PR24

NORTHUMBRIAN WATER *living water* | ESSEX&SUFFOLK WATER *living water*

A3-21A – SERVICE RESERVOIR REPLACEMENTS

NES35A

1. INTRODUCTION

This case sets out our plans for increasing our investment in service reservoir replacement based on the outputs of our risk-based approach to service reservoir maintenance.

While service reservoirs are civil structures with a long asset-life and our approach to maintenance includes refurbishment and life extension, the age profile of our service reservoir portfolio is such that a large number of assets are at, or approaching, end-of-life. While historically, we have invested at an industry median level, and above allowances to maintain our water network non-infra assets, we have identified the need for AMP8 and beyond to invest in service reservoir replacements at a much higher rate than has been necessary to date, to efficiently manage asset health, supply resilience and water quality.

We did not include this investment in our draft business plan for 2025-30 due to the need to balance investment and affordability, and so planned to progress this investment in 2030. We did ask customers about this during our plan development, and they supported a plan that included these investments – but we removed this following our quantitative affordability and acceptability testing as it would not be affordable in the context of other investments. However, following the draft determination, which resulted in lower forecast bills than our business plan in the Northeast, we now have a further opportunity to bring forward this “no regrets” and critical investment from AMP9, which will reduce risks to customers and smooth bill increases over the longer term.

The case is structured to follow Ofwat’s PR24 methodology requirements for cost adjustment claims, as described in Ofwat’s PR24 final methodology. The case is not seeking to suggest that we are different to other companies in the water industry, as we expect the issues discussed and evidenced within this case for our business to be similar to those experienced by other companies across the sector. Rather, we consider that this is one example, in addition to for example mains replacements, where historical and modelled expenditure allowances for maintaining asset health are now too low.

We therefore expect the whole sector will need to increase expenditure in service reservoir replacement in the coming years. However, because we are proposing bill increases at the lower end of the industry range and it is now affordable, and our customers support investing in AMP8, we are proposing to begin addressing this issue earlier than other companies. This will allow us to achieve a sustainable rate of replacement more proactively, while tempering future bill increases for our customers in line with our long-term strategy.

In this case we set out:

- the evidence from our risk-based approach for management of service reservoirs, which highlights the need to significantly increase the rate of service reservoir replacement in AMP8 and beyond to achieve sustainable asset health;
- our analysis of relevant historic spend and calculation of the implicit allowance for service reservoir replacement;
- our priority sites for investment in AMP8 and prioritisation methodology, and

- best option for customers and cost efficiency.

It should be noted that in line with our prioritisation process described in Section 2, the four priority sites for AMP8 investment are in our Northumbrian Water region. However, we anticipate that investment in AMP9 and beyond will also be required at sites in our Essex & Suffolk Water region.

The AMP8 enhancement costs associated with this case are summarised in Table 1 below. Through our optioneering and costing approach we have calculated project costs for our 4 AMP8 priority sites to derive an overall AMP8 Capex. We have then subtracted the implicit allowance and maintenance savings costs to calculate the AMP8 Capex for our adjustment claim. For most sites, there is no delta in opex. The exception is Ryhope where the preferred option involves an increase over current opex costs due to the requirement for additional pumping. Our costing approach is fully explained in Section 5 – Cost Efficiency.

TABLE 1: SUMMARY OF AMP8 ENHANCEMENT COSTS

Service Reservoir	Capex (£m)	Opex (£m)	Total (£m)
Auton Stile	11.402	-	
Blakelaw	2.813	-	
Ryhope	16.195	0.103	
Stoneygate	20.507	-	
Total Project Capex	**50.92**		
Implicit allowance	-2.315		
Maintenance savings	-0.92		
Total (Project Capex – implicit allowance – maintenance savings)	**47.685**	**0.103**	**47.788**

Source: NWL cost-analysis (detail in Section 5)

This value exceeds the threshold in Ofwat's materiality criteria, which is set at 1% of Water Network Plus Totex.

2. NEED FOR INVESTMENT

2.1. BACKGROUND

In our resilience appendix (NES09), we explained the work we had done on asset health across our business, this included service reservoirs. Investment to replace concrete tanks at service reservoirs were considered a high priority by our customers[1] – along with water treatment works and wastewater treatment works – as they relate to the main function of the company to provide a safe, continuous water supply. As a result of our customer research, we looked at potential options for balancing affordability against an increased investment in asset health.

This challenge led to us removing our business case for service reservoirs from our draft plan and including mains replacement without changing the overall level of investment for asset health – and so remaining close to the level of investment that our customers supported in our qualitative research.

In our long-term strategy for service reservoir and treated water storage assets, we said that:

> "beyond 2030, we consider that capital maintenance expenditure will need to increase further" [2]

For our core pathway, we used an estimate of a 40% increase in investment from 2020-25 levels, starting in 2030. This was a conservative view that represented a minimum "no regrets" increase. We noted that "the required level of investment could be significantly higher". We said that the decision point for this would be 2028, ready for investment from 2030 onwards, and decisions would be made at each subsequent price review to determine the most appropriate level of capital maintenance investment. So, we have subsequently initiated and led work to examine the evidence and best approach for future regulation to enable this – working with other companies, regulators, and stakeholders to begin these conversations.

With lower forecast bills than our business plan in the North East, we now have a further opportunity to bring forward some "no regrets" investment from AMP9.

- Historical industry spend on service reservoirs is primarily driven by maintenance rather than replacements. These maintenance costs are increasing – our costs are now around £50m of base capex in each AMP, a rise from £21m in AMP6 to forecast £50m in AMP8 (see Section 2.6). Our intervention costs are increasing because of material costs and limited specialist contractors; and the proportion of reservoirs requiring investment after inspections has increased from 50% to 90%. In AMP7, it has been a challenge to absorb these costs – through efficiency and re-prioritisation.
- We have replaced one service reservoir under base allowances since 2010 – our Hebron reservoir – and built one new reservoir in enhancement (Springwell). Replacement costs due to aging assets are not generally captured in Ofwat's base models which use historical expenditure – these allowances do not include new

[1] Pre-acceptability research Part B, NES, 2022
[2] 'Shaping our future: Our Long-term strategy 2025-2050', NES_LTDS, NWL, October 2023, p.91.

replacements for service reservoirs. The step change in base maintenance compounds the funding challenge to replace service reservoirs.

- Our maintenance strategy for AMP7 – and in line with our business plan for AMP8 – is to deliver interventions to extend the lifespan of service reservoirs. Some of these repairs, such as “overbanding” to repair leaking structures, have a lifespan limited to around 15 years. Asset deterioration and the instructions for use of approved products has meant that these repairs can only be carried out three times, and then replacement is needed. In the past, we have used liners as a last resort for extending the life of service reservoirs – but UKWIR issued guidance in 2017[3] which increased the assessment of risk of deterioration for reservoirs with liners, stating that where there is risk of ingress behind a liner, the structure should be assessed as Grade 5 (poor). Liners are therefore considered inappropriate in conditions where ingress due to wall and floor deterioration is a risk and therefore significantly limits the application of liners for refurbishment of end-of-life assets. As such, liners are omitted from Section 9.4 of the UKWIR guidance which covers best practice.
- We have a long-term plan to replace our service reservoirs that have a masonry construction due to higher risk and a higher likelihood of failure. These particular service reservoirs are old (mostly Victorian-era), have reached the end of their lives and require excessive maintenance. The DWI supports our plan to replace service reservoirs with masonry construction.
- We planned to replace five reservoirs in AMP9, at a cost of £62.4m. We considered including this investment in our AMP8 plan and discussed this with customers – who agreed they would invest now if it would deliver value and reduce future step increase in prices[4]. With a shift in affordability since the business plan, we could now bring the majority of this forward to AMP8. This aligns with decisions to delay some investment in monitoring to AMP9 (which will increase our AMP9 plan).
- We expect to continue with a multi-AMP approach to replace service reservoirs, and we are working on the longer-term replacement plan, including inspections. The pace and extent of the asset replacement plan will depend on what we expect to be increasingly stringent expectation from DWI and the evolution of requirements for reservoir inspections for smaller reservoirs – as well as developing the evidence on long term deterioration of asset health. We provide evidence of the link between asset condition and age/maintenance cost, to show the future impact of this requirement.

2.2. STATUTORY NEED FOR INVESTMENT

We have 304 service reservoir sites, comprising 541 compartments. Compartments can either be separate structures on the same site or may be co-joined compartments within the same overall structure. Our service reservoirs perform a supply demand balancing function within the potable water network. They store treated water, ideally near to where it is needed, to meet the diurnal demands of the customers. They also provide a level of resilience to maintain customer supplies during

[3] UKWIR Good Practice for Service Reservoirs (UKWIR 19-RG-05-05)
[4] Pre-acceptability research Part B, NES, 2022

scheduled or non-scheduled outage events. In addition, service reservoirs play a role in energy efficiency, allowing us to manage electricity consumption at our water treatment sites during peak tariff periods. These treated water structures are required to meet statutory regulations.

- Reservoirs act 1975.[5]
- Health and Safety at Work etc. Act 1974.[6]
- Water Supply (Water Quality) Regulations 2016[7] and associated guidance[8]

Standards that are used for the build, operation and maintenance of these assets are:

- BS EN 1508:1999 Water Supply. Requirements for systems and components for the storage of water;[9]
- BS EN 805:2000 Water Supply. Requirement for systems and components outside buildings;[10]
- National Principle of Water Supply Hygiene and relevant technical guidance notes, and[11]
- Research material: UKWIR Treated Water Storage Assets: Good Practice for Operation and Management Version 2 (the UKWIR Good Practice document).[12]

BS EN 1508:1999 and the UKWIR Good Practice document sets out that reinforced concrete is the preferred material for treated water storage structures. Both this and our own experience supports the abandonment or replacement of masonry structures as they are prone to ingress from all the joints between masonry and are reaching the point where there are no further feasible options for the frequent repairs required to maintain structural integrity.

Water Quality Compliance

Our water quality compliance is represented through Compliance Risk Index (CRI). We maintain our service reservoirs to ensure that we are able to maintain CRI performance. The element of our CRI score attributable to service reservoirs (water storage) demonstrates good compliance – with an average of 0.18 between 2017 and 2023. We address this issue in more detail in section 4.2 of our DD response to our asset health business case.

We follow a sampling regime to ensure that our service reservoirs are meeting water quality compliance requirements, notifying the DWI of any anomalies. The structures require periodic inspections every 3 or 5 years (dependent on condition grade found in the prior inspection), this typically results in over 100 compartment inspections annually. The findings and remedial work recommended through these inspections is captured and prioritised for action, our base expenditure budget should fund the inspection, maintenance, repair, refurbishment and replacement within a funding

[5] Reservoirs Act 1975 (legislation.gov.uk)
[6] Health and Safety at Work etc Act 1974 – legislation explained (hse.gov.uk)
[7] Water Supply Regulations 2016
[8] Guidance on implementing the Water Supply (Water Quality) Regulations

envelope. The asset inspections enable us to take a risk-based approach to asset intervention. However, we note that the rising cost of reservoir repairs on poor condition and end-of-life assets will put increasing pressure on maintenance budgets if a long-term sustainable approach to asset replacement is not implemented. The following section summarises our service reservoir asset condition, explaining how the maintenance need for these assets is changing over time.

2.3. ASSET CONDITION

Our service reservoir compartments are inspected, and the condition grade of the core components is graded as per our condition grade scoring criteria, which are based on UKWIR Good Practice for Service Reservoirs (UKWIR 19-RG-05-05). This is specific to each component, an example of this for 'walls and/or roofs' is show in Table 2 below.

TABLE 2 CONDITION GRADE CRITERIA

Material	Condition Grades				
	1	2	3	4	5
Brick & Masonry	As new	Pointing recessed up to 5mm and/or staining/ discolouration to masonry	Pointing recessed more than 10mm and/or cracking <1mm over approx. 25% of area	Pointing significantly recessed and/or cracking >1mm over approx 40% of area or greater	Visible or known ingress/egress
Concrete	As new	Cracks <0.2mm wide and/or Friable concrete up to 1mm deep on internal surface.	Cracks 0.2 to 0.5mm wide but no ingress. Friable concrete up to 10mm deep on internal surface. Some corrosion staining from reinforcement.	Cracks >0.5mm wide but no ingress. Friable concrete 10 to 25mm deep. Significant corrosion of exposed reinforcement.	Visible or known ingress/egress
Steel (riveted, welded or 'boiler plate')	As new	Paint flaking over areas <100 x 100mm. Light corrosion	Area of coating failure >100 x 100mm. Mill scale rusted away, slight surface pitting	Notable loss of section from corrosion, but no ingress	Visible or known ingress/egress. Perforation due to any mechanism and/or corrosion deposits in bottom of tank
GRP/Plastic	As new	Discoloured	Exposed fibres externally	Visible cracking or movement / exposed fibres internally	Visible or known ingress/egress. Holes (daylight from inside)
HDPE (e.g. Wheolite)	As new	Discolouration	Signs of age, surface starting to roughen, becoming brittle	Poor condition but no leakage	Visible or known ingress/egress. Split or punctured

Source: NWL Condition Grading methodology

Our condition grading approach is based directly on UKWIR's good practice guidance, taken from the 2017 UKWIR Report (No.19/RG/05/50)[13]. The UKWIR Condition Grades are as follows:

1. 'As new' condition except for tolerable cosmetic defects, highly unlikely to impact on H&S, WQ, security of supply or structural integrity.

2. Deterioration starting to show but very unlikely to impact on H&S, WQ, security of supply or structural integrity.

3. A defect or deterioration that is unlikely to impact on H&S, WQ, security of supply or structural integrity. Defect / deterioration should be monitored at next inspection.

4. A defect or notable deterioration that could impact on H&S, WQ, security of supply or structural integrity. May require planned investment at or before next inspection.

5. A defect or severe deterioration that will almost certainly impact on H&S, WQ, security of supply or structural integrity. The defect/deterioration should be rectified immediately.

As the asset base ages, there is an increase in the number of asset components moving to lower condition grades where the options for remedial work become limited. Refurbishment of tanks becomes unfeasible from both a water quality and health and safety perspective.

Some of our service reservoir assets can no longer sustain further refurbishment and need to be scheduled for replacement (Section 2.5.5 sets our prioritisation methodology for AMP8 replacement sites, which takes into account construction type, asset age and previous refurbishment interventions).

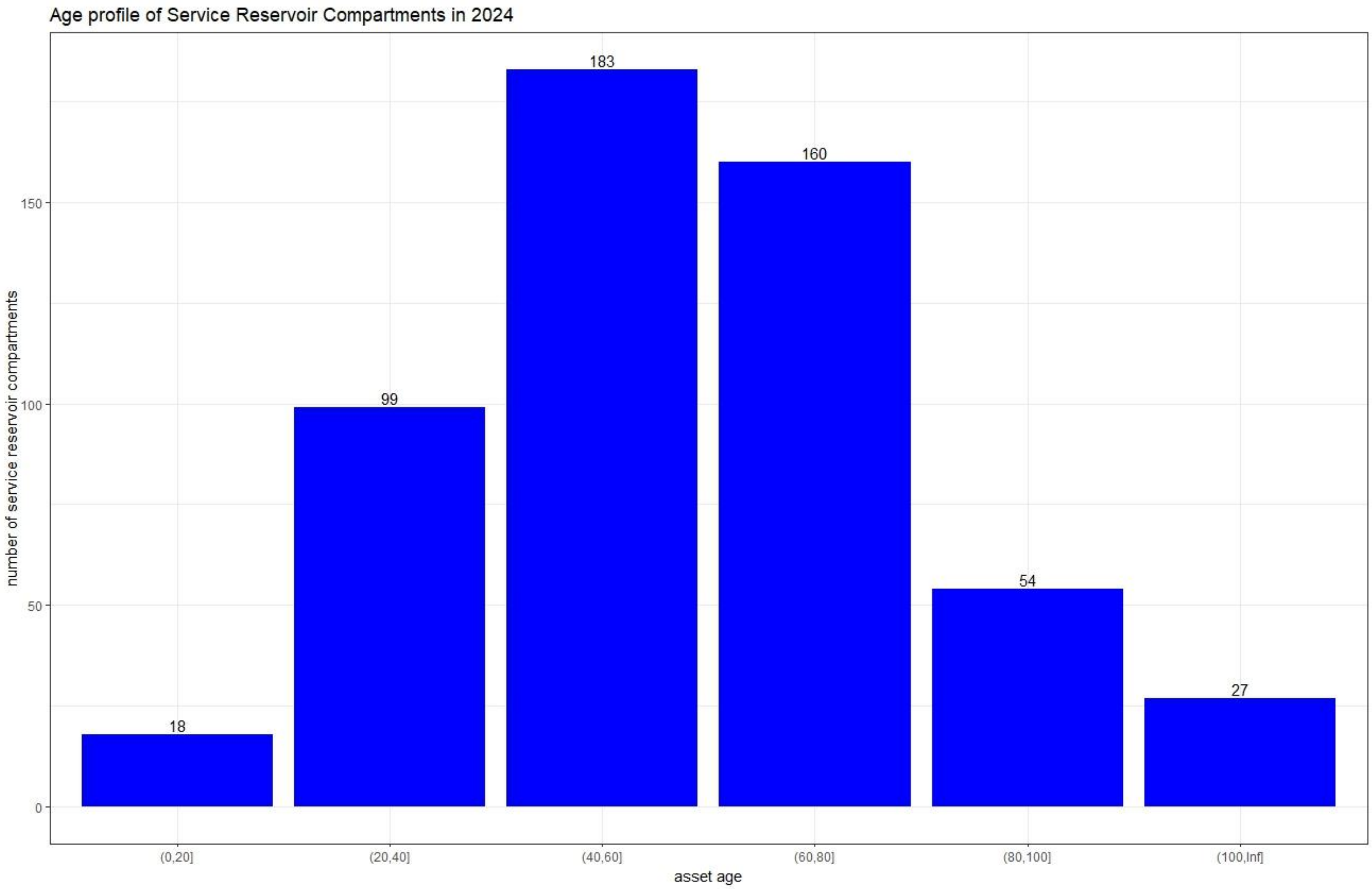
Due to the long life of service reservoirs, replacement of these assets has not occurred frequently in the past, with only 1 base maintenance replacement required in the last 15 years.

Age profile

The age profile of service reservoir assets can be seen in Figure 1.

[13] UKWIR Treated Water Storage Assets: Good Practice for Operation and Management (2017)

FIGURE 1: AGE PROFILE OF SERVICE RESERVOIR COMPARTMENTS (2024)



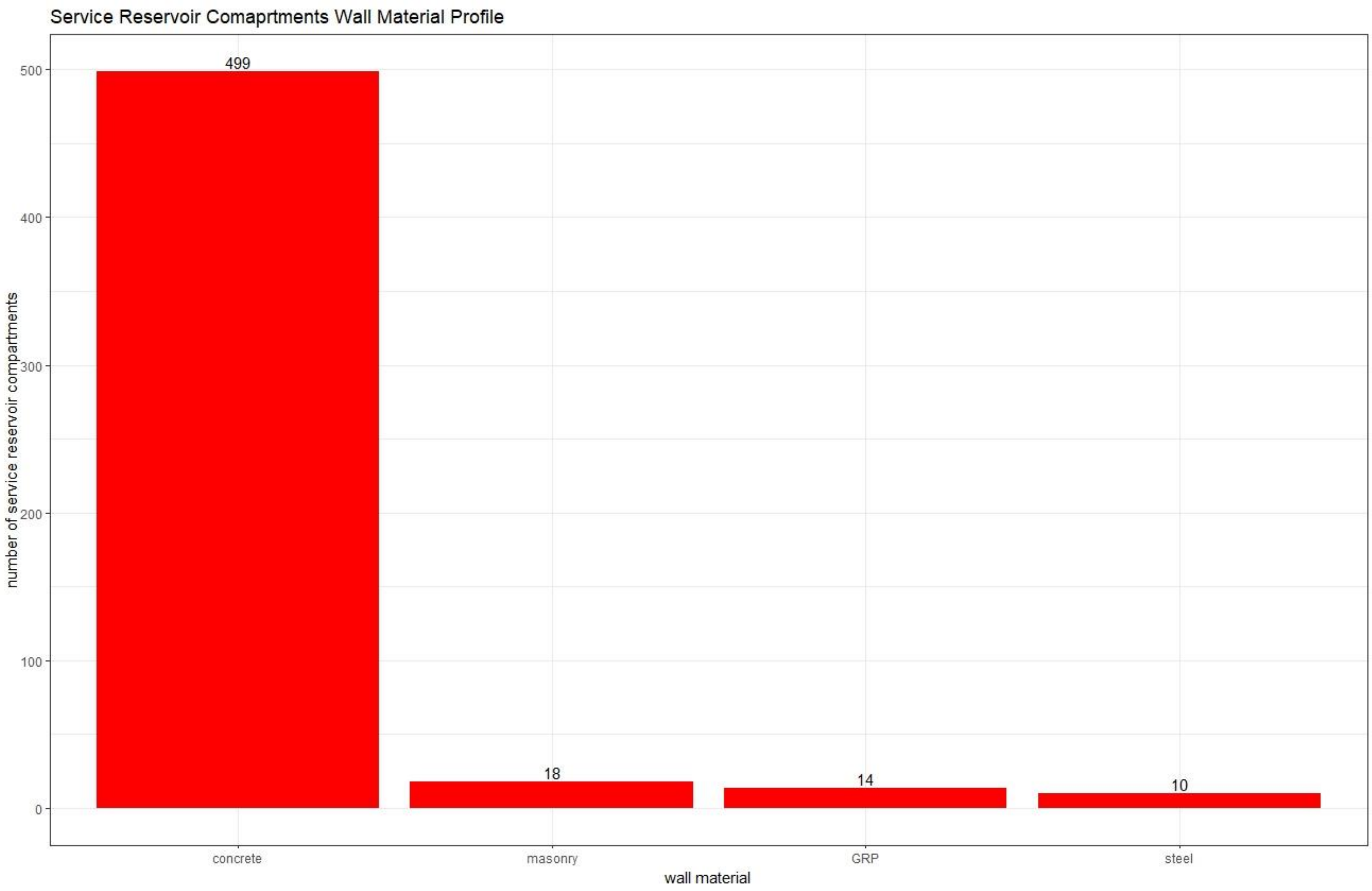
Source: NWL Service Reservoir asset data

The observed and forecast life expectancy for these assets varies dependent on the construction material. As of July 2024, 5% of our service reservoir assets are over 100 years old and a further 10% are between 80 and 100 years old.

Material types

The material types of our service reservoir assets are shown in Figure 2. As per our asset strategy, our preferred material type is concrete and we highlight the need to replace assets with non-preferred material types, starting with our masonry assets. This is due to the health and safety risks and technical feasibility challenges associated with continuing to find refurbishments or repairs of these materials. Masonry assets make up 3.3% of the asset base (18 structures).

FIGURE 2: SERVICE RESERVOIR WALL MATERIAL



Source: NWL Service Reservoir asset data

Components within a single service reservoir can be constructed of different materials. Figure 2 shows the wall material, this is the largest component within the service reservoir and hence is the best representation of the overall asset material.

Condition grades

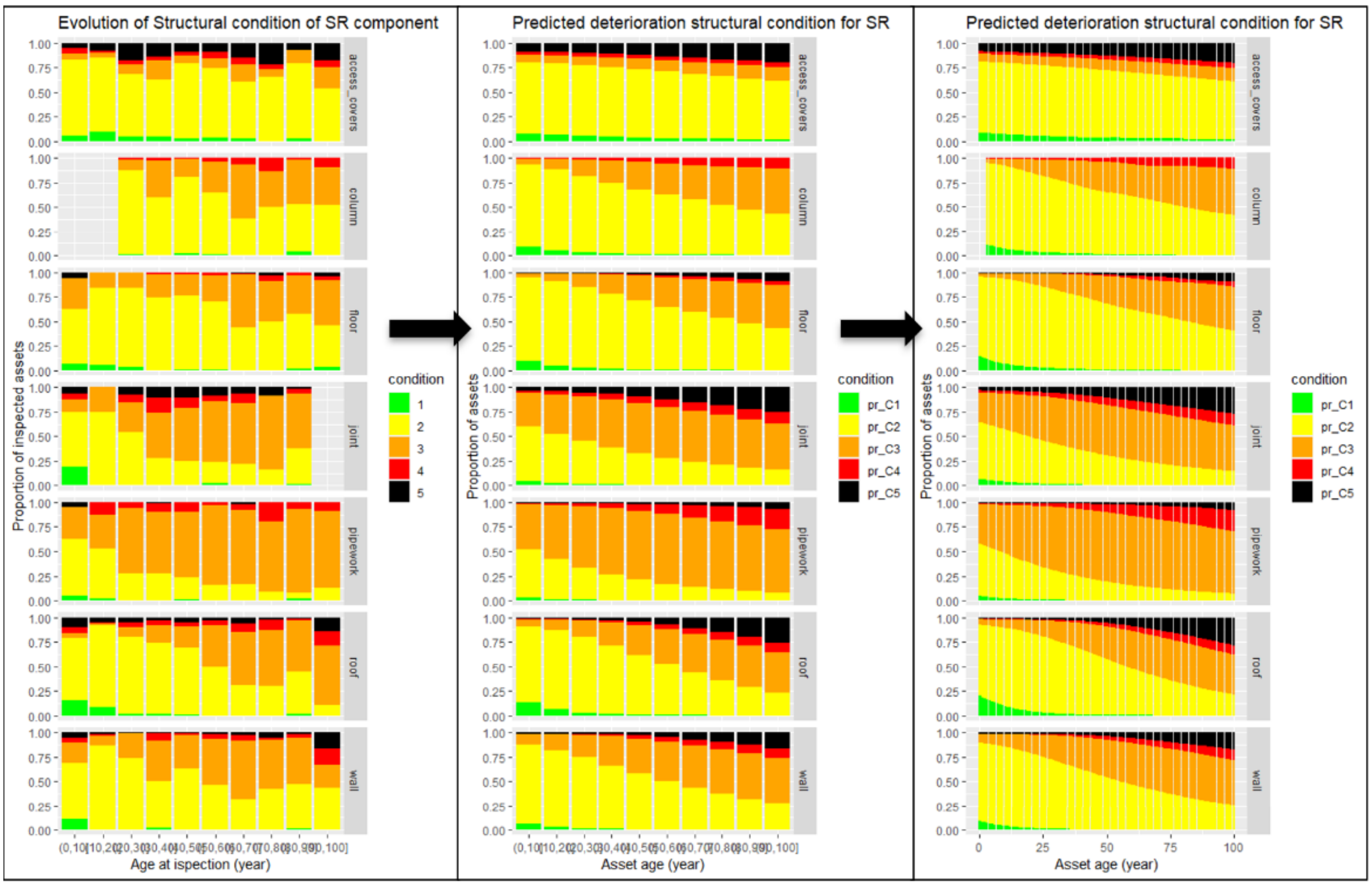
Our condition grade data, collected over time for each component of each service reservoir has been used to develop deterioration models for these assets. These models are built to show the deterioration rate over the next 25 years. We can assess the envelope of asset life of a service reservoir to help determine asset population replacement time and cost, to plan efficient interventions. Once asset components are assessed as grade 4, they are scheduled for intervention, and all interventions are targeted at returning the asset to a minimum of condition grade 3. Our service reservoirs that have any component assessed as condition grade 5 are all in the age band 60+.

2.4. DETERIORATION MODELS

Based on our observed condition grade across the core components of our service reservoirs we have developed deterioration models and profiled the need for future replacement of our service reservoir assets.

Our deterioration models have been built based on our understanding of our assets from the observed condition grades for each component. Figure 3 shows how we take the condition grade for each component against age at inspection, we use this to further predict condition grade across future age, and to establish the predicted deterioration curves for each of the structural components.

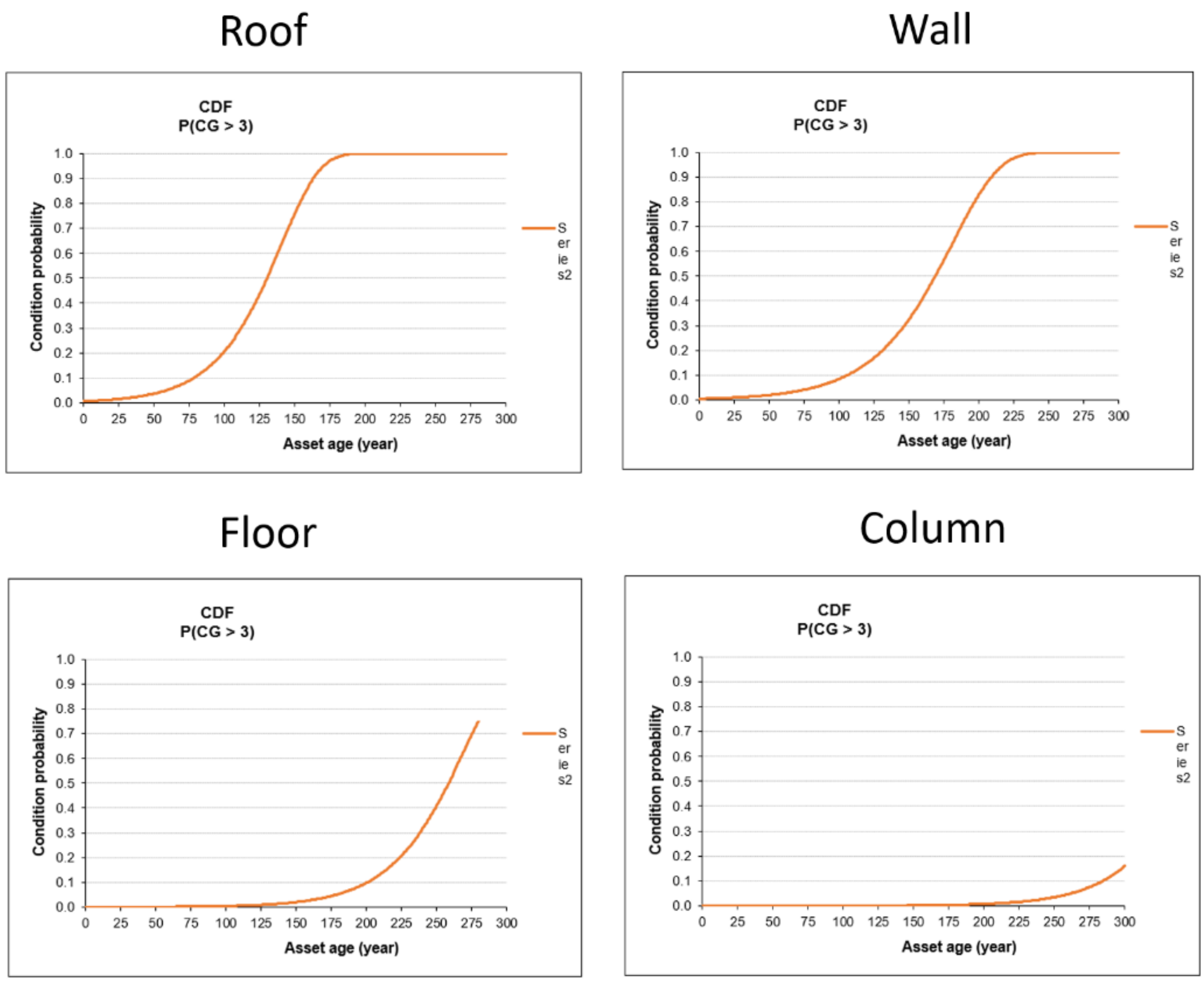
FIGURE 3: CONDITION GRADE LED DETERIORATION CURVES



Source: NWL deterioration analysis

We then take these deterioration curves and turn them into ‘survival curves’ as shown in Figure 4 for the 4 main components of the service reservoir structures. These curves show the cumulative distribution of components reaching grades 4 and 5, and therefore in need of intervention.

FIGURE 4 SERVICE RESERVOIR COMPONENT SURVIVAL CURVES



Source: NWL deterioration model detail

For example, for roof components, 50% of these components are predicted to reach grade 4 or 5 by the time they are 130 years old.

We have devised with the Water Industry Commission for Scotland and Scottish Water a methodology for projecting asset population replacement time and cost using:

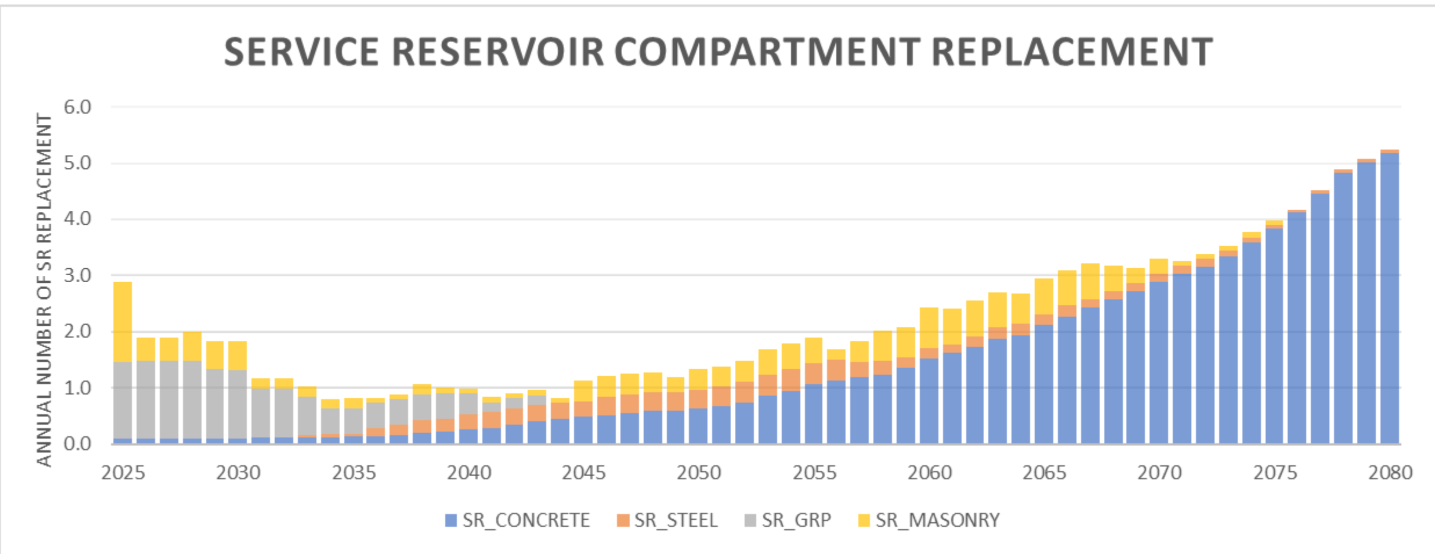
- Asset life expectancy
- Asset population age distribution
- Asset replacement cost.

This simple approach allows for rough estimates of investment needs and profiles to be made. We have adapted this approach to help relate our known asset deterioration curves and survival rates, to life expectancy. We combine the component data for the assets to create a single life distribution for service reservoir compartments. To show alternative approaches, we have modelled two scenarios.

- Simulation A: 'First past the post' models the time for one component to reach grade 4 or 5.
- Simulation B: 'First past the post plus 30 years' models the time for one component to reach grade 4 or 5, plus assumes a life extension of 30 years can be achieved through repairs. This 30-year life extension has been validated by expert engineering judgement.

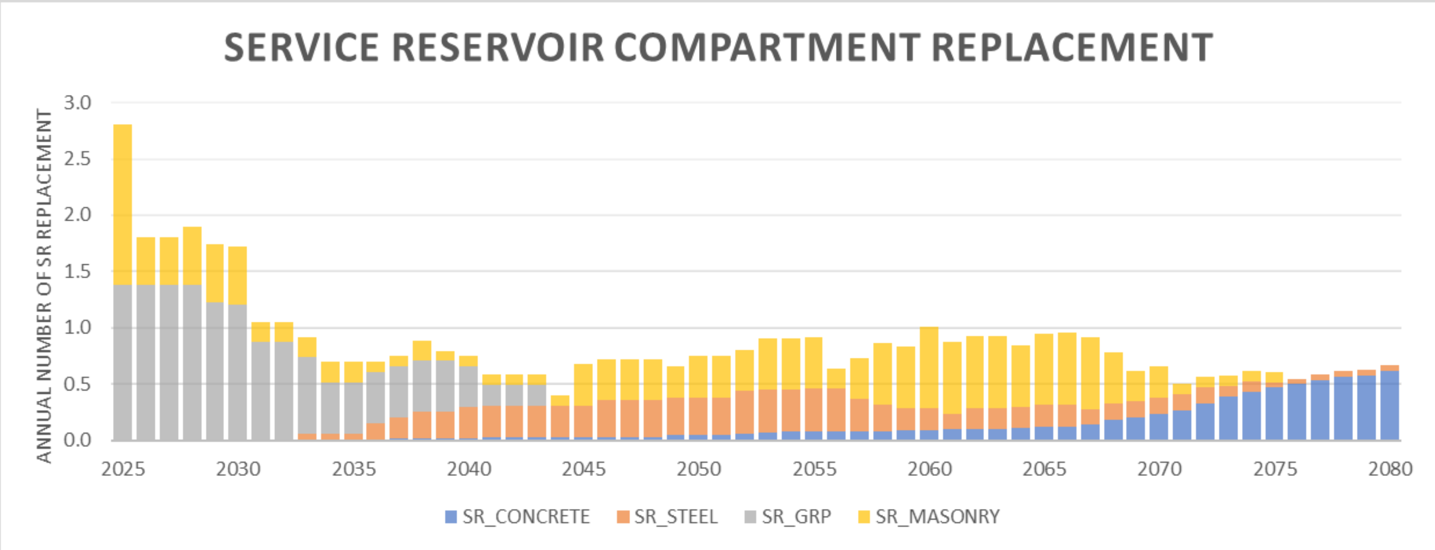
Figure 5 and Figure 6 show the resulting output for these two scenarios.

FIGURE 5: SIMULATION A: 'FIRST PAST THE POST'



Source: NWL asset deterioration modelling output

FIGURE 6: 'FIRST PAST THE POST PLUS 30 YEARS'



Source: NWL asset deterioration modelling output

Simulation B, shown in Figure 6, is the most conservative view of replacement need out of the two model simulations. This assumes that we are able to extend the life expectancy by 30 years through repairs and refurbishments, without asset replacement. This simulation shows the annual profile of number of reservoir compartment replacements required over a 55-year time horizon. The replacement number of compartments for AMP8 (2025-2030) is over eight, however, due to deliverability we are prioritising four service reservoir replacements for AMP8. Our priority sites are all single compartment service reservoirs, and therefore we are proposing to replace 4 compartments in AMP8. The prioritisation approach and detail of these assets is covered in Section 2.5.5.

2.5. THE NEED FOR THIS INVESTMENT IN AMP8

2.5.1. Increasing need for intervention

We have shown how our service reservoir assets move through condition grades and deteriorate over time. As more of our assets are moving beyond condition grade 3, we have seen an increase in the remedial work required as a result of the inspections. This increase over time can be seen for NWL in Figure 7 below, and the comparative trend for Essex & Suffolk region in Figure 8.

FIGURE 7: INCREASING MAINTENANCE REQUIREMENT (NORTHUMBRIAN WATER)

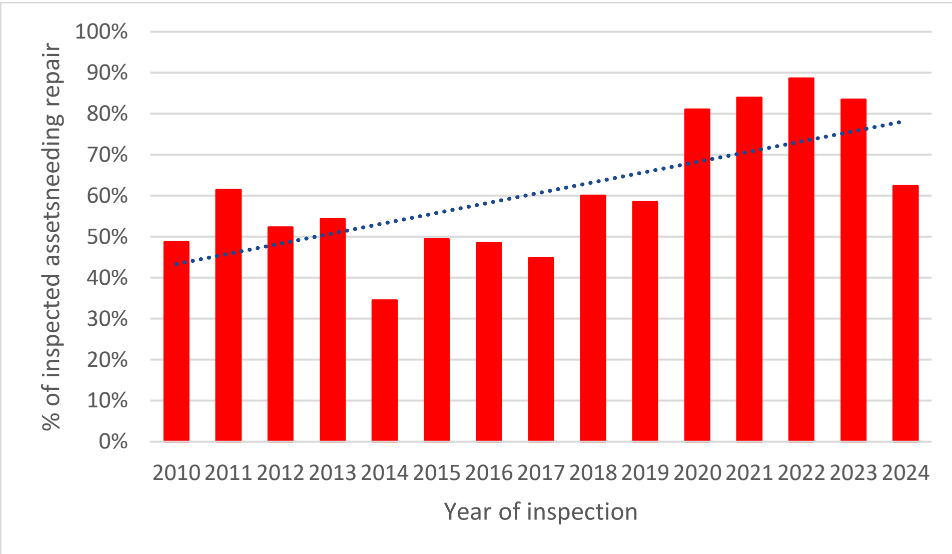
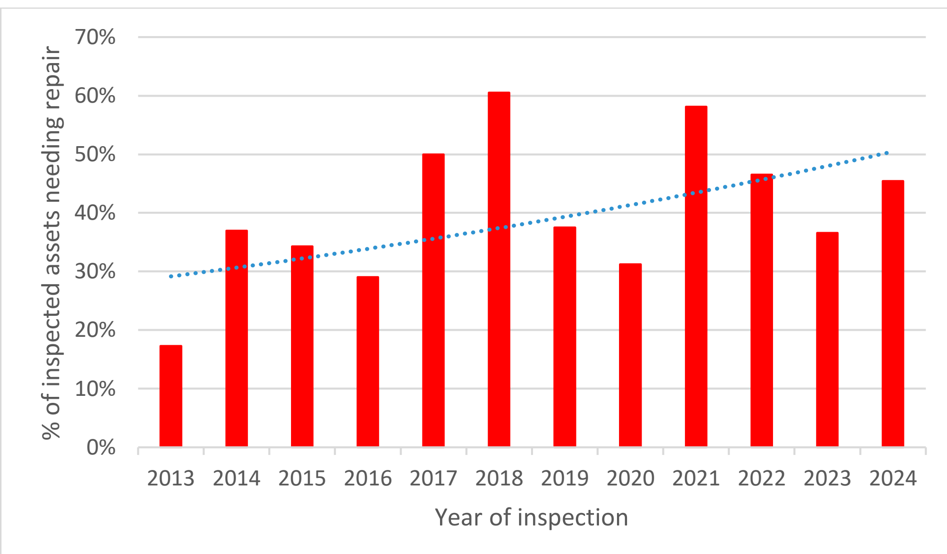


FIGURE 8: INCREASING MAINTENANCE REQUIREMENT (ESSEX & SUFFOLK)



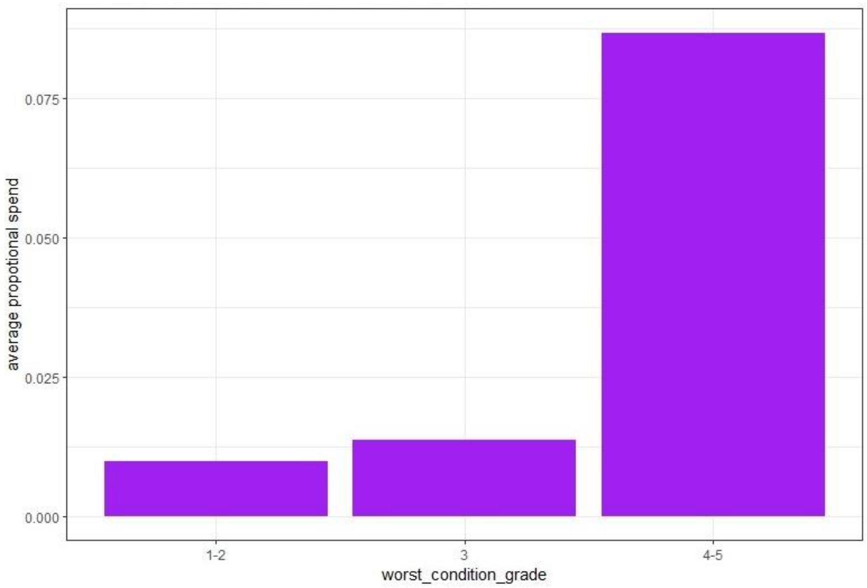
Source: NWL Service Reservoir inspection and maintenance data

This figure shows the percentage of our inspected assets that require repair, rather than the percentage of the overall asset base. As shown in the graph, we have monitored this metric for many years and it has informed our maintenance spend.

2.5.2. Increasing cost of intervention

The average cost of maintenance and repair for assets beyond condition grade 3 (grade 4 and 5) is over 5 times higher than the average cost for assets in condition grade 1 or 2, as shown in Figure 9. The more assets that reach condition grade 4 or 5, the higher the maintenance, repair and refurbishment costs are across the service reservoir asset base.

FIGURE 9: AVERAGE SPEND PER CONDITION GRADE



Source: NWL Service Reservoir condition, inspection and maintenance data

Note: Y-axis is average repair spend as a percentage of total compartment replacement cost. For grades 4 and 5 repairs cost approximately 7.5% of the replacement cost compared to approximately 1% of the replacement cost for a grade 3 compartment. The replacement cost is estimated based on the compartments capacity and a basic cost curve.

As more of our assets age, there is a greater proportion of assets reaching condition grades 4 and 5 and requiring an intervention. The increase in interventions is increasing the amount we need to spend and will become impractical from an operational delivery perspective, due to the operational impact of intrusive repair and refurbishment approaches. More extended time out for repairs creates a loss of system resilience at a time when resilience is becoming more critical due to climate change. We need to act now to start a rolling replacement process to minimise future activity for deteriorating assets.

2.5.3. Deliverability

As our services cannot be interrupted, we need to ensure that we take into account the deliverability of the proposed rate of replacement. Many of our reservoir replacements need additional land purchase, planning consent and have environmental considerations. We need to start planning the replacement of these critical assets to enable a programme of delivery starting in AMP8, prior to asset failure. This will be the start of a rolling programme of replacement as these ageing assets that are made of non-preferred materials move towards the tipping point where it is no longer viable for them to be repeatedly refurbished. A rolling programme will also support efficient delivery and supply chain capacity.

Service reservoir replacement often requires the acquisition of additional land to be able to build an alternative service reservoir and then decommission the old one. The requirement for land purchase can involve long lead times and therefore the replacement of these assets needs to be anticipated and planned up to 5 years ahead of forecast commissioning dates.

2.5.4. Risk of asset failure

We carefully manage the risk relating to our service reservoir assets, as demonstrated through our inspection frequency and required repair information. We need to invest in replacing our highest priority service reservoirs now to avoid putting our customers at a higher risk of loss of supply. If any of our service reservoirs were to fail, on a typical day, there would be an alternative supply solution. However, in the event of a secondary factor, such as an extreme demand scenario or a critical main burst, it is more likely that there will be a supply issue. Hence by not investing in these assets within AMP8, our level of risk would increase.

2.5.5. Prioritisation of asset investment

For our Service Reservoir assets, we prioritise investment on a risk-based approach informed by the outputs of statutory inspections, assets condition assessments and deterioration modelling.

We assess all our water storage assets using the ALFA approach (Assessment of Low Failing Assets modelling methodology), which provides a tendency to fail (TTF) assessment based on failure modes and asset attributes, and a consequence of asset failure. Since PR09, this method has been embedded in our asset management approach to identify future issues and prioritise activities for asset groups which fail very rarely in practice and for which there is insufficient historical failure data to build performance relationships.

We prioritise inspections using a tool that takes elements of the ALFA modelling in combination with more operational considerations such as recent adverse bacteriological results, history of ingress and overall asset size. This differentiates between sites that may have equal time between inspections and allows us to plan interventions proactively. The outputs of the inspections generate a task list of investment needs. All water quality needs are addressed before assets are returned to service, but some asset needs can be addressed during future inspections.

For our Service Reservoir assets, we examine the task list of investment needs that remain after water quality work has been carried out, as part of the risk-based approach.

In addition, our deterioration modelling adopts the UKWIR best-practice model developed specifically for service reservoirs through the industry funded project Treated Water Storage Assets: Good Practice for Operation and

Management[14]. This ensures our assumptions related to asset lives, common failure modes, risk of failure and benefits of interventions are based on industry research. We use the service reservoir model developed by UKWIR to forecast rates of deterioration and plan the timing of interventions to manage risk to service.

To prioritise our service reservoir interventions, multiple factors are taken into account, including:

- age – many of our service reservoir assets are well beyond standard asset-life assumptions and are of a primitive or outdated design;
- condition – condition assessment is a key part of the statutory inspection process and outputs. We also monitor asset condition as part of routine operational activity;
- water quality risk – we monitor the CRI risk associated with reservoir condition and performance;
- construction method – we operate a range of reservoir types, each with characteristics and risk factors specific to the design and construction method - e.g. masonry structures are particularly susceptible to deterioration and potential ingress/egress resulting in water quality issues, and
- criticality/zone resilience – the criticality of network storage is related to network configuration and ability to supply from other sources as well as size and number of customers served.

These factors were assessed to identify the four priority service reservoirs for investment in AMP8. Our AMP8 priority sites are summarised in Table 3 below. Most were constructed over 100 years ago and have already received a number of maintenance interventions aimed at extending asset life by slowing deterioration and mitigating water quality risk. Three sites are of a masonry type construction. In the case of Stoneygate, the reservoir was constructed on a geological fault (unknown at the time) which is a key driver of the condition and risk score and why this is a priority site even though it is not masonry construction. Auton Stile is constructed from stone slabs on puddle clay, which due to the jointing is also classed as a masonry structure. The tank is >100 years old, and because it is located in an area of high water-table, options to reline to extend the asset life are not feasible (see Section 2.1).

TABLE 3: PRIORITY SERVICE RESERVOIR SITES FOR AMP8 INVESTMENT

Reservoir	Capacity	Age	Construction Type	History / Condition
Auton Stile	10.5 MLD	Constructed in 1918	Stone, masonry jointing, single compartment	Poor condition due to age. Liner option not feasible due to ground conditions (high water table). Ingress risk.
Blakelaw	1.5 MLD	Constructed in 1854	Masonry, single compartment	Has been relined in the past. Liner now deteriorated. Unfeasible to reline.

[14] UKWIR Project 19/RG/05/50 (2017)

Ryhope	16.5 MLD	Constructed in 1870	Masonry walls, concrete roof, single compartment	Concrete relining applied in the past - stripped out and relined with membrane following water quality failures in 2019 but lining compromised and at risk due to high water table.
Stoneygate	22 MLD	Original construction early 20th Century, roof added in 1950s. Expanded 1981.	Concrete, single compartment	Originally constructed on a geological fault line. Susceptible to cracking caused by ground movement.

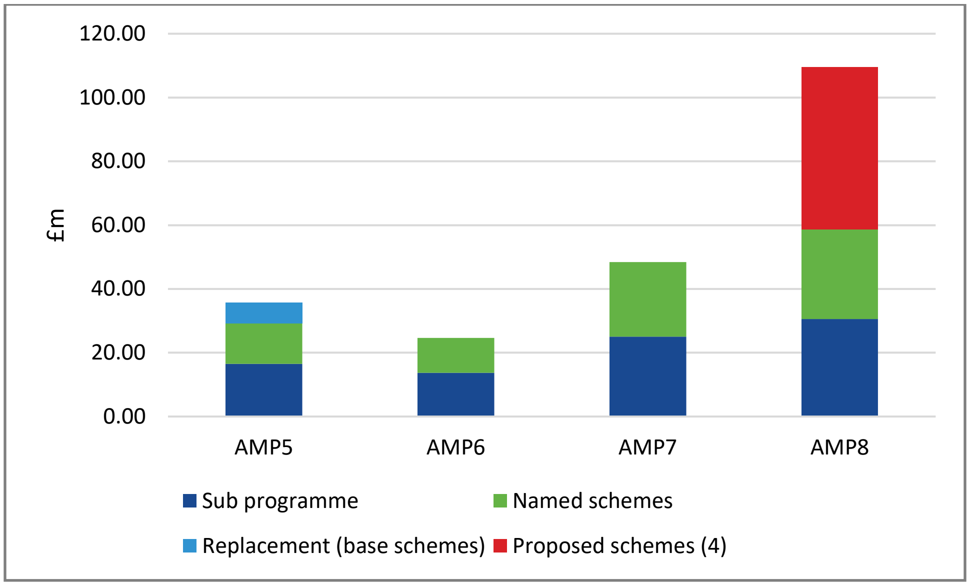
Source: NWL Asset data records

We will continue to monitor and assess these risk factors and apply the same prioritisation methods to determine the target reservoirs for replacement in future AMPs.

2.6. OUR PROGRESS UP TO 2025

Service reservoirs are long life civil assets, our service reservoir asset strategy follows the principles of repair, refurbishment then replacement. Over a 15-year period (forecast up to 2025/ end of AMP7), we have funded maintenance, repairs, refurbishments and replacement at an average of £7.31m per year (£36.3m per AMP) the increase in this expenditure from AMP5 through to our AMP8 forecast is shown in Figure 10 below. In this figure, the “sub programme” is the costs of repair and maintenance resulting from our service reservoir inspection programme; and “named schemes” are the costs for repair and maintenance where costs are significant and exceed our internal threshold for funding for general repairs and maintenance.

FIGURE 10: SERVICE RESERVOIR INVESTMENT



Source: NWL Service Reservoir maintenance cost data

The construction of one service reservoir has been funded through base expenditure since the start of AMP5. This equates to an average of 1 every 15 years. Our analysis shows the need to implement a step-change in AMP8, shown by the red bar which represents the four proposed AMP8 service reservoir replacements. The modelling also shows this will need to be followed by a further step up in future AMPs to achieve a long-term sustainable replacement rate.

2.7. ALIGNMENT TO THE LONG-TERM DELIVERY STRATEGY

Our long-term strategy sets out our target to improve drinking water quality, secure the long-term health of our assets to ensure a sustainable water supply includes our ambition to deliver high quality drinking water.

Our long-term targets (2050)

- Consistently deliver high quality water (Compliance Risk Index of zero)

2.8. CUSTOMER SUPPORT FOR THE NEED

Our research shows that our customers expect us to meet our statutory obligations; it is not appropriate to discuss delaying or phasing investment where there isn't an alternative option to meet the regulatory needs of the drinking water safety plan.

Our research shows that customers gave highest priority support to investment in drinking water quality and supply of drinking water; our customers rank improving water quality (CRI) as one of their "high" priorities (prioritisation of common PCs, NES44).

In our qualitative affordability and acceptability testing (NES49), customers supported our "preferred" plan which included these investigations. Customers found this plan acceptable because it focused on the right things, is good for future generations, and is environmentally friendly. Customers who did not find this plan acceptable said that this was expensive, and water companies should pay out of their own profits. In our quantitative research (NES50), 74% of customers supported our preferred plan, including this investment.

In the short window available between the publication of the draft determinations and the deadline for responses we have limited opportunity to conduct further customer research. We have conducted some targeted research with a small number of customers using our People Panel. This research showed that a majority of the panel members (21 of 36) thought that we should challenge Ofwat's position on asset health expenditure, although the proportion was lower for customers in the Northumbrian Water region.[15] Customers were not specifically asked about this investment, but it can be inferred from this support for asset health investment more generally that customers support the need for investment in this area.

3. BASE EXPENDITURE ALLOWANCES

This section provides evidence that, while the maintenance of these assets is entirely within management control, the investment required for asset replacement is not fully accounted for within the modelled allowances, and this investment is material. We consider that this is because existing expenditure allowances are not sufficient to maintain asset health. The level of expenditure required to maintain asset health across our portfolio of assets fluctuates over time, as the age and condition of our assets varies. This is to be expected from an asset base which does not have a uniform age profile or uniform construction. We are entering a period where increased expenditure on asset health including for service reservoirs is required. The analysis is shown in below.

3.1. BASE REQUIREMENTS AND IMPLICIT ALLOWANCE

Historically Northumbrian Water's rate of replacement for service reservoirs has been low; there has been one reservoir replaced since the start of AMP5 (2010). A further one is currently being built, which is funded as an enhancement based on improvements to resilience. This has been because lower cost maintenance options have been viable in the past, such as patch repairs, lining and other refurbishments. These lower cost options have historically been the efficient approach to maintaining these assets in the best interests of customers.

Now, further rehabilitation will not deliver stable improvements to serviceability. This is evidenced by high spend rates on poorer condition assets as shown in section 2.5.2. When reservoirs have undergone an increasing number of refurbishments, it has been observed that the rate of failure of these previously effective solutions has increased.

[15] 'Northumbrian Water Group: People Panel Draft Determinations toplines', Explain, August 2024.

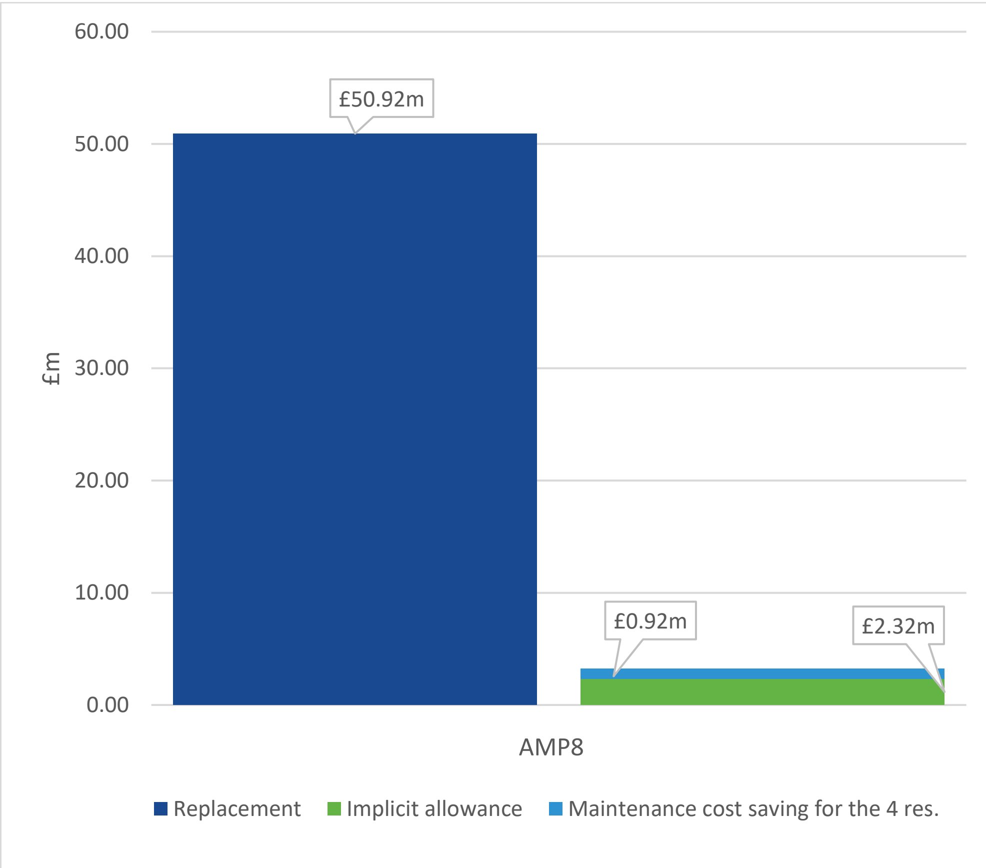
Since 2010 our expenditure on service reservoir assets has increased, and the future required spend is increasing still, as shown in section 2.6. Based on the modelled forecast deterioration shown in section 2.2, we need to replace four service reservoirs in AMP8. The previous profile of base funded replacements since 2010 has been 1 reservoir in 15 years.

Based on the level of replacement funding over the last 15 years, we have calculated the implicit allowance to be £0.463m per year (£2.32m per AMP). In addition, we have calculated an annual maintenance saving of £184k associated with the four priority sites. This is based on analysis of our actual maintenance costs for Auton Stile, Blakelaw, Ryhope and Stoneygate during AMP5, AMP6 and AMP7, which we have used to generate an annual average of £0.184m (£0.921m for AMP8).

Our forecast cost for the required four schemes in AMP8 is £50.92m, and the detail behind the approach to prioritisation, selection, optioneering and costing is shown in Section 4 onwards.

The difference between the required expenditure less the implicit allowance and reduced maintenance costs is £47.68m, as shown in Figure 11 below.

FIGURE 11: AMP8 INVESTMENT VS BASE ALLOWANCE



Source: NWL iMOD costs (proposed investment) and historic maintenance costs

Figure 11 highlights the difference between the implicit allowance and the required expenditure, based on the historic information relating to our expenditure (in 2022/23 prices). The next section goes on to explain how this fits with the modelled allowances from an industry perspective.

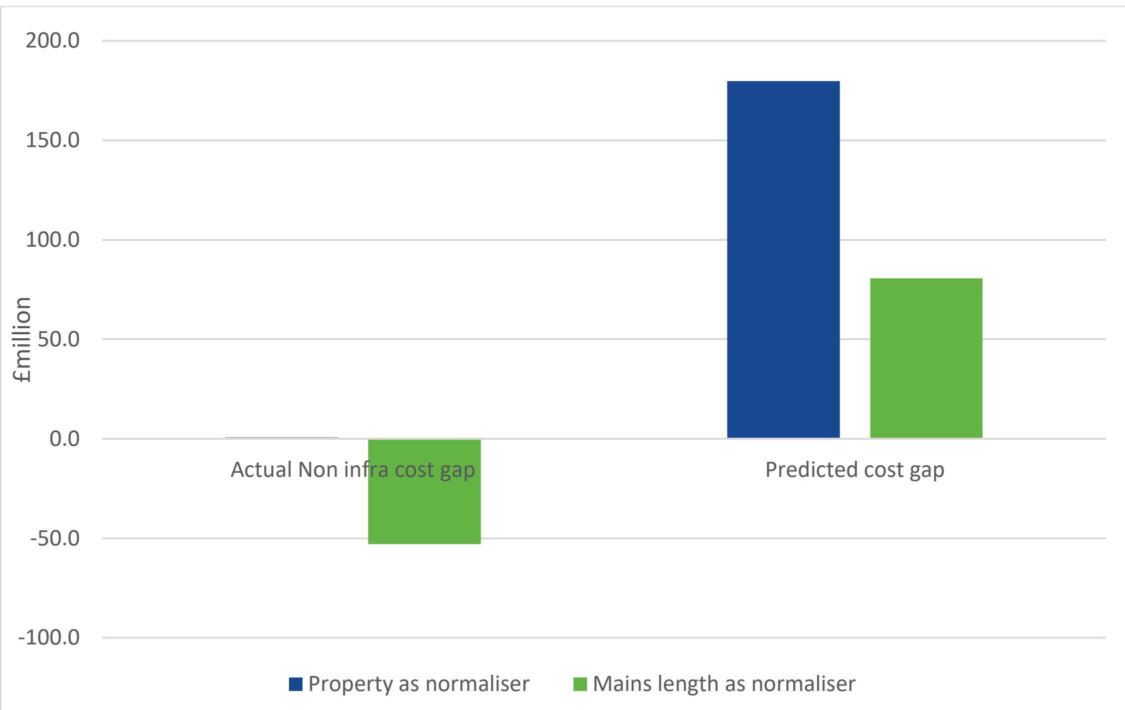
3.2. INDUSTRY COMPARISON

We have carried out industry analysis of water distribution non-infra capital maintenance spend, on both a per household basis, and normalised by km of network. Water distribution non-infra includes investment in service reservoirs and is the most granular industry cost data available on which to base our analysis. The results of the analysis, summarised in Figure 12 show that:

- We have invested at very close to the median level of investment for this category of expenditure. We spent £0.7m less than the median level of expenditure (calculated per household) over the 12-year period 2011-12 to 2022-23. However, using length of mains as the normaliser, we spent £53m more than the median over the same period.

- Ofwat's own cost models for treated water distribution (opex and capital maintenance combined) fund us at a level less than the median – e.g. in 2022/23 the median level of predicted costs from Ofwat's models is £80/household whereas the model funds us at £72 per household (10% less).
- The gap between Ofwat's estimate of costs and the median for Northumbrian Water is £180m (on a per household basis) going back to 2011/12 (i.e. we have been funded £180m less than the median between 2011/12 and 2022/23). Using length of mains as the normaliser, the predicted cost for treated water distribution is £81m less than the median.

FIGURE 12: TOTAL WATER DISTRIBUTION (TWD) COST GAP



Source: NWL analysis of industry data submissions

The analysis shows that we have invested at or above the industry median level for capital maintenance in this area but have been funded at a level much lower than the median. This demonstrates that we have not spent less than other companies and supports our case for additional funding on top of existing allowances which we are currently overspending against our allowed revenues to maintain asset health.

We note that we have used the same method for assessing historic spend against allowances as we have for asset health at civil assets in our main response document (NES80).

3.3. LONGER TERM VIEW OF INVESTMENT NEED

Section 2.2 demonstrates the analysis we have undertaken to assess the impact of deterioration on our service reservoir assets over the long-term and identify the appropriate rate of replacement. The need to replace four service reservoirs in AMP8 is the first step in an ongoing multi-AMP approach to achieving a sustainable programme to ensure asset health over a long-term planning horizon.

During AMP8 we will continue to monitor the condition and performance of our service reservoirs, updating our analysis on the basis of our ongoing inspection and maintenance programme, to ensure our projections remain accurate and the selection of priority sites for replacement in future AMPs is based on the best available data. In line with our risk-based approach to prioritisation, we anticipate the primary focus for the next few AMPs will be on replacement of remaining masonry and GRP structures.

4. BEST OPTION FOR CUSTOMERS

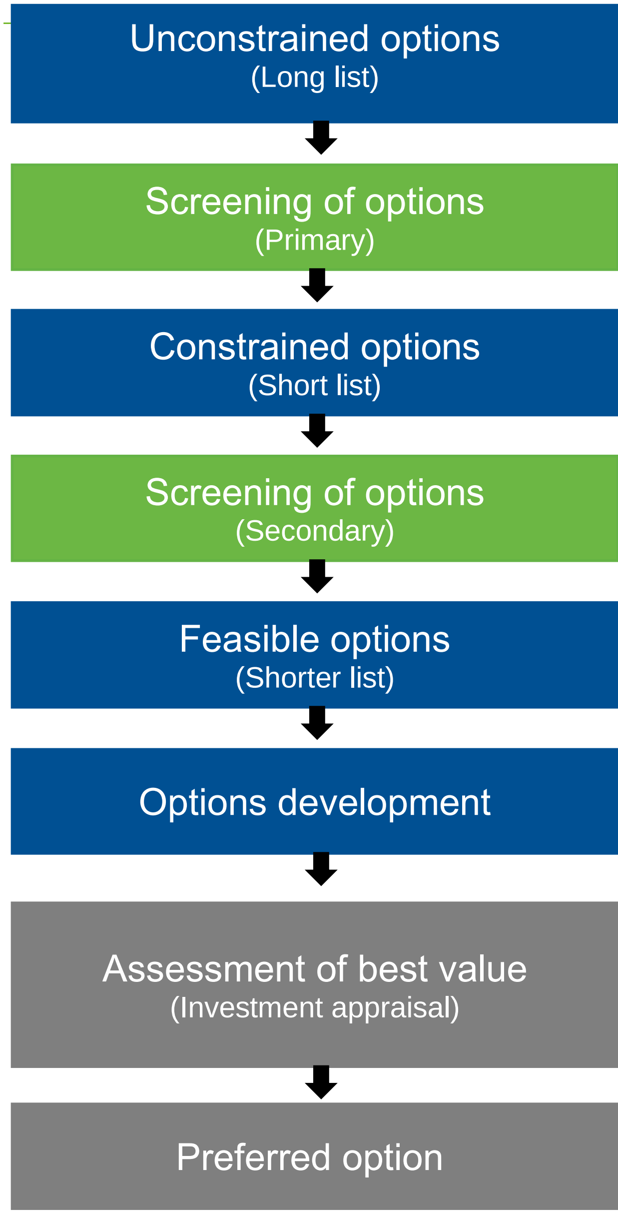
This section explains:

- how we have developed our proposals for investment and identified our preferred options for investment including the costs and benefits of the preferred solutions for customers;
- the evidence that we have of customer support for these proposals, and
- why the proposals are not suitable for DPC in either instance and why we are not able to secure third party funding.

To determine the best option for customers to address the need, we carried out an options identification and screening process as outlined in Figure 13. Our process for identifying the best option for customers is based on the principles of The Green Book: Central Government Guidance on Appraisal and Evaluation produced by HM Treasury.[16] A description of each step and the output from it is contained in the following sections.

[16] The Green Book: Central Government Guidance on Appraisal and Evaluation, HM Treasury, 2022

FIGURE 13: PROCESS FOR DEVELOPING OPTIONS



Unconstrained list of technology options (section 3.1)

We have developed a broad range of options through cross business options development workshops.

Constrained list of technology options (section 3.2)

We have screened the unconstrained list of technology options against:
1) expected to meet statutory obligation, and
2) technically feasible in accordance with health and safety requirements and technology application.

Options development (section 3.3)

For the constrained list of options, we developed the scope up to the Level 3 where possible to enable more detailed cost estimates. With more detailed scope information we have measured the benefits, including carbon emissions, for each option.

Assessment of best value (section 3.3)

We have undertaken an assessment of benefits and net present value for each of the options from the constrained list at each site.

We have also assessed each option against a deliverability assessment as part of our benefits assessment.

Preferred option (section 3.3.2)

We have selected the preferred option based on the outcomes of the best value assessment to maximise value for customers while achieving the regulatory requirement for each need.

Source: NWL PR24 Optioneering methodology

4.1. BROAD RANGE OF OPTIONS

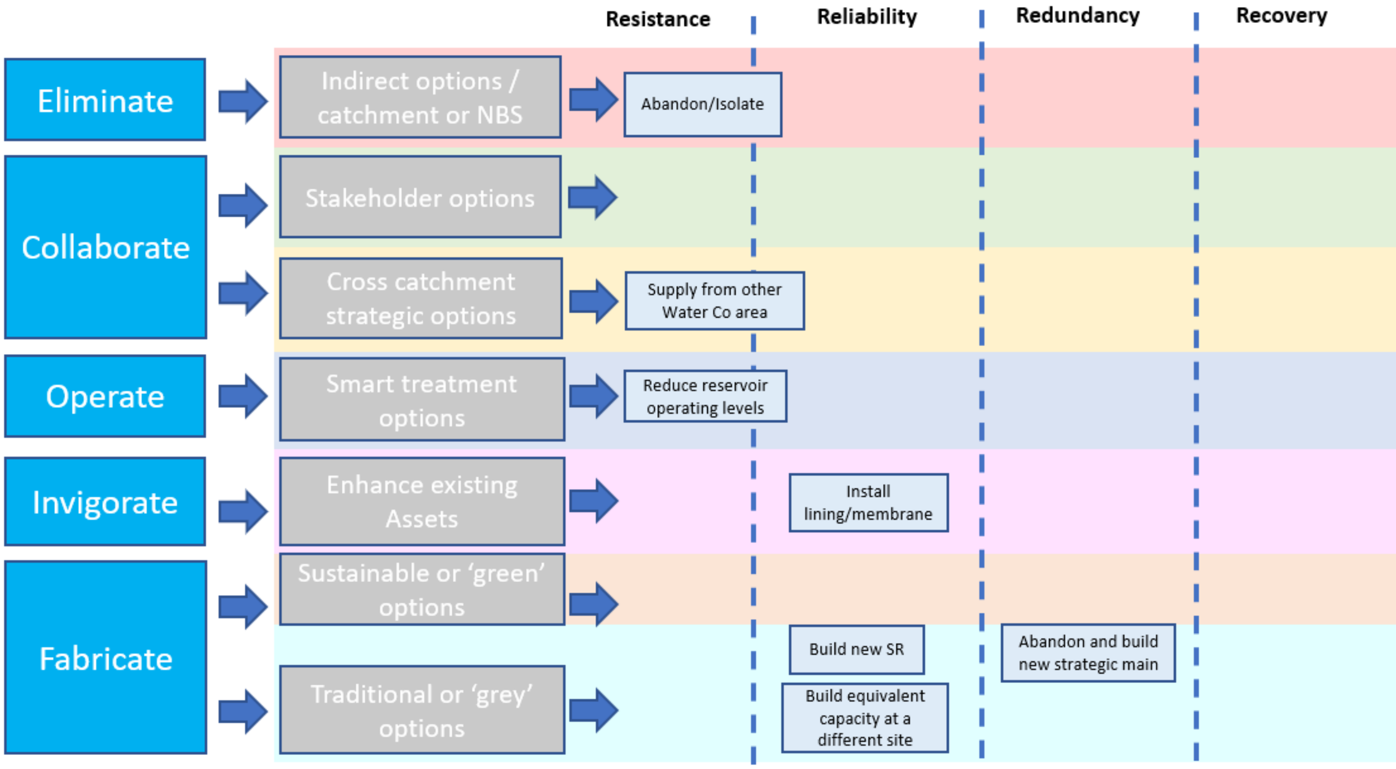
We have developed a range of 7 options, categorised according to the 4 Rs of Resilience.

- Resistance – prevent disruption by providing measures to resist the hazard such as options that reduce the likelihood of asset failure or service impact.
- Reliability – measures to ensure the ongoing reliability of assets, including refurbishment or replacement.
- Redundancy – backup measures that can be implemented when required to manage risk and ensure continuity of service.
- Response and recovery – fast and effective response to, or recovery from, disruptive events. We did not identify any appropriate options that can be used in response to or to recover from age-related deterioration of Service Reservoir assets.

Our unconstrained list considers options in line with our Totex Hierarchy, with differing levels of costs and benefits categorised as follows:

- Eliminate – identification of processes or practices that eliminate the risk of Service Reservoir failure. This includes the option to abandon, isolate or bypass service reservoir assets.
- Collaborate – working with stakeholders to re-assign the issue or co-fund to address it. Costs can be shared with third parties either to deliver the same or an additional level of social and environmental benefit. In this case, the only viable option would be to consider cross-boundary supply options, by agreement with neighbouring water companies. However, none of our priority sites for AMP8 are close enough to the boundary of our operational area to make this a viable option. This will be considered in future AMPs, based on the geographical location of priority service reservoir sites.
- Operate – this would involve improving our operational management practices to reduce the risk of age-related failure of service reservoir assets.
- Invigorate – this would involve investing in existing infrastructure to improve performance. These options will provide an increased level of benefit but may be of a lower cost than fabricate options. In this case, options are limited to refurbishment or re-lining of service reservoir structures. It should be noted that our priority sites have previously been refurbished, with linings applied (in some cases multiple times) to extend the asset life and provide best value for customers. As per the DWI's guidance, linings are a temporary solution to extend asset life and not generally considered repeatable once the lining has deteriorated.
- Fabricate – investing in new assets to augment or replace existing assets to address the need. While these options are likely to have the highest capital costs, a new service reservoir will likely have an asset life > 100 years. Therefore, timely replacement of old and deteriorated assets can be better value for customers than frequent and increasingly costly refurbishment interventions.

FIGURE 14: THE UNCONSTRAINED LIST OF OPTIONS AND ALIGNMENT TO THE TOTEX HIERARCHY CATEGORIES AND 4RS OF RESILIENCE



Source: NWL PR24 Optioneering process

4.2. OPTIONS SCREENING

We have screened our unconstrained list of options for the four priority AMP8 Service Reservoir sites to determine whether the intervention:

- is technically feasible,
- addresses the need identified in Section 2.

Options that did not satisfy both criteria were rejected with remaining options carried forward to secondary screening, as shown in Table 4.

Secondary screening of the constrained list of options involved determining the costs, carbon impacts and benefits for each option. This process produced a feasible list of options for each need, which is shown in

Table 5. We identified three feasible options for Blakelaw, and two for Auton Stile, Stoneygate and Ryhope.

Our assessment of benefits for the options is included in Section 4.3 and our approach to costing is outlined in Section 5. This has been used to inform the cost benefit appraisal to determine the preferred option.

TABLE 4: OPTIONS SCREENING

Totex Hierarchy	Options		Technically Feasible?	Addresses AMP8 risk?	Resilience approach	Notes
Eliminate	1	Abandon and bypass Service Reservoir	No	No	Resistance	**Rejected:** Reduction in SR capacity in the network impacts supply resilience
Collaborate	2	Abandon Service Reservoir and supply from other Water Co area	No	No	Resistance	**Rejected:** Not feasible due to the locations of the 4 priority reservoirs.
Operate	3	Reduce operating levels	No	No	Resistance	**Rejected:** Reduces water available for supply with no reduction in water quality or asset failure risk
Invigorate	4	Install lining/membrane	Yes	No	Reliability	**Rejected:** Priority sites have already been lined at least once. Short term solution and complex to execute where previous linings have deteriorated.
Fabricate	5	Build new Service Reservoir (like for like replacement)	Yes	Yes	Reliability	**Carried Forward:** Land purchase necessary to allow construction alongside existing asset and retain continuity of supply
	6	Abandon and build new equivalent capacity at a different site	Yes	Yes	Reliability	**Carried Forward:** Feasible where nearby sites have space to accommodate equivalent capacity.
	7	Abandon and feed from alternative site with Pumping and network upgrade	Yes	Yes	Reliability	**Carried Forward:** Only feasible where SRs are close to alternative site with appropriate capacity
	8	Abandon and build new strategic main extension to replace supply	Yes	Yes	Redundancy	**Carried Forward:** Only feasible where SRs are close to existing strategic mains, otherwise likely to be prohibitively expensive.

Source: NWL PR24 Optioneering process

TABLE 5: CONSTRAINED LIST OF OPTIONS FOR OUR PRIORITY SITES

Totex Hierarchy Categories	Options		Resilience approach	Priority Sites
Fabricate	5	Build new Service Reservoir (like for like replacement)	Reliability	Auton Stile, Blakelaw, Stoneygate
	6	Abandon and build new equivalent capacity at a different site	Reliability	Ryhope, Blakelaw
	7	Abandon and feed from alternative site with Pumping and network upgrade	Reliability	Blakelaw
	8	Abandon and build new strategic main extension to replace supply	Redundancy	Auton Stile

Source: NWL PR24 Optioneering process

4.3. BEST VALUE

4.3.1. Benefit scoring

For each option carried forward to this stage we have completed a benefits assessment using our Value Framework[17] which contains a wide range of benefits that reflect measures relating to performance commitments or other social and environmental values. Our Value Framework is embedded into our portfolio optimisation tool, Copperleaf. Table 6 shows the range of benefits (value measures), including their quantification and monetisation values, that we have used for the assessment of the shortlisted options.

TABLE 6: RANGE OF BENEFITS IDENTIFIED FOR RAW WATER DETERIORAITION

Value measures	Description	Unit	Value	Aligned to a performance commitment?
Interruption to Supply	Cost of reducing interruptions to supply events	£/interruption duration per property per year	Value derived from lookup table based on scale and duration of event	Yes
Reduced Unplanned Outage	Cost of reducing the number of unplanned outages	£/Ml	Value calculated based on lookup table of event duration and population affected	Yes

[17] Northumbrian Water Limited Value Framework Definition Document, v1.16, Copperleaf Technologies Inc., 2002

CRI Score	Reduction of instances of Drinking Water Inspectorate (DWI) noncompliance	CRI Score	Non-monetised, but £ value is captured in Water Quality Compliance model (below)	Yes
Water Quality Compliance	Number of water quality non-compliance events	£/Non-compliance event	Value derived from lookup table depending on event type and scale	No – captured in CRI score (above)
Operational Emissions	t/CO_2e / year	tCO_2e	£256.20 [18]	Yes
Embedded Emissions	t/CO_2e / year	tCO_2e	£256.20 [14]	Yes

Source: NWL Copperleaf Value Models

For the benefits assessment, we score the impact of the 'do nothing' option as a baseline, and then score the benefits associated with each of the alternative options. Annual benefits are scored over a 30-year time horizon.

The value measures in Table 6 cover water quality risk, water supply interruption risk and both the operational and embedded carbon impacts.

4.3.2. Cost benefit appraisal to select preferred option

For each of the feasible options we have carried out a robust cost benefit appraisal within our portfolio optimisation tool to select the preferred option. This calculates a net present value (NPV) over 30 years, using the Spackman discounting approach in accordance with the PR24 Guidance, and the cost to benefit ratio for each option. The ratio is calculated by dividing the present value of the profile of benefits by the present value of the profile of costs over the appraisal period of 30 years.

Costs and benefits have been adjusted to 2022/23 prices using the CPIH[19] Index financial year average. The impact of financing is included in the benefit to cost ratio calculation. Capital expenditure has been converted to a stream of annual costs, where the annual cost is made up of depreciation / regulatory capital value (RCV) run-off costs and allowed returns over the life of the assets. Depreciation (or run-off) costs are calculated using straight-line depreciation over the appraisal period. To discount benefits and costs over time, we have used the social time preference rate set out in The Green Book[20].

[18] £ value per tonne of CO_2e in 2025/26, annual increase (varying rate) reaching £378.6/t CO2e in 2054/55

[19] Consumer Prices Index including owner occupiers' housing costs.
[20] The Green Book: Central Government Guidance on Appraisal and Evaluation, HM Treasury, 2022

The NPVs generated by our portfolio optimisation tool are included in Table 7. We note that the NPVs for all options are negative. However, our benefits assessment has been limited by available value models, and so our NPV is not a true reflection of all benefits that will be delivered through these options. Regarding the limitations of the NPV figures generated, we note that:

- This investment relates to replacement of existing end-of-life assets to maintain existing levels of service, and therefore the benefit relates only to the avoidance of service impact through degradation-related asset failure. Calculated benefits in our Copperleaf system are therefore relatively small.
- Therefore, the NPV calculation is predominantly driven by the project capex and carbon costs, with little monetised benefit calculated over the 30-year NPV period to offset those costs.

TABLE 7: BENEFIT TO COST RATIO AND THE PREFERRED OPTIONS TO ADDRESS THE GEOSMIN NEEDS

Site	Option	Net Present Value (30 years) (£m)	Benefit: Cost	Type of Option
Auton Stile	Build like for like replacement on adjacent land (10.5 MLD)	-£10.718	0.02	Preferred
	Abandon and duplicate South Derwent main from Mosswood WTW to Auton Stile	-£73.610	0.00	Alternative
Blakelaw	Build like for like replacement on adjacent land (1.5 MLD)	-£2.598	0.03	Preferred
	Abandon and feed from West Swansfield (upgrade Camphill PS & network)	-£4.120	0.3	Alternative
	Abandon and build 1.5 MLD capacity at Shilbottle Grange (new 7.8km main)	-£15.003	0.01	Alternative
Ryhope	Build like for like replacement (16.5 MLD) at Dalton WTW site with Pump Station to lift into existing main	-£16.037	0.06	Preferred
	Build replacement at Dalton site with 25 MLD capacity to replace both Ryhope and Mill Hill service reservoirs	-£28,046	0.04	Alternative
Stoneygate	Build like for like replacement on adjacent land ((22 MLD)	-£19.653	0.01	Preferred
	Build like for like replacement on same land – includes temporary measures to maintain supply during construction	-£22.367	0.01	Alternative

Source: NWL Copperleaf output

In all cases, the data shows the replacement option to have the most favourable NPV compared to the alternative solutions considered.

4.4. THIRD PARTY FUNDING

No opportunities for third party funding are available to address this need.

4.5. DIRECT PROCUREMENT FOR CUSTOMERS

We assessed these investments against the Direct Procurement for Customers (DPC) guidance. We noted that they would not pass the ‘size’ test, as they have a whole life cost less than £200m.

4.6. DELIVERABILITY ASSESSMENT

We have carried out a deliverability assessment for our options to provide certainty that our short-listed options are deliverable during AMP8. This has considered:

- The technical feasibility of implementing the intervention – all the short-listed options are technically feasible to implement.
- Phasing of delivery and expenditure based on projects of a similar scale and complexity in AMP7.
- Lessons learned from other projects to encourage efficiency – specifically learning obtained during delivery of recently constructed service reservoirs and contact tanks (e.g. Springwell), including aspects related to timescales for planning consultation and approvals.

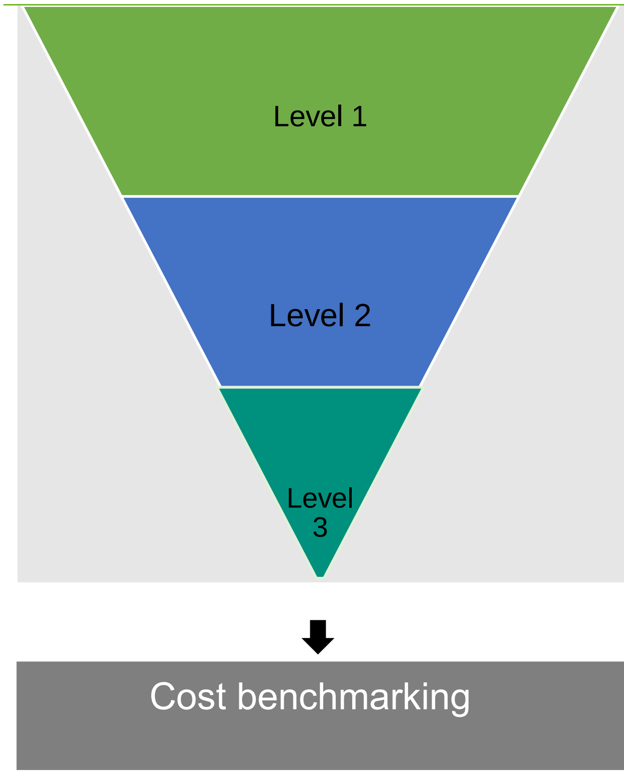
Our deliverability assessment has concluded that we can deliver any of our short-listed options in the 2025-30 period.

5. COST EFFICIENCY

5.1. COST METHODOLOGY

A full description of our costing methodology is contained in appendix A3 – Costs (NES04). We have used a three-level estimating approach for developing our PR24 costs, as outlined in Figure 15.

FIGURE 15: COST ESTIMATION



Level – 1 (confidence: – 50% to +100%)

Costing is carried out using Northumbrian Water's iMOD Express or Costing Tools, which utilise costing curves at the asset level. This enables order of magnitude estimating for rapid optioneering.

Level – 2 (confidence: - 50% to + 50%) – Chosen Approach

Costing is carried out using Northumbrian Water's iMOD cost estimating system, which utilises costing curves for the main items of scope. This provides detailed cost estimates for main scope items.

Level – 3 (confidence: - 20% to +30%)

Detailed bottom-up cost estimates are developed for all items within scope. This requires detailed scoping to enable more detailed cost to be established.

Cost benchmarking

We have benchmarked 100% of the preferred options against the available cost curves from other companies. Further detail is provided in Section 4.3.

Source: NWL PR24 cost benchmarking

Costing of our service reservoir options has been carried out to Level 2, using our iMOD system – our engineering scoping and cost estimating software system, which provides an integrated platform for project scope definition, whole life costing and tender evaluation. There are two estimating approaches within the iMOD system: iMOD Express and iMOD Engineering Scoping and Estimating. iMOD Express is an asset level cost triage system that provides high-level CAPEX and OPEX estimation based on a single overarching cost driver. We use this extensively for Level 1 estimations. We used the full iMOD estimation package to develop Level 2 costs for our short-listed service reservoir options.

The iMOD Engineering Scoping and Estimating comprises a suite of 50 engineering scoping models and a large and detailed cost database containing thousands of costing data-points on a range of components and assets. With minimum input criteria based on data that is readily available at project inception, the system can provide a detailed Capex, Opex and whole life costing for a range of interventions based on relevant cost curves. The cost estimates have been produced using Asset Policy Group (APG) Water specific cost curves for Process, Component, Contract, and Project Overheads.

5.2. PREFERRED OPTION COSTS

The iMOD Level 2 costs generated for the preferred options at our four priority sites are shown in Table 8. Capex includes the engineering scope cost and overheads. Based on our deliverability assessment, we can deliver all four projects within the AMP8 period. No opex costs are recorded against most sites as there will be no change from the current opex requirement. However, opex costs for Ryhope are included as the scope of the preferred solution is to build equivalent capacity at our Dalton WTW site which requires additional opex to power a pumping station that will lift flows into the main. Therefore the opex costs included for the Ryhope option reflect the delta between current opex costs and the calculated opex for the preferred option. AMP8 Opex costs for have been calculated in line with the spend profile shown in

Table 9, with only year 5 incurring the additional opex costs on completion and commissioning.

TABLE 8: IMOD COSTS FOR PRIORTY SITES

Site	Preferred Option	Capex – excl. OH + risk (£m)	Capex – inc. OH + risk (£m)	Annual Opex (£m)	AMP8 Total Opex (£m)	Totex (£m)
Auton Stile	Build like for like replacement on adjacent land (10.5 MLD)	4.782	11.402	N/A	N/A	11.402
Blakelaw	Build like for like replacement on adjacent land (1.5 MLD)	1.014	2.813	N/A	N/A	2.813
Ryhope	Build like for like replacement (16.5 MLD) at Dalton WTW site with Pump Station to lift into existing main	6.928	16.195	0.103	0.103 (year 5)	16.298
Stoneygate	Build like for like replacement on adjacent land ((22 MLD)	8.865	20.507	N/A	N/A	20.507

Source: iMOD cost estimation

The Capex spend profile for delivery of the four priority service reservoir projects is shown below. These figures are total estimated costs, prior to deduction of the calculated implicit allowance and maintenance savings.

TABLE 9: OPTION TOTAL CAPEX PROFILE IN AMP8 (£M)

Site	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Auton Stile	0.25	3.10	6.89	1.17	0.00	**11.402**
Blakelaw	0.13	1.73	0.95	0.00	0.00	**2.813**
Ryhope	0.32	3.98	9.97	1.92	0.00	**16.195**
Stoneygate	0.31	3.34	10.72	5.65	0.48	**20.507**
Total	**1.01**	**12.16**	**28.53**	**8.74**	**0.48**	**50.92**

Source: iMod cost estimation

Table 10 below shows the calculation of capex costs associated with our claim. We have deducted the following costs from the total capex:

- Annual implicit allowance of £463k, calculated based on our historic service reservoir replacement costs as detailed in Section 3.1.
- An estimated annual maintenance saving of £184k associated with the four priority sites. This is based on analysis of our actual maintenance costs for Auton Stile, Blakelaw, Ryhope and Stoneygate during AMP5, AMP6 and AMP7, which we have used to generate an annual average.

TABLE 10: AMP8 CAPEX COSTS AFTER ADJUSTMENT

Site	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Total Capex	1.01	12.16	28.53	8.74	0.48	50.92
Implicit Allowance	0.463	0.463	0.463	0.463	0.463	2.315
Maintenance cost saving	0.184	0.184	0.184	0.184	0.184	0.92
Capex Claim	**0.363**	**11.513**	**27.883**	**8.093**	**-0.167**	**47.685**

Source: iMOD (project costs), historic service reservoir costs (implicit allowance and maintenance cost saving)

5.3. COST BENCHMARKING

We have benchmarked all four of our preferred option project estimates against comparable water and wastewater companies. The benchmarking compares our iMod estimates against five comparable water and wastewater companies in England and Wales. A mean average from company data has been used as the benchmark with a 25th and 75th percentile provided as a suitable range. The cost comparisons have been calculated using the latest cost curve data from each company, and reflect the same data used by each company to build its PR24 submission. The costs generated by each cost curve are based on appropriate sizing metrics – in the case of service reservoir assets, the cost models are based on overall capacity in megalitres per day (MLD). Where included in the scope, additional elements such as connecting pipework, pumps and other ancillary items have also been incorporated in the benchmarking. Overall, between 94% and 100% of the scope of each project cost estimate has been benchmarked.

The benchmarked costs have been adjusted for inflation using CPIH and have a price base of Q2 2022.

Table 11 shows the outcome of the cost benchmarking analysis for the service reservoir sites. The analysis shows our iMod calculated costs are 23% higher than the benchmark cost. A potential explanation for the variance is the fact we have built few new service reservoirs in recent years (in line with our risk-based approach to service reservoir maintenance described in Section 2), and the cost data from current resilience projects for additional reservoir capacity (e.g. Springwell) are not yet incorporated in our cost model. Updating the model in future years, based on project cost analysis for new build service reservoirs, will improve the number of data points and the overall accuracy of our cost model.

We accept that based on our benchmarking data, it would be reasonable to apply a 23% efficiency to our costs. However, because the results of the cost benchmarking were generated after completion of data table reporting, we have not applied this to the costs shown in Table 1 and Table 10.

TABLE 11: COST BENCHMARKING OUTCOMES

Site	Northumbrian cost	Benchmark cost	25th percentile	75th percentile	Delta	Delta %
Auton Stile	11,401,300	9,782,718	8,837,407	10,728,030	1,618,581	16.55%
Blakelaw	2,813,281	2,749,526	2,159,015	3,340,036	63,755	2.32%
Ryhope	16,194,304	13,430,741	12,331,726	14,529,757	2,763,562	20.58%
Stoneygate	20,506,703	15,305,785	14,365,385	16,246,186	5,200,917	33.98%
Total	**50,915,590**	**41,268,772**	**37,693,534**	**44,844,010**	**9,646,817**	**23.38%**

Source: Cost Benchmarking Outputs

In addition to benchmarking project scope, we conducted analysis of client and contractor indirect costs, comparing our own project and contract overheads to data provided by the same six comparator water companies. Table 12 shows that our indirect costs are calculated as 63.40% of direct costs compared to the industry benchmark of 73.86%. Our indirect costs are therefore 10.46% below the industry benchmark. Our estimate also includes a 10% uplift for risk and 30% for estimating uncertainty.

TABLE 12: INDIRECT COST BENCHMARKING OUTCOMES

Indirect cost type	Northumbrian cost	Benchmark cost	Delta
Total Contractor Indirect	36.88%	48.01%	-11.14%
Total Client Indirect	26.52%	25.84%	0.68%
Total Project Indirect	63.4%	73.86%	-10.46%

Source: Cost Benchmarking Outputs

6. CUSTOMER PROTECTION

We have not proposed a specific PCD for this enhancement case, but this would be closest to the PCD for reservoir safety proposed in Ofwat's DD – that is, based on delivery by 31 March 2030 and with independent third-party assurance.

In our business plan, we recommended setting these types of PCDs at the specific rates for each deliverable rather an average unit rate, to reflect the different costs of these.