This initiative could extend to creating standard conditions of contract for use in the sector. Defra, regulators, owners and consultancy businesses should all be consulted on the content. The Environment Agency, in its

expanded role supporting owners to embrace best practice in the management of their reservoirs, should consider if and how this could extend to promoting best practice in the procurement of panel engineers.

Pooling the resources of smaller owners

Larger owners told the review that they are currently able to secure the panel engineers they need without significant difficulty, although a number expressed concern about the capacity of the market during the implementation of the Balmforth Review. As discussed above, large owners are increasingly using frameworks or other long-term arrangements to secure access to panel engineers.

Bodies representing smaller owners have told this review that they would be open to the idea of exploring with their members the principle of pooling demand to create similar frameworks or other ways of creating programmes of work and/or using a standard set of terms and conditions.

Larger consultancy firms have told this review that in principle this would help overcome some of the commercial barriers they face in accepting commissions from smaller owners. Care will, however, need to be taken to ensure that any such initiative does not exclude smaller consultancies or independent panel engineers from accessing this work. We understand that requirements such as higher Professional Indemnity Insurance levels, previous experience with the client's assets and a wide geographical spread of offices, have tended to shut smaller consultancies out of some frameworks, further entrenching the advantage of larger players.

Professional Indemnity Insurance

Consultancies large and small, as well as independent panel engineers, report that the cost of securing Professional Indemnity Insurance (PII) has risen very significantly in recent years, with some reporting increases of over 100%. One small or medium enterprise told us that PII is now equivalent to nearly 10% of their turnover.

The issue of rising PII premiums goes beyond Panel engineering and the wider water and flood management sector. Discussion with senior ICE members suggests these increases in premiums are a construction industry wide trend. This is a view reinforced by a number of panel engineers who report being told by their insurers that the Grenfell Tower tragedy is affecting the insurance industry's appetite for taking on risks across the built environment as a whole.

Our discussions with Defra suggest that there is an opportunity for the sector to engage collectively with the insurance industry to identify any opportunities to tackle rising PII premiums. Areas to explore could include the benefits delivered by the government's active role in the safety regime, the positive impact of the implementation of the Balmforth Review on reservoir safety and the identification of data that may allow the hazards posed by dams to be assessed separately from those posed by the wider civil engineering and construction sector.

If this approach is not fruitful and insurance premiums rise to the point where they significantly constrain the supply of panel engineers and their ability to service owners, government may need to consider some form of centralised, collective insurance, similar to arrangements in the National Health Service.

An Independent Reservoir Inspectorate

In our call for evidence, we canvased opinion on the radical option of creating an Independent Reservoir Inspectorate that would deliver Section 10 inspections and potentially other elements of the ARPE role. Different options would be available for the design of such a body, which could include engineers continuing to be employed by consultancy businesses but delivering the inspecting engineer role through an inspectorate that set standard fees and conditions.

Our consultation exercise did reveal some limited support for this option. The suggested potential benefits for the supply of panel engineers include:

- increased margin (or at least certainty on fees) for consultancy businesses, incentivising investment in training and development
- easier access to panel engineers for smaller owners.

Other benefits include:

- enhanced independence (though this was challenged in relation to ARPEs working through the inspectorate and carrying out inspections on public sector assets)
- opportunity to improve training and development
- opportunity to drive quality and consistency.
- opportunity to encapsulate the roles currently being undertaken by the ICE Reservoirs Committee and the Reservoir Safety Research Advisory Group, providing these functions through professionally run services rather than relying on the goodwill of groups of volunteers. These were offset by significant disadvantages, including:
- the high level of disruption involved in transitioning to the new model, set against uncertain outcomes
- potential for owners to face increased costs and bureaucracy
- complex and potentially fractious relationships between the inspectorate and consultancy businesses
- difficulties relating to the construction engineer and Qualified Civil Engineer roles
- a heightened risk of a regulator appointing an engineer with less experience of the owner's dam type, leading to a reduction in the value of their recommendations. One contributor argued that while in principle an APRE is competent to inspect all dams, in practice "there is no point appointing a Pennine dam specialist for a 72m-high concrete buttress dam"

In his response to our call for evidence, Professor Balmforth also expanded on his reasons for rejecting this option in his review. He explained that in his view an independent inspectorate would work against the fundamental principle that those responsible for creating a risk should also be responsible for its management. He added that where an independent inspectorate exists (as in the nuclear sector) the work of inspecting engineers is very often duplicated by a responsible owner.

He had therefore concluded that at best a separate reservoir inspectorate would tend to increase bureaucracy and costs and at worst undermine safety by allowing owners to abdicate some of their responsibility. In line with other contributors, he did, however, acknowledge that an independent inspectorate may provide the opportunity to better support the development of panel engineers and, by extension, their supply but argued that there are other ways of achieving this.

Based on the above, our conclusion is that the case has not been made for such a radical and disruptive move in the short term. There may, however, be value in Defra building the contingency to take such a radical step into the modernised legal framework it will need to bring forward as part of the implementation of the Balmforth Review. Our review has identified high levels of uncertainty and a need for an iterative approach to solving the problem of the supply of panel engineers. In these circumstances it would be unwise to take long-term options off the table.

The discussion generated by this proposal can also inform action to improve the commercial environment for reservoir owners and consultancy businesses. Contributors rejected the idea of fixed fees because of the very wide diversity of UK dams and reservoirs and the different demands they generate. They did, however, acknowledge the potential value of setting expectations for minimum panel engineer inputs for different types or categories of dams, both in terms of quality of work and ensuring fees reflect the level of risk. The ICE should consider this issue in any best practice guidance for the procurement of panel engineers.

Recommendation 5: Improve the commercial environment in which panel engineer services are delivered.

a) The ICE should create best practice guidance on the procurement of panel engineer services and review the case for creating a new standard contract.
b) The Environment Agency should review if and how its new role in promoting best practice among panel engineers and asset owners can be used to improve procurement practice among owners.
c) The ICE should convene a stakeholder task and finish group to remove barriers to smaller owners accessing panel engineer services. This should include the creation of frameworks or other ways for smaller owners to pool their demand and resources.
d) Defra should facilitate a dialogue between reservoir sector stakeholders and the insurance industry with a view to identifying opportunities to reduce or slow the rise of Professional Indemnity Insurance premiums.
e) Defra should, as a contingency measure, consider including the capacity to introduce an independent inspectorate into the revised legal framework it will need to introduce to implement the Balmforth Review recommendations.

5.6 Promoting panel engineer careers to a wide and diverse audience

We believe that to achieve a sustainable supply of panel engineers over the longer term, the reservoir sector needs to deepen the pool of professionals from which it recruits. This task can be broken down into four parts.

First, it should be easier for professionals in adjacent areas of engineering, with relevant skills and experience, to become panel engineers. As previously discussed, the Service Reservoirs Panel and the Non-Impounding Reservoirs Panel may be useful tools to attract structural and geotechnical engineers. The ICE, BDS and the Reservoirs Committee could usefully engage with representative bodies such as the Institution of Structural Engineers and the British Geotechnical Association to gain a greater understanding of what other actions are needed to encourage their members to pursue membership of these Panels. This engagement exercise could be extended to other representative bodies active in the sector, which should certainly include the Chartered Institution of Water and Environmental Management (CIWEM).

Second, barriers to overseas engineers, with relevant skills and experience, achieving Panel membership should be identified and removed. This is a subject the review would have liked to investigate further but the limited work we have carried out suggests this is a missed opportunity. Existing panel engineers who have worked extensively overseas report that this experience was not valued highly at their interview for Panel membership. We are aware that the Reservoirs Committee has sought to address this issue in recent years with new guidance, but this is a message that could usefully be reinforced. We understand that the explanation given to applicants for not giving weight to their experience in other countries is that this work was not carried out under UK legislation and regulation. If this is true, it strengthens the case for investing in formal training that covers the legislative and regulatory basis of the UK regime(s), which could then be extended to potential entrants to the UK market.

Third, any new programme of reservoir construction provides a platform for promoting the long-term career opportunities presented by the sector. Defra, OFWAT, water companies and consultancy partners should all collaborate to promote these opportunities to potential recruits of all ages. This could include considering more radical options, such as including the cost of panel engineer training and development in water companies' Regulated Asset Base or public sector part-sponsorship of individual panel engineers.

Fourth, only 2 of the 33 members of the All Reservoirs Panel are female. The corresponding figure for the supervising engineers Panel is 13 out 134. This is clearly a very low level of diversity even by the standards of UK engineering and construction. Data relating to other protected characteristics is not available but we have been told that the sector is overwhelmingly white. This is an obvious missed opportunity for a sector suffering from long-term recruitment challenges.

Our call for evidence did identify some positive signs; one major consultant reported that on its internal training scheme for supervising engineers, 27% of the candidates are female. Similarly, in recent years the British Dam Society has had a female Chair and female Chair of its Young Professionals group, providing greater visibility of women working in the sector.

Other recommendations in this review may help address these disparities. As an example, introducing an intermediate panel, developing career pathways and introducing progressive assurance of attributes would create opportunity to promote the sector to professionals

seeking greater flexibility because of personal commitments or who have taken career breaks.

We do, however, believe that more could and should be done. A starting point would be to review existing diversity initiatives being pursued by sector stakeholders and the wider engineering sector. This may reveal opportunities to consolidate activity to improve its impact.

Recommendation 6: Promote panel engineer careers to a wide and diverse range of audiences.

a) The ICE and the Reservoirs Committee should engage with the British Geotechnical Association, the Institution of Structural Engineers, the Chartered Institution of Water and Environmental Management and other relevant bodies, to inform a plan that will support engineers in adjacent sectors to pursue membership of the Panels.
b) The Reservoirs Committee should review whether more weight could be given to overseas experience and issue new guidance as appropriate.
c) Defra, the ICE, BDS, the devolved administrations, OFWAT, water companies and consultancy businesses should develop a shared plan to exploit the opportunities for increasing the supply of panel engineers created by the likely increase in water supply reservoir projects over the next decade. This should include engaging with universities to identify opportunities for increasing research and teaching on dams and reservoirs.
d) The ICE, BDS and the Reservoirs Committee should review existing diversity initiatives and identify opportunities to fill any gaps or consolidate activity to improve their impact.

Annex A: terms of reference

Purpose

To develop proposals to secure the long-term supply of suitability qualified and experienced engineers to join official reservoir safety engineer panels, enabling them to carry out construction engineer, inspecting engineer and supervising engineer roles in the UK.

To develop proposals for increasing the number of engineers on reservoir engineer panels in the short to medium term over the next five years.

To consider the retention of reservoir engineers within the sector, whether they are working for civil engineering companies or other employers, or as self-employed engineers.

Description

This project is to help shape and inform the response to recommendations made by the Independent Reservoir Safety Review concerning the future supply and professional development of engineers. In particular, it aims to ensure the sustainability of sufficient suitably qualified engineers to carry out the inspecting engineer and construction engineer roles and duties. This project will focus on the following recommendations made from the Balmforth Review: recommendations 7, 8(a), 8(b). Note that 8(a) is included in case of links and dependencies but work for 8(a) will be taken forward separately.

Scope

The aim is to consider the attractiveness of a reservoir engineer specialism, including for individuals and the commercial market, and identify measures that could be taken to improve and promote this specialism within civil engineering, and with new entrants into civil engineering. In particular to:

- define and understand the causes of incentives and disincentives for professional engineers and firms to undertake reservoir inspections as official panel engineers
- compare incentives and disincentives in the reservoirs sector to an adjacent sector/s with successful incentivisation
- identify the solutions to create positive incentives to ensure a healthy future supply of Supervising, Inspecting and construction engineers
- identify transferable knowledge, skills, experience and training that would enable engineers to move into reservoir engineer roles from other sectors
- identify ways in which universities, employers and the ICE could help develop the knowledge, skills and experience needed for engineers to enter the reservoir engineer specialism
- identify training and professional development to enable reservoir supervising engineers to become Inspecting and construction engineers

In considering these matters, the following should be taken into account:

- the consultancy and professional services landscape in the civil engineering sector

- the distribution of work within members of the reservoir engineer panels
- the educational base and professional qualification processes for civil engineers
- ongoing professional development of civil engineers and the incentives to move between sectors
- best practice in other countries for managing reservoir engineers' professional development
- the influence of public policy and regulation on the reservoirs sector specifically and professional services in general, and that the regulatory regimes for UK Administrations are different though broadly consistent. Each administration should be consulted as part of the project.

Annex B: panel engineer demand assessment

MOTT MACDONALD

1. Purpose

Upcoming changes in regulation following the Toddbrook reservoir incident and the subsequent reservoir safety and legislation review by Professor David Balmforth may increase the demand for panel engineers (PE) considerably.[7] The changes include, among others, lowering the threshold in storage from 25,000m³ to 10,000m³ for the reservoirs to be potentially subject to safety inspections under the Reservoirs Act 1975 (the Act). This could disrupt the availability of PE to perform the necessary inspections and discharge other critical duties. In light of this, the assessment undertaken aims to estimate and quantify the future demand for both:

- all reservoirs panel engineers (ARPE) (taken to include all inspecting engineers for convenience), and
- supervising engineers (SE)

The review applies to reservoirs located in Great Britain although the extent to which the recommendations will be taken forward under the respective devolved governments is presently unknown

2. Output

The final output is an Excel spreadsheet containing all calculations, results and two charts displaying the estimated demand over time; one chart for ARPE and other for SE.

3. Methodology

3.1 Introduction

The methodology has been outlined in the following image and explained in more detail in the sections below. The displayed workflow has been applied to ARPE and SE. Additionally, given the nature of the regulatory changes, two separate analyses have been performed for short term and long-term timeframes. In this context we use short term and long term to differentiate between:

- an anticipated one-off spike in demand for PE caused by the need to carry out inspections and other activities for reservoirs brought under regulation for the first time

[7] Reservoir review: part B (2020) - GOV.UK (www.gov.uk)

- a permanent increase in PE workload following the completion of the implementation of the Balmforth Review recommendations

Methodology outline

1. Engage with PE to understand current workload
2. Estimate current workload in days per reservoir and year
3. Estimate current number and proportions of reservoirs requiring different inputs
4. Calculate total days per year = ∑(days from 2 x reservoirs from 3) and scale the value to a handy metric - number of SE full time equivalent
5. Review regulatory changes and establish three risk categories - High Risk, Medium Risk, Low Risk
6. Define parameters to scale the days calculated in 2 to account for workload increases after the regulatory changes based on the scenarios from 5
7. Calculate future demand using the parameters from 6. The proportions of reservoirs requiring inputs from 3 were considered but were applied to a larger number of reservoirs
8. Plot the results

3.2 Current demand estimation

This section refers to steps 1 to 4 of the methodology outline.

3.2.1 ARPE

The current demand (base demand) has been estimated following a calculation done independently by three different ARPE's. In this initial calculation, the different ARPE duties were broken down into the following categories:

- Inspection
- Qualified Civil Engineer (QCE) oversee remedial works
- construction engineer (CE) planning/design/construction
- CE post construction
- Discontinuance

The number of reservoirs requiring works per year were estimated, along with the number of days required per each of those reservoirs. Additionally, the proportions of reservoirs were calculated as a percentage of the total as shown in table 3.1. The demand only covers services directly relating to the Act and excludes the demand for ARPE services in UK reservoir planning studies, involvement in research, preparation of guidance, attendance on committees, etc.

Table 3.1: Current demand ARPE

Reservoirs Act Section	Activity	Number of reservoirs requiring input	Percentage of reservoirs requiring input	Inputs per reservoirs and years (days)	Percentage inputs breakdown	Total inputs required per year (days)
10 (1)	Inspection	250	8.6%	5.7	50%	1416.7
10 (6)	QCE oversee remedial works	125	4.3%	6.7	29%	833.3
6 & 7	CE planning/design/ construction	17	0.6%	25.0	15%	425.0
6 & 7	CE post construction	17	0.6%	2.2	1%	36.8
13	Discontinuance	10	0.3%	15.0	5%	150.0

The total days per year for ARPE's is 2861.8, or a total full time equivalent of 14.

The number of reservoirs requiring input and the days per reservoir considered in this model are the average of the values selected by the aforementioned three ARPE's. The total days per year were divided by 200 to obtain the number of ARPE full time equivalent, which is the number of necessary ARPE if they were to work full time on ARPE duties – most of the ARPE carry out many other tasks on a normal basis. This ARPE full time equivalent is deemed to be a useful metric to establish comparisons.

Supervising engineers (SE)

The estimation of the current SE workload was calculated by simply multiplying the number of reservoirs requiring inspection by the number of days each inspection requires. The number of days required was determined during discussions with several SE. The modelling assumed a total average input of 1.5 days per reservoir. No information was available on the number of reservoirs requiring more than one annual visit. It is believed that the great majority only require a minimum of one visit per year.

Table 3.2 Current demand for SE's

Reservoirs Act section	Activity	Number of reservoirs requiring input	Percentage of reservoirs requiring input	Inputs per reservoirs and years (days)	Percentage inputs breakdown	Total inputs required per year (days)
12	Inspections (including deliverables produced)	2892	100%	15	100%	4338.0

The total days per year for SEs is 4338, or a total full time equivalent of 22.

3.3 Review of changes. Establishing parameters and scenarios.

This section refers to step 5 within the methodology outline**Error! Reference source not found.**.

In order to understand the impact in the future demand of PE that the changes in legislation may cause, a number of sessions were organised between PEs and a member of the ICE to discuss the potential increase in workload.

It was agreed that, given the nature of the changes introduced and how the anticipated effects in the workload could vary over time, the assessment should differentiate between short term and long term to provide an adequate representation.

The final scenarios for future demand of ARPE and SE are set out below. The total number of reservoirs in the system after the changes come into effect is based on the numbers presented in the Balmforth Review (p20). The percentage of reservoirs removed from the 'high risk' category and the proportion of reservoirs classified into the different 'classes' (Class 1, 2 and 3) is also derived from the Balmforth Review (p78-79). In this case Professor Balmforth's assessment of the impact of different thresholds is based on Average Societal Loss of Life (ASLL). The rest of the parameters have been established through a series of discussions with panel engineers. It is anticipated that 'Class 3' reservoirs will require a similar amount of input as the current reservoirs under the current 'high risk' category, so for these no increase in workload is expected.

3.3.1 ARPE short term

The scenarios and parameters to estimate the short-term demand for ARPE are as follows:

<u>High Demand</u>

- Total number of reservoirs: 4000
- Reservoirs removed from 'high risk' category: 0%
- Class 1 reservoirs percentage: 10%
- Class 2 reservoirs percentage: 35%
- Class 3 reservoirs percentage: 55%
- Estimated remedial works workload increase due to measures in the interest of safety (MIOS): 200%
- Estimated workload increase in CE planning duties due to class and risk category classification: 40%
- Number of years throughout which the new safety documents (plans and maps) have to be produced for newly registered reservoirs: 1
- Number of days required to produce all safety documents (plans and maps) for an individual reservoir: 1.5
- Estimated workload increase due to more regular inspections and quantitative risk assessment for Class 1 reservoirs: 100%
- Estimated workload increase due to qualitative risk assessment for Class 2 reservoirs: 65%

- Number of years throughout which the new reservoirs will have the initial inspection: 1
- Number of days required to do the initial inspection for new reservoirs and produce necessary documents: 10
- Duration of short time projection – years to produce new safety documents (plans and maps) and initial inspections considered separately: 5

Medium Demand

- Total number of reservoirs: 4000
- Reservoirs removed from 'high risk' category: 25%
- Class 1 reservoirs percentage: 10%
- Class 2 reservoirs percentage: 35%
- Class 3 reservoirs percentage: 30%
- Estimated remedial works workload increase due to measures in the interest of safety (MIOS): 100%
- Estimated workload increase in CE planning duties due to class and risk category classification: 40%
- Number of years throughout which the new safety documents (plans and maps) have to be produced: 1
- Number of days required to produce all safety documents (plans and maps) for an individual reservoir: 1
- Estimated workload increase due to more regular inspections and quantitative risk assessment for Class 1 reservoirs: 100%
- Estimated workload increase due to qualitative risk assessment for Class 2 reservoirs: 65%
- Number of years throughout which the new reservoirs will have the initial inspection: 3
- Number of days required to do the initial inspection for new reservoirs and produce necessary documents: 8.5
- Duration of short time projection – years to produce new safety documents (plans and maps) and initial inspections considered separately: 5

Low Demand

- Total number of reservoirs: 4000
- Reservoirs removed from 'high risk' category: 32%
- Class 1 reservoirs percentage: 5%
- Class 2 reservoirs percentage: 18%
- Class 3 reservoirs percentage: 45%
- Estimated remedial works workload increase due to measures in the interest of safety (MIOS): 70%
- Estimated workload increase in CE planning duties due to class and risk category classification: 40%

- Number of years throughout which the new safety documents (plans and maps) have to be produced: 1
- Number of days required to produce all safety documents (plans and maps) for an individual reservoir: 0.75
- Estimated workload increase due to more regular inspections and quantitative risk assessment for Class 1 reservoirs: 75%
- Estimated workload increase due to qualitative risk assessment for Class 2 reservoirs: 50%
- Number of years throughout which the new reservoirs will have the initial inspection: 5
- Number of days required to do the initial inspection for new reservoirs and produce necessary documents: 7.5
- Duration of short time projection – years to produce new safety documents (plans and maps) and initial inspections considered separately: 5

3.3.2 ARPE long term

The scenarios and parameters to estimate the long-term demand for ARPE are as follows:

<u>High Demand</u>

- Total number of reservoirs: 4000
- Reservoirs removed from ‘high risk’ category: 0%
- Class 1 reservoirs percentage: 10%
- Class 2 reservoirs percentage: 35%
- Class 3 reservoirs percentage: 55%
- Estimated workload increase due to more regular inspections and quantitative risk assessment for Class 1 reservoirs: 100%
- Estimated workload increase due to qualitative risk assessment for Class 2 reservoirs: 65%

<u>Medium Demand</u>

- Total number of reservoirs: 4000
- Reservoirs removed from ‘high risk’ category: 25%
- Class 1 reservoirs percentage: 10%
- Class 2 reservoirs percentage: 35%
- Class 3 reservoirs percentage: 30%
- Estimated workload increase due to more regular inspections and quantitative risk assessment for Class 1 reservoirs: 100%
- Estimated workload increase due to qualitative risk assessment for Class 2 reservoirs: 65%

<u>Low Demand</u>

- Total number of reservoirs: 4000
- Reservoirs removed from ‘high risk’ category: 32%
- Class 1 reservoirs percentage: 5%

- Class 2 reservoirs percentage: 18%
- Class 3 reservoirs percentage: 45%
- Estimated workload increase due to more regular inspections and quantitative risk assessment for Class 1 reservoirs: 75%
- Estimated workload increase due to qualitative risk assessment for Class 2 reservoirs: 50%

3.3.3 SE short term

The scenarios and parameters to estimate the short-term demand for SE are as follows:

<u>High Demand</u>

- Total number of reservoirs: 4000
- Reservoirs removed from 'high risk' category: 0%
- Class 1 reservoirs percentage: 10%
- Class 2 reservoirs percentage: 35%
- Class 3 reservoirs percentage: 55%
- Estimated workload increase workload due to class and risk category classification: 10%
- Number of years throughout which the new safety documents (plans and maps) have to be produced: 1
- Number of days required to produce all safety documents (plans and maps) for an individual reservoir: 1.5
- Estimated workload increase due to more regular inspections and quantitative risk assessment for Class 1 reservoirs: 100% (it is conservatively assumed that the SE would be involved in the risk assessment)
- Estimated workload increase due to qualitative risk assessment for Class 2 reservoirs: 65% (assumption as above)
- Duration of short time projection – years to produce new safety documents (plans and maps) considered separately: 5

<u>Medium Demand</u>

- Total number of reservoirs: 4000
- Reservoirs removed from 'high risk' category: 25%
- Class 1 reservoirs percentage: 10%
- Class 2 reservoirs percentage: 35%
- Class 3 reservoirs percentage: 55%
- Estimated workload increase workload due to class and risk category classification: 5%
- Number of years throughout which the new safety documents (plans and maps) have to be produced: 1
- Number of days required to produce all safety documents (plans and maps) for an individual reservoir: 1.25
- Estimated workload increase due to more regular inspections and quantitative risk assessment for Class 1 reservoirs: 80%

- Estimated workload increase due to qualitative risk assessment for Class 2 reservoirs: 50%
- Duration of short time projection – years to produce new safety documents (plans and maps) considered separately: 5

Low Demand

- Total number of reservoirs: 4000
- Reservoirs removed from 'high risk' category: 32%
- Class 1 reservoirs percentage: 5%
- Class 2 reservoirs percentage: 18%
- Class 3 reservoirs percentage: 45%
- Estimated workload increase workload due to class and risk category classification: 0%
- Number of years throughout which the new safety documents (plans and maps) have to be produced: 1
- Number of days required to produce all safety documents (plans and maps) for an individual reservoir: 1
- Estimated workload increase due to more regular inspections and quantitative risk assessment for Class 1 reservoirs: 60%
- Estimated workload increase due to qualitative risk assessment for Class 2 reservoirs: 35%
- Duration of short time projection – years to produce new safety documents (plans and maps) considered separately: 5

3.3.4 SE long term

The scenarios and parameters to estimate the long-term demand for SE are as follows:

High Demand

- Total number of reservoirs: 4000
- Reservoirs removed from 'high risk' category: 0%
- Class 1 reservoirs percentage: 10%
- Class 2 reservoirs percentage: 35%
- Class 3 reservoirs percentage: 55%
- Estimated workload increase due to more regular inspections and quantitative risk assessment for Class 1 reservoirs: 100%
- Estimated workload increase due to qualitative risk assessment for Class 2 reservoirs: 65%

Medium Demand

- Total number of reservoirs: 4000
- Reservoirs removed from 'high risk' category: 25%

- Class 1 reservoirs percentage: 10%
- Class 2 reservoirs percentage: 35%
- Class 3 reservoirs percentage: 55%
- Estimated workload increase due to more regular inspections and quantitative risk assessment for Class 1 reservoirs: 80%
- Estimated workload increase due to qualitative risk assessment for Class 2 reservoirs: 50%

Low Demand

- Total number of reservoirs: 4000
- Reservoirs removed from 'high risk' category: 32%
- Class 1 reservoirs percentage: 5%
- Class 2 reservoirs percentage: 18%
- Class 3 reservoirs percentage: 45%
- Estimated workload increase due to more regular inspections and quantitative risk assessment for Class 1 reservoirs: 60%
- Estimated workload increase due to qualitative risk assessment for Class 2 reservoirs: 35%

3.4 Future demand calculation

This section refers to steps 6 to 8 in **Error! Reference source not found.**.

In order to calculate the demand for SE, the multi-step process below has been carried out. The scenarios above and the short term–long term split have been considered. The description in this section takes into account only the cases in which all parameters apply. When the parameters do not apply, they equal 0 in the formulas below.

The basic equation to calculate the future demand is:

$$\text{input}_{\text{activity}} = (\text{number of reservoirs} \times \text{days required as per current demand} \times \text{P1}) + \text{P2}$$

This equation has been applied to the different activities and the results added. Subsequently, the final figure was divided by 200 to obtain the full time equivalent.

1. The number of reservoirs requiring input were calculated using the same task proportions as per the current demand but multiplying them by the total number of reservoirs in the system after the regulatory changes.
2. The parameter P1 has been used when it was deemed difficult to estimate the increase in number of days directly.
   For instance, the parameter to express the additional workload as a percentage due to MIOS was considered to be 200% for the High Demand scenario of the short term demand for ARPE services. P1 is calculated in this case as follows:

$$\text{P1} = 1 + \frac{200\%}{100} = 1 + 2 = 3$$

The following table 3.4.1 and 3.4.2 shows how all P1 parameters were calculated:

Table 3.4.1: P1 parameters.

Activity	P1 parameters
Inspection	1+ (Workload increase for Class 1 reservoirs X Percentage Class 1 reservoirs) + (Workload increase for Class 2 reservoirs X Percentage Class 2 reservoirs)
QCE oversee remedial works	1+ Estimated remedial workload increase due to measures in the interest of safety (MIOS)
CE planning/design	1 + Estimated workload increase in planning duties due to class and risk category classification
CE post construction	Same workload per reservoir as before changes -i.e., P1 = 1
Discontinuance	Same workload per reservoir as before changes -i.e., P1 = 1

The parameters for the activities ‘Inspection’, ‘QCE oversee remedial works’ and ‘CE planning/design’ stem from the scenarios established in section 3.

3. The P2 parameters were used when a direct increase in number of days per year required could be estimated. Table 3.4.2 sets out how they were calculated.

Table 3.4.2: P2 parameters

Activity	P2 parameters
Inspection	(Number of new reservoirs X days required per inspection) / Number of years throughout which the new reservoirs will have the initial inspection
QCE oversee remedial works	No increase i.e., P2=0
CE planning/design/ construction	(Number of new reservoirs X days required to produce safety documents plans and maps) / Number of years throughout which the new safety documents plans and maps have to be produced
CE post construction	No increase i.e., P2 = 0
Discontinuance	No increase i.e., P2 = 0

The number of new reservoirs were calculated by subtracting the estimated number of reservoirs after the changes in regulation requiring inspections and the current number of reservoirs in the system.

The parameters for the activites ‘Inspection’ and ‘CE planning/design/ construction’ stem from the scenarios established in section 3.

4. Once the workload was calculated for each activity and scenario and the results scaled to full time equivalent, the visualisations were produced[8].

[8] Important note: if the parameters are changed, the visualisations may not update correctly automatically, especially if the number of years required to carry out the initial inspections or to produce the safety documents (plans and maps) are changed. It is recommended to review the model and update the formulas, so the plots update automatically in every case.

4. Results

The results are displayed graphically in figures 4.1 and 4.2

Figure 4.1: All Reservoir panel engineer (ARPE) demand plot.

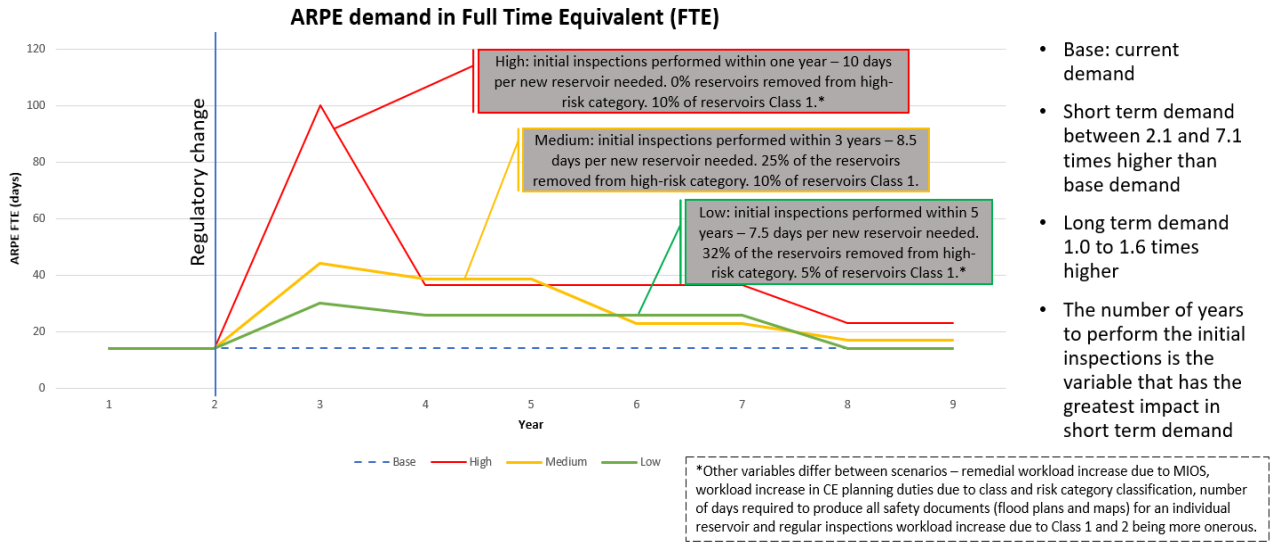
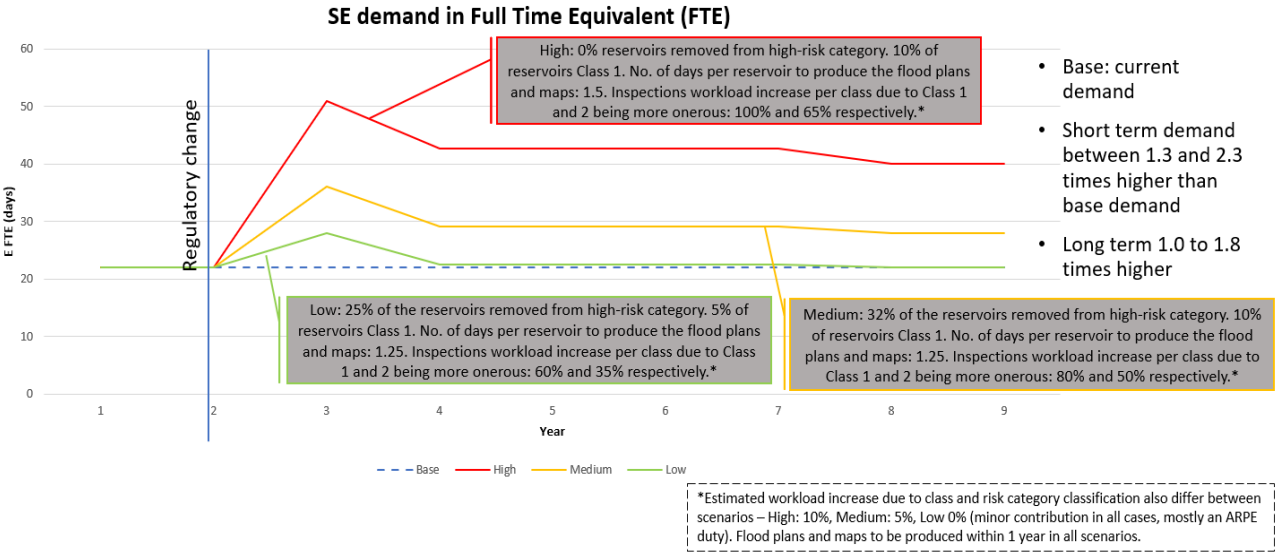


Figure 4.2: supervising engineer (SE) demand plot.



5. Caveats and recommendations

The current estimation and the parameters used to calculate the future demand for SE are based on a large number of assumptions. These assumptions are in turn based on discussions with a small group of SE (8 members) in order to understand all variables considered. The data and parameters could be therefore considerably biased; the results are subject to great uncertainty.

In light of this, it is strongly recommended that before the regulatory changes are implemented further liaison with panel engineers and other stakeholders is carried out and the model produced reviewed in full. Inevitably the result will change according to details around how the recommendations are implemented I the legislation and indeed the model may be used to inform the impact of regulatory change on panel engineer demand.

The short-term effects can be especially abrupt, disrupting and acute; a smoother transition may be achieved by, for instance, allowing for a period of several years to carry out the initial inspections for the new reservoirs entering the system.

Annex C: survey of panel engineer career plans

Future numbers of All Reservoirs panel engineers

The Balmforth Review expressed particular concern about the adequacy of the future supply of ARPEs, a view that was reinforced by responses to our call for evidence.

In August 2022, we carried out a short survey of the career plans of members of the All Reservoirs Panel and the supervising engineers Panel. At present, all successful candidates for membership of the All Reservoirs Panel move up from the lower panel.

We received responses from

- 21 (65%) of the 33 members of the All Reservoirs Panel
- 83 (62%) of the 134 members of the supervising engineers Panel

Assuming the responses received are representative, we expect the number of ARPEs in 2027 to be very close to the current figure of 33.

Future plans of panel engineers

With regard to the career plans of panel engineers, the headline findings were:

- Seven (33%) of the All Reservoirs Panel members who replied to the survey indicated they intend to step down within the next five years.
- Nine (11%) of the supervising engineers Panel members who replied to the survey indicated they intend to apply for membership of the All Reservoirs Panel within the next five years

On a simple pro-rata basis, this means:

- Circa 11 members of the All Reservoirs Panel can be expected to step down within the next five years.
- Circa 15 members of the supervising engineers Panel can be expected to apply for membership of the All Reservoirs Panel within the next five years.
- Circa 10 applications will be successful (if the 2021 interview pass rate of 67% is maintained)

These survey results should be treated cautiously. The results draw on a small sample at one moment in time. Nevertheless, they are a useful indication of the direction of travel and indicate that total ARPE numbers are likely to stagnate over the coming five years.

Other survey questions

We also asked panel engineers a series of other questions that have informed the review's conclusions and recommendations. These results are presented below:

All Reservoirs panel engineers

(i) If you intend to step down from the All Reservoirs Panel, what are your reasons (tick all that apply)?

Response	Percentage of Respondents
Other/not applicable as I do not plan to step down	66%
My current appointment will expire and I do not plan to reapply	33%
I plan to retire	27%
Recent or planned changes have made the role less attractive	13%
Rising Professional Indemnity Insurance premiums	13%
My employer has a declining interest in offering panel engineer services	7%
Other/not applicable	0%
None of the above	0%

(ii) Is there a succession plan for ARPEs in your organisation?

Response	Percentage of Respondents
Yes	70%
No	15%
Not applicable – I am an independent panel engineer	15%

(iii) If you plan to step down, is there anything that can be done to make you reconsider?

Response	Percentage
Yes	7%

Response	Percentage
No	60%
Not applicable	33%

supervising engineers

(i) If you do not intend to apply for the All Reservoirs Panel in the next five years, why not (tick all that apply)?

Response	Percentage of Respondents
I work for a reservoir owner and do not want to change employer	44%
I need further qualifications and experience	38%
The role is not attractive to me	21%
My employer is not supportive	2%

(ii) Which if any of the following actions would encourage you to apply to the All Reservoirs Panel (tick all that apply)?

Response	Percentage of Respondents
An Intermediate Panel that reduced the size of the jump from the supervising engineers Panel to the All Reservoirs Panel	57%
A clearer, structured pathway to help you move from supervising engineer to ARPE	46%
Greater access to design and construction experience	33%
Other	29%

Response	Percentage of Respondents
Greater access to training and mentoring	20%

Annex D: list of contributors to the review

- Andrew Crudgington is the principal author of this report.
- The review was project-managed by Brendan Van Rooyen.
- The review team would like to thank the following who acted as a review group for our conclusions and recommendations:
- Richard Coakley, Chair of the ICE Reservoirs Committee
- David Littlemore, Chair of the British Dam Society/Stillwater Associates
- Alan Warren, Technical Director, Mott MacDonald

We would also like to thank the newly formed panel engineer sub-committee of the ICE Reservoir Committee who have been extremely generous with their time and input. The sub-committee is made up of:

- Alan Brown, Jacobs
- Siobhan Butler, Canals & Rivers Trust
- Paul Farnell, Severn Trent
- John Foster, Mott MacDonald
- Mark Hayward, Fairhurst
- Chris Scott, Black and Veatch

We would like to give special thanks to Carlos Laguna Sanchez of Mott MacDonald for his work on the demand scenarios summarised in Annex B.

The following organisations responded to our call for evidence:

- AECOM
- Arup
- Association of Drainage Authorities
- Atkins
- British Dam Society Young Professionals Group
- Canals & Rivers Trust
- Chartered Institution of Water & Environmental Management
- DPower Ltd
- Edinburgh City Council
- Environment Agency
- Fairhurst
- HR Wallingford
- Hydroplan Ltd
- Jacobs
- JBA Consulting
- Mott MacDonald

- National Farmers Union
- National Trust
- Northern Ireland Department for Infrastructure
- Puma Energy
- Scottish Environmental Protection Agency
- Scottish Water
- South Ayrshire Council
- Stantec
- United Utilities
- Welsh Water

The following individuals responded to our call for evidence

- Professor David Balmforth
- Sean Faulkner
- Neil Harding
- Dr Andrew Hughes
- Stuart King
- Peter Mason
- Crawford Munroe
- Craig Scott
- Andrew Sheerman-Chase
- Julian Welbank