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APPENDIX 3.2

ENHANCEMENT BUSINESS CASES

March 2019

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WINEP NERC Priority Habitat

Name of claim	PR19 ENHANCEMENT BUSINESS CASE: WINEP – Making ecological improvements at abstractions (Habitats Directive, SSSI, NERC, BAPs)	
Name and identifier of related claim submitted in May 2018	Not Cost Adjustment Claim	
Business plan table lines where the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line A1	
Total value of enhancement for AMP7	£1.00 million	
Total opex of enhancement for AMP7	£0.00 million	
Total capex of enhancement for AMP7	£1.00 million	
Depreciation on capex in AMP7 (retail controls only)	[n/a]	
Remaining capex required after AMP7 to complete construction	None.	
Whole life totex of claim	N/A	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	Material	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		✓
Need for investment/expenditure	Meet regulatory drivers relating to the Natural Environment & Rural Communities (NERC) Act	
Need for the adjustment (if relevant)	N/A	
Outside management control (if relevant)	N/A	
Best option for customers (if relevant)	To complete works as outlined in this business case. Regulatory obligation as in WINEP.	
Robustness and efficiency of claim's costs	See Section 7: All costs for schemes in this business case were provided and assured by the NW Cost Assurance team. These costs were benchmarked and assured (Assessment and forecasting of historical spend). The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018. The cost confidence in each business case as a whole has been assessed using the following methodology:	

	• **Green** - Over 75% achieving Green RAG status • **Amber** – Over 65% achieving Green or over 90% achieving Amber RAG status • **Red** – Not achieving Green or Amber. This review has assessed scheme costs as Amber. NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.
Customer protection (if relevant)	See Section 8: WINEP cost adjustment mechanism
Affordability (if relevant)	See Section 8: The bill impacts would rise to £0.03 a year in 2024/25. This is set within an overall bill drop of more than 12% in AMP7.
Board Assurance (if relevant)	See Section 8: The full board have signed a revised Board Assurance Statement at the full board meeting on the 29th of March 2019 confirming that they have seen and are confident in the enhancement cases.

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WINEP NERC Priority Habitat

1. Executive Summary

This enhancement scheme business case covers a named scheme in our part of the Water Industry National Environment Programme (WINEP) with a NERC driver to increase priority habitat. As the WINEP is compiled by the Environment Agency, the inclusion of the schemes in the WINEP means that it is supported by the Environment Agency.

This enhancement scheme will meet the regulatory drivers relating to the Natural Environment & Rural Communities (NERC) Act and is part of the Environment Agency's WINEP. It covers measures that will conserve and enhance the biodiversity value of Northumbrian Water Group's (NWG's) landholding and the area in which it operates. It will achieve this by increasing the amount of priority habitat both on NWG's land; it will monitor and measure the impact of NWG's work on its landholding and; it will increase the amount of priority habitat in NWG's operating area through partnership working. The measures to be undertaken have been agreed with the Environment Agency and Natural England.

The total estimated cost to complete this work is £1.00m and will be spent on both NWL's NW and ESW land holdings.

Customer engagement is less relevant for this enhancement as it derives from a statutory programme of work (the WINEP) and is therefore obligatory, regardless of customer opinion. Engagement has been carried out with the Water Forum and other interested stakeholders in NWG's operating area all of whom are supportive of the scheme. The principles of NWG's NERC related input into the WINEP have been discussed with the Water Forum which includes a representative of the Consumer Council for Water (CCW) who supported the approach being taken and implemented via the 3 lines included within WINEP3. Other customer research carried out on behalf of NWG indicates that customers generally support NWG's aspirations. Focus group research (Explain, 2014) found that most participants (87%) agreed with NWG going above and beyond government requirements and spending more of customers' money on protecting wildlife and habitats. Recent workshops (Explain, 2017) indicated that participants expect NWG to be speaking to and working with the Environment Agency and other environmental organisations on environmental issues.

2. Context and Scope

This scheme meets the business outcome: We take care to protect and improve the environment in everything we do, leading by example. NWG's ambition for the wider environment is "to work with others to play our part and demonstrate national leadership in providing an enhanced and sustainable environment, valuing the natural capital and the supporting ecosystem services it provides, to meet the needs and aspirations of our customers, partners and communities within our regions".

Within NWG's wider environment strategy, this scheme will contribute to two of the objectives:

- To aim for a positive impact on the environment across our business activities and set targets to drive change where we can;
- To protect and enhance biodiversity and support conservation activities in the catchments within our regions.

All aspects of this enhancement scheme are in alignment with the aims of Defra's recently published 25 Year Environment Plan and will support some if its objectives.

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WINEP NERC Priority Habitat

The proposed work is over and above the current level of conservation management, focusing on habitat restoration and creation, leading to a genuine enhancement in the biodiversity value of NWG's operating areas.

The regulatory driver for this work is the Natural Environment & Rural Communities (NERC) Act, and it will be delivered via the Water Industry Natural Environment Programme (WINEP). Whilst this regulation has been in existence for a number of years now, this enhancement work will enable NWG to increase the work it can deliver, and significantly contribute to the targets of Defra's 25 Year Environment Plan.

NWG is the owner of a variety of habitats, including many of those on the priority habitats list (as detailed in section 41 of the NERC Act). When NWG undertakes capital projects on its landholdings under its permitted development rights, this can lead to the loss of priority habitats that were previously managed for their conservation value. It can also lead to opportunities for the creation of new areas of priority habitat which adds to the stock of natural capital that NWG manages. The first two parts of this enhancement scheme aim to ensure that NWG leaves a positive impact on priority habitats and biodiversity as a consequence of the work it carries out; and will measure and monitor the impact that NWG is having.

NWG also plays a large part in the catchments in which it operates and on which it relies for raw water. The third part of this scheme enables NWG to utilise it's reputation for positive partnership working and to help leave a positive, lasting legacy in its operating areas by helping to create and restore priority habitat, focussing on areas outside the protected sites, as recommended in the 25 Year Environment Plan.

The enhancement scheme is in three parts:

- To increase the priority habitat owned by NWG by 1%. This equates to 12ha (using Natural England's GIS layer (2017) as the baseline).

- Increase the biodiversity value of the land owned and / or managed by NWG. Currently a site ranking system for biodiversity (& other ecosystem services) is being developed, once this is in place, a target will be set to increase a number of NWG's sites into a higher rank – this will test the effectiveness of the ranking system.

- To work in partnership in NWG's operating areas to enhance or restore 250ha of priority habitat, using Branch Out as a delivery mechanism.

This expenditure is classed as enhancement rather than base maintenance because it is included in the Water Industry Natural Environment Programme (WINEP). Completion of the WINEP will enhance the capacity and quality of services beyond current levels and support our Environmental outcomes as well as ensuring NERC obligations are fully met in a way that aligns with Defra's 25 Year Environment Plan.

This Business Case relates to the NERC driver line in Table WS2; there is a slight overlap with regard to development work to the Branch Out software, which is shared with the INNS driver line in Table WS2. The costs for this work have been shared between the two lines.

3. Customer Stakeholder and Expectation

The expected scope of NERC related measures to be included in the PR19 WINEP is set out in the Environment Agency's "PR19 Driver Guidance: NERC and biodiversity priorities" (Jan 2017). The driver objective is to deliver "investigations or schemes to contribute to biodiversity priorities and obligations on water company owned land or in the catchments they influence and operate in".

NWG has liaised with local Environment Agency and Natural England teams, and via escalation to the Environment Agency's national consistency panel, to ensure that our plans meet their expectations. The latest version of the WINEP3, issued 30th March 2018, confirms the Environment Agency's acceptance of the proposed programme.

Whilst this enhancement scheme is regulatory driven, we have still consulted with our stakeholders to ensure they are in support of this. Workshops were held in summer 2017 attended by a variety of stakeholders with an interest in the natural world, it was agreed that NWG could have a positive impact on biodiversity on and off its own landholding. The principles of NWG's NERC related input into the WINEP have been discussed with the Water Forum which includes a representative of the Consumer Council for Water (CCW) who supported the approach being taken and implemented via the 3 lines included within WINEP3.

Early engagement with the Water Forum explored the options for the aspects of this enhancement scheme solely on NWG's landholding. They challenged the level of change it could achieve and suggested utilising the great track-record NWG has for working in partnership to be more ambitious and deliver greater benefits. This led to the development of the third aspect of this scheme – restoring and creating priority habitat in NWG's operating area.

Stakeholder engagement has demonstrated how important NWG's stakeholders consider NWG's impact on the natural world to be. This scheme provides a quantifiable means of enhancing NWG's land holding and adding to the amount of priority habitat which it owns and / or manages.

Other customer research carried out on behalf of NWG indicates that customers generally support NWG's aspirations. Focus group research (Explain, 2014) found that most participants (87%) agreed with NWG going above and beyond government requirements and spending more of customers money on protecting wildlife and habitats. In 2016 NWG conducted customer research on River Water Quality. The outcome was that customers were strongly supportive of improvements in River Water Quality. Recent workshops (Explain, 2017) indicated that participants expect NWG to be speaking to and working with the Environment Agency and other environmental organisations on environmental issues.

In March and April 2018, NWG conducted two phases of deliberative qualitative research with customers to explore their acceptability for a range of discretionary enhancement schemes. The schemes were presented in the context that in 2020 customers' bills would be reduced by 10% and that the schemes could be funded by making the 10% reduction smaller. When reviewing the results of the engagement, we considered customers' acceptability to be anything over 70%. This was based on CCWater's Threshold of Acceptability research that was carried out for PR14. The second phase of research was conducted because in the first phase a number of customers stated that they did not know if they accepted the schemes. We discussed this with our Water Forums and agreed that we should carry out additional engagement to understand why this was, and what information we would need to provide to customers to allow them to answer the acceptability question. The results from the acceptability engagement were discussed with our Water Forums, who welcomed the generally very high levels of customer support for the schemes. Members did not agree on a definitive threshold for support in percentage terms, however some views shared were

that anything over about 60% would be acceptable. All our enhancements were included in our overall acceptability research, where our plan was supported by 91% of customers.

Delivery of WINEP is a statutory requirement and hence not dependent on customer support, however our plan is stronger for knowing that customers do support this. Our Water Forums are supportive of our WINEP proposals which we shared with them in April 2018.

Therefore, we believe that the scope of the WINEP is in keeping with customer's expectations.

In summary, successful delivery in customer benefit terms, will be completion of the agreed WINEP programme.

4. Current and Historical Service Delivery and Expenditure

There have not historically been any NERC driven schemes delivered via the WINEP; however NWG has a good track record of delivering other enhancement schemes via this mechanism.

The NERC Act has been in existence since 2006, and NWG has historically met its regulatory requirements though its operational budget, and hasn't included enhancement schemes through previous National Environment Programmes. Recently there have been a number of initiatives that the WINEP seeks to strengthen via the NERC driver such as the National Pollinator Strategy. The specific priorities that the Environment Agency requires water companies to contribute to are:

- The biodiversity priorities in the 25 Year Environment Plan
- Halt overall biodiversity loss
- Support healthy well functioning ecosystems and establish coherent ecological networks
- Seek wider biodiversity benefits and linking habitats
- More and better places for nature for the benefit of wildlife and people and the associated Lawton principles of making our network of wildlife sites 'bigger, better and more joined up'
- Where there is opportunity more people should understand how a clean environment improves their lives and livelihoods

This Environment Agency approved enhancement scheme aims to work towards these priorities which expand and build on the original requirements of the NERC Act (2006) – a duty to conserve biodiversity.

5. Forward Looking Analysis

This enhancement scheme will ensure that NWG meets its regulatory requirements with regards to the NERC Act. The NERC Act places a duty on every public authority, including water companies, to have regard to conserving biodiversity. This is with the aim of restoring or enhancing a species population or habitat and reflects the government's ambition for the 'prevention of further human-induced extinctions of known threatened species'. Section 41 of the NERC Act sets out a list of species and habitats which in the Secretary of State's opinion are of principal importance for the purpose of conserving biodiversity in England (priority habitats and species).

This enhancement scheme will also enable NWG to contribute to meeting biodiversity priorities identified in the 25yr Environment Plan; to support healthy well-functioning ecosystems and establish coherent ecological networks; to help try and halt overall biodiversity loss and; to

contribute to making more and better places for nature for the benefit of wildlife and people in line with the Lawton principles.

6. Option Appraisal

With the aim for NWG to ensure that it makes a positive impact on biodiversity, and the NERC regulatory driver, the option of doing nothing was not considered. Initially work focussed on the difference NWG could make on its own landholding, building on the amount of priority habitat it currently owns and manages. The level of a 1% increase in priority was set, alongside development of targets monitoring and measuring the biodiversity value of its landholding once the ranking system currently being developed is in place. The proposed split of habitats included in the 1% increase is based on the increasing concern for availability of habitat for pollinators (an additional driver from Defra) and the cost of establishment of the different habitat types.

The Water Forum challenged this ambition and suggested NWG builds on its reputation for partnership working to deliver more so investigations were carried out to determine what could be done, and at what scale. It was then agreed that the enhancement scheme should be expanded to include working in partnership for the benefit of biodiversity in NWGs operating area.

Options for deliver of this latter part of the scheme were – if new partnerships should be established, if NWG could carry out the restoration work before passing the land onto others to manage etc. It was decided that the best option for the sustainable management of the habitats and for value for money is to use the Branch Out project that is already in place, and modify it to have one strand focussing purely on priority habitat creation and restoration.

7. Preferred Plan / Option and Costings

The preferred plan for the first aspect of the enhancement scheme is to increase the amount of priority habitat on NWG's landholding by 12 ha. 12 ha represents 1% of the Natural England priority habitat GIS layer that was available in 2017. This will be split across NWG's operating area, with 2/3rd delivered in the north east region and 1/3rd in the east anglian region, which is proportionate to the relative sizes of the two operating regions. Records will have to be kept detailing if priority habitat is lost as a consequence of NWG's operating activity as well as records showing where habitat is restored or created.

Risks: There is a risk that depending on the impact of NWG's overall investment programme on NWG's current landholding, work to adequately compensate that may require greater than normal level of consultant input to ensure that the overall gain of 12ha is required due to the relatively small size of the conservation team. This is unlikely, but still a potential risk which could result in an additional cost associated with consultant use in the delivery of the investment programme. This risk will be managed by close prioritisation of work within the Conservation Team and early identification of potential problems to discuss re-scheduling of works to reduce unmanageable peaks in work load. Also, it may be that five years isn't sufficient for newly created habitats to be considered priority habitats, but the plan of how to get them to that point should be in place.

The second aspect of this scheme is to monitor and measure the impact that NWG is having on its landholding in terms of value for nature. Before any strong targets can be set for the on-going management of NWG's landholding for biodiversity value, a baseline needs to be established. Work is on-going to implement an innovative ranking system, aiming to consider the other ecosystem services NWG's landholding provides alongside its biodiversity value. Once this in

place, the enhancement scheme will test this ranking system to ensure it is fit for purpose and will determine what targets can be set for future years.

Risks: It may take longer than expected to implement the site ranking system which may delay the start of the testing process to monitor and measure biodiversity value. The other risk is that the ranking tool is not effective and modifications have to be made to it, and no budget has been allocated for modifications. Sufficient testing of the ranking system will however be able to be carried out even if it hasn't been fully implemented; and the there is a high confidence level that learning from the outputs of that testing will be sufficient to identify requirements for investment and developments in future periodic reviews.

The third part of this scheme provides for NWG to work in partnership with other users and owners of its catchments to restore or create priority habitats within these catchments. This will help the areas build their resilience with regards to the future of the natural world, and enable priority habitats to be focussed on in areas outside of the normally favoured protected sites. The plan is to use the well established Branch Out project to enable the delivery of 250ha of priority habitat creation or restoration in NWG's operating area. As partnership working is key to this aspect, NWG would not look to be the sole funder of the projects, and would expect the money available through Branch Out to constitute approximately 1/8th of the total costs.

Risks: Currently this level of leverage is being achieved, but the main risk to this aspect of the scheme is that other funding sources are not available, and there is a greater reliance on Branch Out to support the work financially. If that situation arises, consideration will be given to in-kind support and where it doesn't impact on the area of habitat delivered, being flexible on the amount of additional funds that the projects are expected to have. The other risk to this is that there demand for projects to create priority habitats isn't there. With the current level of demand it is considered that this is unlikely.

Costing

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach.

All costs for schemes in this business case were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[1]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed costs for schemes in this business case are £1.00 million Capex and £0 million Opex]. The detailed cost calculations for each line of the WINEP are provided below.

[1] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methdology

These costs were benchmarked and assured as follows:

- Assessment and forecasting of historical spend

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[2]. The cost confidence in each business case as a whole has been assessed using the following methodology:

- **Green** - Over 75% achieving Green RAG status
- **Amber** – Over 65% achieving Green or over 90% achieving Amber RAG status
- **Red** – Not achieving Green or Amber.

This review has assessed scheme costs as Amber. NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

The tables below summarise the costs used, and where the costs have been derived from. A spend profile is also shown. On the advice of NWG's internal Cost Assurance team, 10% on costs have been added to the base figures given in the tables below, to give the overall reported cost of £1.00 million. All costs included in the information below are generated from stated sources, or previous habitat creation projects carried out on NWG land. The costs are efficient because in-house expertise within NWG is being used as far as possible.

NERC programme cost calculations

Scheme deliverable	Cost	Cost development
Increase NWG's priority habitat by 12ha	£168,000	The cost assumes creation of 2 ha woodland, 2 ha wetland, 8 ha grassland. It allows for 2.4ha land purchase (expected to be in conjunction with land purchase for operational reasons). It also allows for post habitat creation monitoring. Land Agents were consulted for land purchase costs and advised a unit cost of £20,000 / ha. Previous project costs were used for habitat creation budgets such as woodland creation at Abberton, wetland creation at Heaton Grange and grassland creation at Hanningfield. Woodland establishment costs have varied over the past few years from £3.30-3.88 / tree, guard, stake & labour; with maintenance costs of £0.90 – 1.30 / tree / year. Planting is done at approx. 2500 plants per ha which is recommended by the FC and equates to 2m spacing approx. (Ref: Rodwell, JohnS; Patterson, Gordon S. 1994. Creating New Native Woodlands Forestry Commission Bulletin 112.). Based on these costs a budget of £16k / ha is included. Previous grassland creation projects have been delivered at a cost of £5k / ha. Recent wetland creation projects have cost £12k per ha, these costs are in alignment with: Creating new wetlands: key principles and a project model, Natural England & Broads Authority, 2008.
Increase the biodiversity value of NWG's land	£72,000	The budget for this aspect of the scheme assumes 8 sites will be used to check the validity of the ranking system as a mechanism for

[2] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

holding		recording impact on biodiversity. It allows for baseline monitoring (£2k / site), enhancement measures (£5k / site) and post enhancement monitoring (£2k / site). Budget figures are based on previous site survey costs and site management costs.
Increase priority habitat in NWG's operating area	£666,250	This budget for this is based on assumptions that the habitat type (wetland, woodland, grassland) will be evenly split, that 50% land purchase will be required, and that by working in partnership the funding NWG provides will achieve 8x leverage. All habitat costs based on the same assumptions as used for the creation of priority habitat on NWG's landholding. An additional budget has been included for development of the Branch Out database, IS have provided those costs – a total budget of £17,661.75 that will be cover both development for this and the INNS line. Branch Out Business Case v0 2.docx

WINEP – NERC scheme spend profile

	2020/21	2021/22	2022/23	2023/24	2024/25	On-costs	Total
	£m	£m	£m	£m	£m	£m	£m
Capex (& totex)	0.166	0.193	0.203	0.177	0.171	0.091	1.00

No additional opex requirements have been identified as a consequence of this programme. Where new habitats require management, it is expected that this will be off-set against a reduction in grounds maintenance in some instances, in others, current partnerships will enable volunteers to carry out site management.

No performance commitment is proposed for this business case as it is a regulatory requirement.

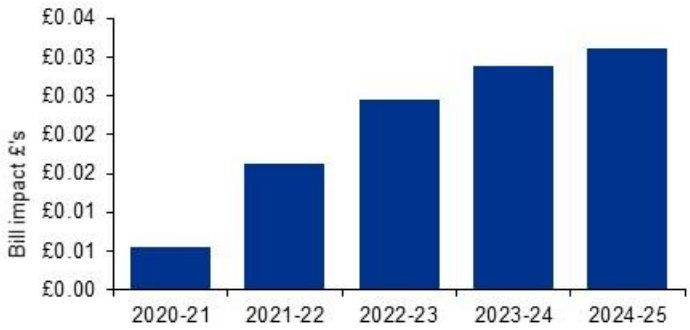
8. Customer Protection

NWL is proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed. We are proposing a cost adjustment mechanism for enhancement costs that will protect customers against late or non-delivery of those enhancement schemes. Full details of our enhancements delivery incentive mechanisms are included in Chapter 4: Measuring and Incentivising Success of our final business plan. More detail specific to the cost adjustment mechanism proposed for WINEP schemes is also provided in Appendix 3.9 of our PR19 Business Plan. The latter sets out a proposed cost adjustment mechanism to be applied in the event of discrepancies in scale between the assumed Water Industry National Environmental Programme (WINEP) at the time of the Final Determination in December 2019 and the confirmed programme in 2021.

However, we do not envisage that the cost adjustment mechanism will be required for NERC Priority Habitat schemes. This is because they are green schemes and the level of certainty about scheme requirement is high.

Affordability

The impact of these enhancement investments on customer bills are shown below[3].



Overall the analysis shows that the bill impacts would rise to £0.03 a year in 2024/25.

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted to grow at between 0.8 - 1.2% per annum[4] driving significant improvements to average customer affordability.

Customer engagement is less relevant for this enhancement as it derives from a statutory programme of work (the WINEP) and is therefore obligatory, regardless of customer opinion. However, various pieces of customer research carried out on behalf of NWG indicate that customers generally support NWG's environmental aspirations. Focus group research (Explain, 2014) found that the vast majority of participants agreed with NWG going above and beyond government requirements and spending more of customers money on protecting wildlife and habitats (87% agreed). Further workshops (Explain, 2017) indicated that participants expect NWG to be speaking to and working with the Environment Agency and other environmental organisations on environmental issues.

Governance and Assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large

[3] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.

[4] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers" [7].

9. Alignment with Stakeholder Needs

NWG has followed the guidelines for the expected scope of NERC measures to be included within the PR19 WINEP, as set out in the Environment Agency's "PR19 Driver Guidance: NERC and biodiversity priorities" Jan 2017. NWG's ongoing liaison with local Environment Agency and Natural England teams, and via escalation to the Environment Agency's national consistency panel, has ensured that our plans meet their expectations. The latest version of the WINEP3, issued 30th March 2018, confirms the Environment Agency's acceptance of the proposed scheme.

Customer focus group, held across NWG supply areas during 2017, indicated a high level of support in principle for NWG's pR19 environmental objectives and general programme.

[7] See Board Assurance Statement

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MAKING ECOLOGICAL IMPROVEMENTS AT ABSTRACTIONS ENHANCEMENT BUSINESS CASE

WS2 - Wholesale water capital and operating enhancement expenditure by purpose Line 1

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MAKING ECOLOGICAL IMPROVEMENTS AT ABSTRACTIONS

Name of claim	Water Industry National Environment Programme (WINEP) enhancement – Making ecological improvements at abstractions	
Name and identifier of related claim submitted in May 2018		
Business plan table lines where the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line 1	
Total value of enhancement for AMP7	£1,544,185	
Total opex of enhancement for AMP7	£0	
Total capex of enhancement for AMP7	£1,544,185	
Depreciation on capex in AMP7 (retail controls only)	n/a	
Remaining capex required after AMP7 to complete construction	None as all schemes expected to be delivered in AMP 7	
Whole life totex of enhancement	N/A	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	N/A	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	0.129% of Water totex (£1.2B)	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		No
Need for investment/expenditure	Fulfill requirements of WINEP.	
Need for the adjustment (if relevant)	n/a	
Outside management control (if relevant)	n/a	
Best option for customers (if relevant)	n/a	
Robustness and efficiency of claim's costs	P12	
Customer protection (if relevant)	P16	
Affordability (if relevant)	P11	
Board Assurance (if relevant)	P17	

APPENDIX 3.2

MAKING ECOLOGICAL IMPROVEMENTS AT ABSTRACTIONS

APPENDIX 3.2

MAKING ECOLOGICAL IMPROVEMENTS AT ABSTRACTIONS

1. Executive Summary

This enhancement scheme is a named scheme in our part of the Water Industry National Environment Programme (WINEP) thus making it a regulatory requirement. It will meet regulatory drivers relating to the Natural Environment & Rural Communities (NERC) Act. It covers measures that will conserve and enhance the biodiversity value of the area in which Northumbrian Water Limited operates. The measures to be undertaken have been agreed with the Environment Agency and Natural England.

Completion of this scheme is mandatory and Ofwat and the Environment Agency expects funding requirements to be accounted for in the Company's PR19 Business Plan.

This scheme will deliver environmental improvements such as habitat creation and improvement and also wider ecosystem service benefits such as on soil carbon and flood risk management, through working with land managers, using funded, targeted interventions to help them make improvements to their farming or other land management practices.

The total cost for this scheme is £1.54 m.

Customer engagement is less relevant for this enhancement as it derives from a statutory programme of work (the WINEP) and is therefore mandatory, regardless of customer opinion. However, engagement has been carried out with the Water Forum and other interested stakeholders in NWL's operating area all of whom are supportive of the scheme. The principles of the NERC related input into the WINEP have been discussed with the Water Forum which includes a representative of the Consumer Council for Water (CCW) who supported the approach being taken. Other customer research carried out on behalf of NWL indicates that customers generally support NWLs aspirations. Focus group research (Explain, 2014) found that most participants (87%) agreed with NWL going above and beyond government requirements and spending more of customers' money on protecting wildlife and habitats. Recent workshops (Explain, 2017) indicated that participants expect NWL to be speaking to and working with the Environment Agency and other environmental organisations on environmental issues.

2. Context and Scope

This expenditure is classified as enhancement rather than base maintenance because it is included in the Water Industry National Environment Programme (WINEP) and completion of the WINEP will enhance the capacity and quality of services beyond current levels and support our environmental outcomes.

As the WINEP is compiled by the Environment Agency, the inclusion of a scheme in the WINEP means that it is supported by the Environment Agency.

There is a regulatory driver for the scheme, Natural Environment & Rural Communities (NERC) Act, which has been included by the EA specifically to cover catchment management schemes to deliver multiple objectives and benefits, e.g. a catchment scheme in that provides wider ecosystem service benefits such as on soil carbon and flood risk management, as well as biodiversity outcomes.

This business case relates to the business plan table WS18 - Explaining the 2019 Final Determination for the water service, block B, line 3 'Number of catchment management schemes'.

Both Ofwat in *'Delivering Water 2020: Our final methodology for the 2019 price review'* (Dec,17) and the DWI in their *'Guidance Note: Long term planning for the quality of drinking water supplies'*

(Sept,17) refer to catchment management as being an integral part of the 'source to tap approach'. The DWI states that 'catchment approaches should remain the first consideration in all source to tap risk assessments'. Ofwat states that they 'expect companies to take advantage of and work with natural processes, where appropriate, such as sustainable urban drainage systems (SuDs) and catchment management approaches'.

The enhancement we are proposing comprises catchment management schemes that will provide:

- Advice;
- Capital grants to land managers to implement measures that will reduce the loss of diffuse pollutants from their farm yards and land;
- Desk and ground based work to better understand the catchments, collating available data and filling in the gaps where required to pinpoint risks to water and habitats; and
- Closer working with external partners to ensure the work delivers on a broad range of issues.

In both areas, the scheme will deliver a project which brings together a number of partners to deliver on biodiversity priorities, whilst providing wider ecosystem service benefits. In the South Tyne the proposal is for a catchment based scheme working in partnership with other Tyne Catchment Based Approach (CaBA) Partners such as the Tyne Rivers Trust, with the scheme being run as a partnership project as a sub-group of the Tyne CaBA. In the Blackwater, the existing and already successful Chelmer & Blackwater partnership may be used as a vehicle for delivery although formation of a sub-group may be more appropriate. This will involve working with new partners as appropriate, for example closer work with Anglian Water to tie in with their nitrate WINEP scheme on the Blackwater and involvement of the recently formed Blackwater Estuary partnership.

All aspects of this enhancement scheme are in alignment with the aims of Defra's recently published 25 Year Environment Plan and will support some if its objectives, and the Water Industry Strategic Environmental Requirements (WISER).

25 Year Environment Plan:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf

Water Industry Strategic Environmental Requirements (WISER):
https://www.customer-panel.co.uk%2Fmedia%2F1017%2Fwater-industry-strategic-environmental-requirements-wiser.pdf&usg=AOvVaw2AJvzzBXGvlQenTh2MVjHN

In the case of the River Blackwater, although a key part of the scheme is around delivering the NERC driver it will also help to achieve drinking water compliance. If some pesticides, such as propyzamide, clopyralid, carbetamide and bentazone reach our raw water intakes in high concentrations, our existing treatment processes, GAC and ozone, cannot reliably reduce concentrations to below the drinking water standard. The DWI acknowledges this by agreeing Pesticide Undertakings with water companies. For NWL, this means that monitoring programmes both at our intakes and within the wider catchments are maintained and that farmers are engaged with to (i) ensure that they are aware of the problem and (ii) inform them how they can reduce the loss of diffuse agricultural pollutants from their farms. There is currently a pesticide undertaking in place for Langford water treatment works. The DWI expects that water companies include PR19 catchment schemes in their WINEP for each of the catchments with pesticide undertakings albeit that they should not be a straight continuation of AMP6 schemes.

The Drinking Water Inspectorate (DWI) confirmed in its guidance note *"Long term planning for the quality of drinking water supplies'* (Sept,17) that it expects that water companies will always plan to meet their statutory obligations for drinking water quality. These mean that water post treatment should always comply with all drinking water standards (prescribed concentration values or PCVs).

Northumbrian Water's overall drinking water quality compliance indicates that this has not always been achieved, with pesticides (particularly metaldehyde) and cryptosporidium being a cause of non-compliance. Looking ahead, metaldehyde is expected to no longer pose a risk to meeting our compliance target due to the restriction on outdoor use by DEFRA, which essentially represents a total ban, which comes into force in June 2020. The Annual Performance Report for 1 April 2016 to 31 March 2017 confirms that the overall drinking water quality target was 99.940%, with the level actually achieved being 99.936%. As stated in NWL Service Policy Document 'Supplying clean drinking water – Improving ODWQ compliance' our aim is to achieve 100% compliance with the Overall drinking water quality (ODWQ) compliance measure for our customers. It is also to sustain 100% compliance in a changing world to meet our Future Horizons 2040 goal.

3. Customer and Stakeholder Expectation

The expected scope of the NERC measures is set out in the Environment Agency's PR19 Driver Guidance – NERC and biodiversity priorities (Environment Agency, Oct 2017). At a high level this states the Environment Agency's expectation is that water companies 'contribute to biodiversity priorities and obligations on water company owned land or in the catchments they influence and operate in'.

Discretionary Enhancements Customer Research

Customer engagement is less relevant for these enhancements as they derive from a statutory programme of work (the WINEP) and are therefore obligatory, regardless of customer opinion. However, various pieces of customer research carried out on behalf of NWL indicate that customers generally support NWL's environmental aspirations.

Focus group research (Explain, 2014) found that the vast majority of participants when asked about 'spending more of customers' money across a number of environmental activities' generally supported this and agreed with NWL going above and beyond government requirements. 94% of respondents agreed that NWL should be working to reduce pesticides and chemicals from river water and 87% agreed on protecting wildlife and habitats (6 focus groups, 52 respondents). Further research called 'Defining the Conversation', carried out in 2016 and 2017 indicated that customers expect NWL to be speaking to and working with the Environment Agency and other expert environmental organisations on environmental issues and when considering how to manage our performance in the wider environment.

In March and April 2018, we conducted two phases of deliberative qualitative research with customers to explore their acceptability for a range of discretionary enhancement schemes. The schemes were presented in the context that in 2020 customers' bills would be reduced by 10% and that the schemes could be funded by making the 10% reduction smaller. When reviewing the results of the engagement, we considered customers' acceptability to be anything over 70%. This was based on CCWater's Threshold of Acceptability research that was carried out for PR14.

The second phase of research was conducted because in the first phase a number of customers stated that they did not know if they accepted the schemes. We discussed this with our Water Forums and agreed that we should carry out additional engagement to understand why this was, and what information we would need to provide to customers to allow them to answer the

acceptability question. The results from the acceptability engagement were discussed with our Water Forums, who welcomed the generally very high levels of customer support for the schemes. Members did not agree on a definitive threshold for support in percentage terms, however some views shared were that anything over about 60% would be acceptable. All our enhancements were included in our overall acceptability research, where our plan was supported by 91% of customers.

WINEP

In 2016 we conducted customer research on River Water Quality. The outcome was that customers were strongly supportive of improvements in River Water Quality.

Whilst this enhancement scheme is regulatory driven, we have still consulted with our stakeholders including engagement with the Water Forum.

As part of our PR19 stakeholder engagement a series of 'Thinking Ahead' workshops were held in the NW area in early 2017 at which stakeholders were invited to help us understand where common interests lay and to identify opportunities to deliver partnership projects. Stakeholders from a wide range of organisations were personally invited to participate including EA, NE, Rivers Trusts, RSPB, NFU, local councils, Wildlife Trust, Forestry Commission and local Universities. In the NW area five workshops were held, one to cover each of the already well-established Catchment Based Approach Partnership (CaBA) areas, as well as a further regional workshop in September which aimed to take a more strategic look across the region. In the ESW area a single regional workshop was held due to the fact the CaBA is not so well established. The outputs of these workshops are available on request.

A key theme identified across the workshops was a desire to take a catchment or landscape scale approach and to widen out the scope and involvement beyond single partner focus and to deliver multiple benefits. This is summarised in the attached pack above under 'Thinking Ahead Key Themes Synthesis'. The theme 'Upstream Land Management and Water Stewardship' talks about an opportunity to widen out scope and involvement beyond single partner focus and to deliver multiple benefits. Particularly in the ESW area partners felt our AMP6 Pesti-wise programme was too single-issue focused, on pesticides, and that opportunities for wider benefits were missed. We have taken that feedback on board and that is why we are including a wider range of measures across our PR19 proposals general but also these two specific projects which will focus on multi-benefits and partnership delivery.

NWL has ensured, through liaison with local Environment Agency Fisheries, Biodiversity & Geomorphology Teams, and via escalating issues with the Environment Agency national consistency panel, that our plans meet their expectations. We have agreed with the EA that these schemes should be included in the WINEP because they present strong opportunities to deliver multiple benefit projects due to e.g. the existence of already successful partnerships, other ongoing schemes, and a broad range of issues to be tackled which would benefit from us taking a more holistic approach. These schemes were agreed through ongoing liaison with the EA through email, telephone conversations and face to face meetings. The latest version of the WINEP3, issued 30th March 2018, confirms the Environment Agency's acceptance of the programme. A full version of the current WINEP can be viewed here https://data.gov.uk/dataset/a1b25bcb-9d42-4227-9b3a-34782763f0c0/water-industry-national-environment-programme although an updated version is expected at the end of March 2019.

The scope of each individual NERC WINEP line will be further developed between now and March 2019 as Measures Specifications Forms are completed.

In summary, successful delivery in customer benefit terms, will be completion of the agreed WINEP programme.

4. Current and Historical Service Delivery and Expenditure

In AMP6 much of NWL's catchment work has been focused through the 'Pesti-wise' programme: https://www.eswater.co.uk/your-home/environment/Pesti-wise.aspx

Pesti-wise was launched in April 2015 and aims to work with farmers and their agronomists to deliver practical guidance and on-farm solutions that helps minimise pesticide run-off and supports sustainable agriculture.

Key objectives include:

i) Prove the concept that voluntary action can reduce raw water concentrations of key pesticides in catchment water-bodies; and
ii) Determine the level of engagement, adoption of best practice, and scale of investment, required to achieve the observed pesticide reductions.

The desired outcome is to reduce average and peak pesticide concentrations at the sub-catchment outlets, compared to a control catchment and the pre-intervention dataset.

Through the Pesti-wise programme we have achieved good levels of engagement across all 5 pilot catchments, although engagement in the Whittle Dene catchment has been lower than the others. We have however gained a wealth of experience of what works and what doesn't, and the team continues to improve its ability to get farmers on board. AMP6 Pesti-wise Engagement figures are summarised below:

Catchment	Total Area Engaged (1.1 visit) %	Total Area Engaged (1.1 visit, event or telephone call) %	Additional Comments
Roxwell Brook	92	100	
Layer Brook	77	92	Remaining 8% held by 19 different landowners i.e. lots of very small land holdings
Dickleburgh Stream	92	94	
Tyelaw Burn	51	84	90% if none arable land excluded
Whittle Dene	33	48	Estimate 65% if non-arable land excluded from total land area value

The Pesti-wise grant scheme ran from April 2015 until February 2017, during which time a total of 51 Pesti-wise grant offers were made across the five pilot catchments and total grant funding of £373,707 has been paid out for improved pesticide application equipment and handling facilities.

Full analysis of any improvement in water quality will be undertaken at the end of the five year programme. Broadly speaking metaldehyde levels have been lower both in frequency and concentration but we have had three relatively dry autumn / winter periods which means the programme has not been challenged fully. It is therefore not deemed reasonable to draw conclusions at this stage until we have the full AMP6 dataset. We have however seen some

encouraging results in one of the NW catchments in year 2 of the programme with the test catchment having no results for metaldehyde above 0.1ug/l while the control had 30% of weekly samples 0.1ug/l, including a peak of 0.8ug/l.

The programme activity is summarised below:

- 120 one to one farm visits completed to date
- Pesti-wise grants offered for 54 equipment items and 24 infrastructure items.
- Pesti-wise grants accepted for 43 equipment (23 pelleters, 8 auto-section cut-off, 6 straw rakes, 2 drainage racks, 3 pre-emergence markers, 1 set low drift nozzles, 1 light bar) and 18 infrastructure items (8 wash-down areas, 7 roofing, 5 biofilters).
- £373,707.69 paid as grants for improved pesticide application equipment and handling facilities.
- High frequency water quality monitoring at 9 sites

Working on a wider reaching catchment scale project is however a different approach to previous AMP6 work so it is difficult to demonstrate historic service delivery. However the concept of catchment management is one that is widely accepted by the industry and most water companies now undertake catchment management to some extent. There are plenty of examples of successful catchment scale schemes taking place elsewhere, for example South West Water's award winning 'Upstream Thinking' https://www.southwestwater.co.uk/environment/upstream-thinking/ and the Defra Demonstration Test Catchment work www.demonstratingcatchmentmanagement.net There is also lots of research being undertaken on catchment management and how it can be successfully delivered, some good example of which can be viewed through the James Hutton Institute research 'Managing at a Catchment Scale' https://www.hutton.ac.uk/research/projects/managing-catchment-scale

NWL will draw on all available literature and case studies when further developing and delivering this proposed work to ensure expectations are delivered.

5. Forward Looking Analysis

This enhancement scheme will ensure that NWL meets its regulatory obligations with regards to the NERC driven WINEP schemes. The NERC Act places a duty on every public authority, including water companies, to have regard to conserving biodiversity. This is with the aim of restoring or enhancing a species population or habitat and reflects the government's ambition for the 'prevention of further human-induced extinctions of known threatened species'. This enhancement scheme will also enable NWL to contribute to meeting biodiversity priorities identified in the 25yr Environment Plan; to support healthy well-functioning ecosystems and establish coherent ecological networks; to help try and halt overall biodiversity loss and; to contribute to making more and better places for nature for the benefit of wildlife and people in line with the Lawton principles.

Although no specific forecasting has been undertaken, there are a number of risk factors to consider, a key one being climate change, which has the potential to have a significant impact on habitat, biodiversity and water quality, amongst other key ecosystem services. Climate change forecasting is predicting wetter winters and drier summers as well as more extreme rainfall events. Rainfall plays a key role in transportation of contaminants to water and if rainfall events do become more extreme this creates an increased risk of pesticides etc. being washed off the land as well as increased soil erosion, increasing sediment loading to rivers. And a changing climate could have significant impacts on already threatened species and habitats.

Another big uncertainty is the future of farm subsidy post-Brexit. Clearly we do not want to be funding interventions which farmers could get funding for from elsewhere. As we do not have any detail on the future of subsidies we have assumed that we will need to provide support for the specific interventions we want to see. Currently Defra priority areas do not align with our own, hence many farmers are not eligible for the funding we believe is required, for example only a very limited area of our catchments are water priority areas and hence most of the farmers we work with are not eligible for water capital grant items from Countryside Stewardship.

Water quality, habitats and biodiversity are unlikely to improve on their own – we have nothing concrete to indicate farming practices will change to any significant degree in the immediate future, we have to assume that farming will continue as per the status quo which we know does cause problems for water quality. Without appropriate investment into catchment management we are unlikely to see any improvement, there is no reason for farmers to make changes to their practices of their own accord. Many farmers have been reluctant to sign up to currently available Stewardship schemes because of uncertainties (NFU, Mar18, https://www.nfuonline.com/news/latest-news/delivery-of-countryside-and-environmental-stewards/) and if farming subsidies change significantly, which current government policy would suggest they will, this could lead to a reduction in conservation and water protection measures on farm until farmers get on board with a new scheme.

6. Option Appraisal

As described in section 3, stakeholders who attended our PR19 Catchment Management workshops and members of NWL's water forums have been clear that our PR19 catchment management approach should not be single issue focused (i.e. pesticides), that we should look to use our funding to deliver multiple benefits in terms of ecosystem services and that we should look to enhance the environment, not just hold the line, at a catchment scale.

We have supported the Environment Agency including the following two NERC schemes:

i. South Tyne Holistic Water Management Project; and
ii. Chelmer Multi-ecosystem Service Benefit Project.

Both schemes will look to deliver enhancement to priority habitat (and therefore priority species). In doing so, we expect other secondary ecosystem service benefits including improvements in river water quality (e.g. sediment and nutrients) and river flow management. We intend both schemes to be delivered as partnerships projects so that additional funding and expertise can be brought into support that provided by NWL.

Option 1 - Do nothing

Given the strong steer from the Water Forums that they want to see more and broader reaching catchment schemes, and the steer from our regulators, Ofwat and DWI that they expect catchment management to remain a key tool in delivering the 'source to tap' model, opting to 'do nothing' is not deemed to be acceptable. As catchment schemes are named in the WINEP, failure to deliver would mean failure to comply with the WINEP programme.

Option 2 – Holistic Water Management Schemes

The proposal is for two catchment based schemes, one in our NW operating area and one in our ESW area, working in partnership to deliver collaborative multi-benefit projects.

In the NW area this will be delivered in the South Tyne catchment, working in partnership with other Tyne Catchment Based Approach (CaBA) Partners such as the Tyne Rivers Trust, with the scheme being run as a partnership project as a sub-group of the Tyne CaBA. Discussion has already taken place with potential partners and a meeting is planned for June 2019 to formalize this partnership. Initial work will be undertaken to better understand the catchment, collating available data and filling in the gaps where required to pinpoint risks to water and habitats. It will then use this information to deliver extensive water and land management improvements, creation or extension of habitats and build upon existing work in the catchment such as the Water and Abandoned Metal Mines project. The South Tyne was selected as there are many priority habitats and species, and a number of waterbodies failing to meet WFD good status. The South Tyne (including River Allen) has over 200km of watercourse failing WFD chemical status for cadmium and/or lead and their components. There are also over 200km considered bad or poor for Fish, Invertebrates or Macrophytes and Phytobenthos Combined. There are 42 SSSIs with a total area of over 51,000 ha (although may not all fall completely within South Tyne catchment) a large number of which are in unfavourable condition. There are also seven SACs which fall at least partially within the catchment. Operationally speaking, NW abstracts water for drinking water treatment from the River Tyne at Riding Mill and Ovingham. Although in relation to drinking water quality, the Tyne does not have any major issues, water abstracted from the river can become more difficult to treat after heavy rainfall events which often cause falling conductivity and increased sediments and turbidity. High sediment loads in the river can also cause issues at the pumping station, leading to large volumes of sediment having to be removed which is very expensive. This issue is often brought to a head following flooding on the Tyne, for example during Storm Desmond, where a rough estimate suggested 80% of the flow was from the South Tyne rather than the North Tyne. There are therefore opportunities to deliver schemes which although NERC focused, looking to deliver habitat creation and improve the condition of relevant protected sites or areas, will also have WFD benefits through a reduction in metal rich sediment losses to water and reduce operational impacts at the intakes. For example tree planting could be used to help stablise old spoil heaps which are providing a source of both sediment and metals into the watercourses, impacting on priority species and WFD. Exact detail of the work will be agreed with the partnership and landowners.

In the southern operating area this scheme will be delivered in the River Blackwater catchment. This catchment was selected as there are known issues with pesticides and nitrate, there is currently a DWI undertaking in place at Langford water treatment works and the Blackwater is considered to be ‘at risk’ from clopyralid, propyzamide, carbetamide and nitrate. There are lots of opportunities to work in partnership with other organisations to deliver wider benefits, for example-

- Anglian Water have a WINEP scheme to address nitrate on the River Blackwater either by traditional treatment options or nutrient balancing and are potentially considering a reverse auction scheme;
- EA have an interest in conducting a large scale river restoration type project on the Blackwater;
- There is now a Blackwater Estuary Partnership looking to enhance priority habitat;
- The Blackwater catchment is within the Essex Wildlife Trusts Living Landscape area; and
- Maldon District Council are keen to improve the area for tourism.

The Blackwater is made up of five water bodies of which four are classed as moderate for ecological status, by far the most common reason for failure quoted is agriculture and rural land management, so this project will also look for opportunities to improve this as well as enhancing and protecting SSSIs and other important habitat within the catchment

The work will be delivered through continuing and expanding the existing Chelmer and Blackwater

Catchment Partnership, or if more appropriate through the formation of a sub-group, with a view to broadening the scope of our catchment delivery and working more closely with the Combined Essex CaBa.

The scheme aims to stretch and improve NW's current way of working in catchments (i.e. single issue focused) and deliver a broader, more holistic projects, in line with the demands from the Water Forums and other CaBA partners.

Affordability

The impact of these enhancement investments on customer bills are shown below[1].

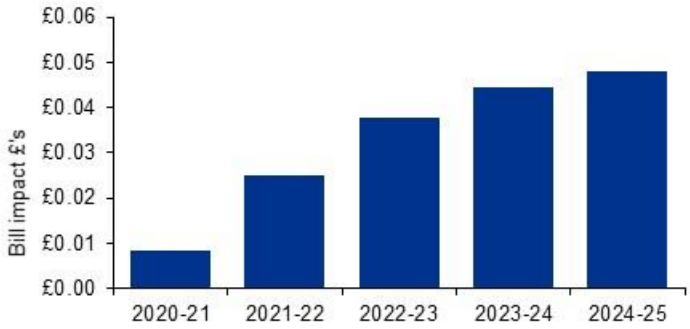

Figure 1 Bill Impacts from Enhancement Scheme

Overall the analysis shows that the bill impacts would be around an increase of £0.01 a year.
This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum2 driving significant improvements to average customer affordability.

The scheme proposed is material to the long-term stability and health of the customer service, and will contribute to a robust future network. This is in the context of an AMP7 plan which customers fully support.

Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remains a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 20303 and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

7. Preferred Plan / Option

[1] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.
[2] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast
[3] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWL_PR19_Interactive_FINAL_RS.pdf

NWL is proposing a preferred programme which will deliver the two holistic schemes described above, in the South Tyne and River Blackwater catchments, as detailed in the WINEP.

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

All costs for the WINEP Drinking Water Protected Areas scheme were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[4]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed costs for the WINEP NERC scheme are £1.54m Capex.

These costs were benchmarked and assured using a combination of traditional unit rate build up estimates and assessment and forecasting of historical spend.

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[5]. This review has assessed the WINEP Drinking Water Protected Areas scheme costs as Green that is NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

The estimated annual spend profile table below is based on the following allocation:

Year 1: 30% of the AMP7 total
Year 2: 30% of the AMP7 total
Year 3: 20% of the AMP7 total
Year 4: 10% of the AMP7 total
Year 5: 10% of the AMP7 total

DESCRIPTION	2020/21	2021/22	2022/23	2023/24	2024/25	Total
	£m	£m	£m	£m	£m	£m
Capex	0.46	0.46	0.31	0.15	0.15	1.54
Opex	-	-	-	-	-	-
Totex	0.46	0.46	0.31	0.15	0.15	1.54

[4] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology
[5] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

APPENDIX 3.2

MAKING ECOLOGICAL IMPROVEMENTS AT ABSTRACTIONS

The following process has been used to identify the totex required to deliver the activity:

i. Appropriate upstream catchment interventions have been identified using NWL's in-house expertise gained through previous and current AMP catchment management work and output from our PR19 catchment workshops held in both the ESW and NW catchments;
ii. The area of land or number of holdings to be targeted has been estimated. However, it should be noted that there is further work to do to confirm the target areas.
iii. The cost of the interventions has been estimated using experience from delivering our AMP6 Pesti-wise programme and from published Government Countryside Stewardship scheme grants; and
iv. The intervention costs have been multiplied up by the target area (ha) or the number of holdings.

The best available information has been used to develop the costs and all costs included have been assured by NWL's internal Cost Assurance team. The cost confidence in each business case as a whole has been assessed using the following methodology:

- **Green** - Over 75% achieving Green RAG status
- **Amber** – Over 65% achieving Green or over 90% achieving Amber RAG status
- **Red** – Not achieving Green or Amber.

The WINEP – NERC programme is assessed overall as Amber.

Furthermore, the cost assurance process and associated costs generated for the water WINEP - NERC enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018. This review has assessed 69% WINEP NERC enhancement costs as 'AMBER' and 9% 'GREEN', namely that NWL has evidenced that the costs used are robust and consistent with good industry practice.[6]

The detail of how the WINEP NERC programme will be delivered will be developed, in consultation with the Environment Agency and other external partners over the next 6 months, with detailed Measures Specification forms for each catchment being completed by March 2019. Below is an extract from the WINEP which provides currently available detail on the interventions we plan to undertake in each catchment. While the detailed scope of works in each catchment, remains to be defined, all these are 'Green' schemes within the WINEP so are 'confirmed' in that sense.

[6] NWL PR19 Enhancement Assurance - Summary Report Rev B, Mott MacDonald, July 2018

APPENDIX 3.2

MAKING ECOLOGICAL IMPROVEMENTS AT ABSTRACTIONS

Extract from WINEP3 (taken 15th March 2018)

Unique ID * (completed on company collation)	Scheme Name/Name of Investigation/Site Name/License name	Name of Waterbody	Water Body Type(s)	Measure Type	Level of Certainty? (P= Purple, R=Red, A=Amber, G=Green
7ES200022	DrWPA - River Blackwater	Blackwater (Combined Essex)	River	Catchment Measure	Green
7NW200570	South Tyne holistic water management project	Catchment Scale: - see additional comments	Water Company Scale	Catchment Measure	Green

The perceived risk of the programme failing to deliver the expected outcomes and proposed mitigation is summarised in Appendix 2.

8. Performance Commitments

Given the driver for catchment management is ultimately to increase our overall drinking water compliance, it would seem logical that a performance commitment should be set around an improvement in intake raw water quality. However, it is important to note that in the case of pesticides (particularly metaldehyde), by far the greatest influence on raw water quality is the weather. For example, metaldehyde is often used in wet weather when slug pressure is high. If we were to have a run of wet summers and autumns, the risk of metaldehyde failures would be significantly higher. We do not have any regulatory control over land managers and so we are at their discretion as to whether they take our advice and offers. Therefore setting a performance commitment for drinking water catchment management would be a significant risk, both in terms of company reputation and financially, if an ODI were attached. Lengthily discussions were had with the Water Forum about possible ODIs but ultimately it was agreed that an ODI for catchment was not appropriate. For example we could have had an ODI on delivery of grant funding which would have been easy for us to achieve but we felt it did not add any value for customers.

We do however feel it is important to have a target and as such the favoured proposal is as follows:

Number of drinking water catchments supported by catchment management partnerships or CaBA delivery groups by 2025.

Current Performance: 4 out of 9 (Chelmer, Blackwater, Waveney, Bure)
Target Performance: 9 out of 9 (current plus Stour, Tyne, Tees, Wear, Coquet)

The justification for this is we have well established and highly regarded agri-advice partnerships in the ESW operating area which provide a key role in our catchment delivery. There was strong support at both our NW and ESW PR19 Catchment Management Stakeholder Workshops in 2017 for all priority catchments to have an agri-advice partnership or delivery group.

It is currently agreed that we will not have this as a formal performance commitment but will use it in setting out our ambition, either via a goal or a section in the business plan narrative.

9. Customer Protection

NWL is proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed. We are proposing a cost adjustment mechanism for enhancement costs that will protect customers against late or non-delivery of those enhancement schemes. Full details of our enhancements delivery incentive mechanisms are included in Chapter 4: Measuring and Incentivising Success of our final business plan. More detail specific to the cost adjustment mechanism proposed for WINEP schemes is also provided in Appendix 3.9 of our PR19 Business Plan. The latter sets out a proposed cost adjustment mechanism to be applied in the event of discrepancies in scale between the assumed Water Industry National Environmental Programme (WINEP) at the time of the Final Determination in December 2019 and the confirmed programme in 2021.

10. Alignment with Stakeholder Needs

PR19 Catchment Management Stakeholder Workshops were held in June and November 2017 for ESW and NW respectively. Stakeholders indicated a high level of support in principle for NWL's PR19 environmental objectives and general programme. Their key points were that NWL should not be single-issue focused; and that the terms of reference of the existing agri-advice catchment partnerships in the ESW should be refreshed and that terms of reference should be created for new agri-advice groups in the NW area. The details of the delivery mechanisms for this proposal will be built over the remainder of 2018 and will be done in conjunction with our partners. We will work through existing catchment partnerships and the CaBA groups to ensure that our plan meets with their expectations and seeks opportunities to work together to deliver multi-benefits and best value for money.

NWL has ensured, through ongoing liaison with the local Environment Agency FBG team, that our plans meet their expectations. Customer focus groups, held across NWL supply areas, during 2017 indicated a high level of support in principle for our PR19 environmental objectives and general programme. Our Water Forum members expect that we will deliver these investigations and solutions promptly.

11. Board Assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers"[7].

[7] See Board Assurance Statement

APPENDIX 3.2

MAKING ECOLOGICAL IMPROVEMENTS AT ABSTRACTIONS

Appendix 1: Cost Breakdown

The table below summarises the proposed offerings to land managers. These will be offered either directly by NWL or through existing or new catchment partnerships – to be confirmed. The offers will be delivered by our catchment advisors supported by an Asset Investment project manager (as in AMP6).

Catchment	Item	Total Area (ha)	Unit	No. Of Holdings	Units per holding	Unit Qty	Unit Price	Total Price	Source	Total
Blackwater (Multi-benefits)	Arable reversion	18000	hectare	170	n/a	180	311.0	279,900	Based on CCS rate (p2, option SW7, link below)	**798,562**
Blackwater(Multi-benefits)	12-24m watercourse buffer strip on cultivated land	18000	hectare	170	n/a	100	353.0	176,500	Based on CCS rate (p2, option SW4)	
Blackwater(Multi-benefits)	Sediment Ponds / Traps	18000	each	170	n/a	85	200.0	17,000	Assumes £10/m2 (as per CSS rate, p4 RP7) & 20m2 pond	
Blackwater(Multi-benefits)	Bunds	18000	each	170		85	637.2	54,162	NWL Cost Estimation Team	
Blackwater(Multi-benefits)	Biofilter and roofed washdown area/ Biobed and uncovered washdown area/possibly Phytobac	18000	each	170		17	10,000.0	170,000	Based on average costs claimed by farmers through Pestiwise	

APPENDIX 3.2

MAKING ECOLOGICAL IMPROVEMENTS AT ABSTRACTIONS

Catchment	Item	Total Area (ha)	Unit	No. Of Holdings	Units per holding	Unit Qty	Unit Price	Total Price	Source	Total
Blackwater(Multi-benefits)	Remote sensing mapping	18000	each	170	n/a	1	25,000.0	25,000	Based on initial quote from APEM (quoted £50k for mapping and survery work but survery work could be done in house)	
Blackwater(Multi-benefits)	Reedbed	18000	metre square	170	1	9	6,000.0	51,000		
Blackwater(Multi-benefits)	Monitoring programme	18000	each	170		1	5,000.0	25,000	see catchment monitoring tab	
South Tyne	Project Officer/Catchment Advisor	80000				1	242,170	242,170		**605,242**
South Tyne	Tree Planting	80000				25	4,500.0	112,500	FC Woodland Creation Grant (average between broadleaf and conifer rate)	
South Tyne	Sediment Ponds / Traps	80000				100	200.0	20,000	Assumes £10/m2 (as per CSS rate, p4 RP7) & 20m2	

Catchment	Item	Total Area (ha)	Unit	No. Of Holdings	Units per holding	Unit Qty	Unit Price	Total Price	Source	Total
									pond	
South Tyne	Bunds	80000				100	585.7	58,572	NWL Cost Estimation Team	
South Tyne	Peat Restoration	80000				90	1500	135000	Based on estimated costs from Paul Leadbitter at North Pennines AONB (awaiting email to confirm)	
South Tyne	Remote sensing / ecosystem services mapping	80000				1	12000	12000	estimate from APEM (email correspondence)	
South Tyne	Monitoring programme	80000				1	5000	25000	see catchment monitoring tab	

Appendix 2 – Table of Risk

Description of identified risk	Chance of risk (high/medium/low)	Impact of risk (high/medium/low)	Planned action to manage or mitigate the risk
Farmers unwilling to engage with us	Low	High	The NWL catchment team have been delivering farmer engagement work for almost a decade and are well experienced in getting farmers 'on board'. In Pesti-wise we achieved over 80% engagement in 4 out of 5 catchments and the 5th catchment, although a struggle at first is now getting good levels of engagement through persistence.
Farmers not willing to adopt the measures we propose/low uptake of measures	Low	High	We have learnt through Pesti-wise that getting the options right is important and will use this experience to help develop our AMP7 schemes. We plan to use recognised grant rates to ensure payment rates meet farmer's expectations and have been questioning farmers on what they would like to see.
Partners unwilling to engage	Low	High	Potential partners for the South Tyne have already been approached and there is clear enthusiasm for the proposed project. In the Blackwater there is already a very successful partnership which will act as a good starting point and engagement has started with new potential partners such as Anglian Water.
The future of farm subsidy post Brexit and potential impacts on farming in general	Medium	Medium	Changes post Brexit could have a huge impact on environmental interventions on farm and clearly we do not want to be funding interventions which farmers could get funding for from elsewhere. As changes do come to light we may need to amend our proposed investment accordingly and this situation will be closely monitored. As we do not have any detail on the future of subsidies we have assumed that we will need to provide support for the specific interventions we want to see as Defra priorities may not align with our own.

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WINEP EELS ENHANCEMENT BUSINESS CASE

WS2 - Wholesale water capital and operating enhancement expenditure by purpose Line 2

APPENDIX 3.2

WINEP EELS

Name of claim	PR19 ENHANCEMENT BUSINESS CASE: WINEP – Eels Regulations (measures at intakes)	
Name and identifier of related claim submitted in May 2018	Not Cost Adjustment Claim	
Business plan table lines w here the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line A2	
Total value of enhancement for AMP7	£3.25 million	
Total opex of enhancement for AMP7	£0.00 million	
Total capex of enhancement for AMP7	£3.25 million	
Depreciation on capex in AMP7 (retail controls only)	[n/a]	
Remaining capex required after AMP7 to complete construction	None on implementation schemes. Unknown for investigations at this stage.	
Whole life totex of claim	N/A	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	Material	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		✓
Need for investment/expenditure	Installation of eel screens, removal of fish passage obstruction and investigation.	
Need for the adjustment (if relevant)	N/A	
Outside management control (if relevant)	N/A	
Best option for customers (if relevant)	To complete works as outlined in this business case. Regulatory obligation and will ensure abstraction sustainability.	
Robustness and efficiency of claim's costs	See Section 7: All costs for schemes in this business case were provided and assured by the NW Cost Assurance team. These costs were benchmarked and assured (Assessment and forecasting of historical spend). The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018. The cost confidence in each business case as a whole has been assessed using the following methodology:	

	• **Green** - Over 75% achieving Green RAG status • **Amber** – Over 65% achieving Green or over 90% achieving Amber RAG status • **Red** – Not achieving Green or Amber. This review has assessed scheme costs as Amber. NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.
Customer protection (if relevant)	See Section 8: WINEP cost adjustment mechanism
Affordability (if relevant)	See Section 8: The bill impacts would rise to £0.10 a year in 2024/25. This is set within an overall bill drop of more than 12% in AMP7.
Board Assurance (if relevant)	See Section 8: The full board have signed a revised Board Assurance Statement at the full board meeting on the 29th of March 2019 confirming that they have seen and are confident in the enhancement cases.

APPENDIX 3.2

WINEP EELS

1. Executive Summary

This enhancement scheme business case covers all named scheme in our part of the Water Industry National Environment Programme (WINEP) with a Eel Regulations driver. As the WINEP is compiled by the Environment Agency, the inclusion of the schemes in the WINEP means that it is supported by the Environment Agency.

This enhancement is a statutory requirement and specifically relates to the measures NWL needs to undertake to ensure compliance with The Eels (England and Wales) Regulations 2009 and other legal requirements relating to fish passage.

The measures to be undertaken have been agreed with the Environment Agency and comprise improving intake screening at three sites, completing two investigations into facilitating eel ingress and egress from Hanningfield and Abberton reservoirs and improving fish passage around obstructions at four sites.

The total estimated cost to complete the required programme of works is £3.25m and covers three schemes and six sites.

Customer engagement is less relevant for this enhancement as it derives from a statutory programme of work (the WINEP) and is therefore obligatory, regardless of customer opinion. However, various pieces of customer research carried out on behalf of NWL indicate that customers generally support NWL's environmental aspirations. Focus group research (Explain, 2014) found that the vast majority of participants agreed with NWL going above and beyond government requirements and spending more of customers money on protecting wildlife and habitats (87% agreed). Further workshops (Explain, 2017) indicated that participants expect NWL to be speaking to and working with the Environment Agency and other environmental organisations on environmental issues.

2. Context and Scope

The water industry has legal obligations under The Eels (England and Wales) Regulations 2009 (the Eels Regulations), which came into force on 15 January 2010 to support the UK in implementing EC Council Regulation (1100/2007) (the EC Eel Regulation). Under the European Regulation, the UK must identify and address actions to halt and reverse the decline in the European eel stock, aiming to meet a target set for the number of mature adult eels leaving each river basin to return to spawn at sea. The EC Eel Regulation requires the UK to consider eel passage as part of the solution and this need is reflected within the provisions contained within the Eels Regulations.

Water companies, as operators of water intakes and owners of other eel barriers, such as weirs, are obligated to identify how they can protect eels to help to restore the stock to a sustainable level.

From 1st January 2015, to be legally compliant with the Eels Regulations, all intakes (abstracting more >20 m^3 per day) and all outfalls must be screened for eels unless the Environment Agency exempts the requirement. In addition, the Environment Agency may serve notice to require the owner of an eel barrier to install an eel pass or other means of facilitating fish passage around an obstruction.

This enhancement will contribute towards the 'We help to improve the quality of rivers and coastal waters for the benefit of people, the environment and wildlife' business outcome.

While many NWL intakes and barriers were addressed during AMP6, some additional sites still require investment in AMP7. The investigations and schemes included within NWL's PR19 WINEP will ensure the company is compliant with its legal obligations under the Eels Regulations. The measures to be undertaken have been agreed with the Environment Agency and comprise improving intake screening at three sites, completing two investigations into facilitating eel ingress and egress from Hanningfield and Abberton reservoirs and improving fish passage around obstructions at four sites.

This expenditure is classified as enhancement rather than base maintenance because it is part of the Environment Agency's WINEP, and is related to compliance with new statutory obligations, the Eels Regulations.

This Business Case relates to the Business Plan table WS2, line 1.1. There is no overlap with other lines.

3. Customer and Stakeholder Expectation

The expected scope of Eels measures to be included within the PR19 WINEP is set out in the Environment Agency's 'PR19 Driver Guidance – Eel Regulations (Implementation)' (Environment Agency, Feb 2017).

This document states the Environment Agency's expectation that in PR19, water companies address all the outstanding high priority eel sites. This includes both high priority eel screening and barrier sites.

For residual medium and low priority eel screening sites in PR19, these should be addressed if, for whatever other reason, the water company is planning capital investment or maintenance works at the site of interest during the PR19 planning / delivery window.

PR14 eel investigations which have identified screening solutions for investments should also be addressed in PR19 with the following caveat, that they also meet the above rule for opportunistic investment, i.e. at the site of interest, other planned works are scheduled in PR19 planning / delivery window.

Medium or low priority eel barriers sites do not need to be addressed in PR19 / AMP7.

NWL has ensured, through liaison with local Environment Agency Fisheries, Biodiversity & Geomorphology Teams, and via escalating issues with the Environment Agency national consistency panel, that our plans meet their expectations.

The latest version of the WINEP3, issued 30th March 2018, confirms the Environment Agency's acceptance of the programme.

A full version of the current WINEP can be viewed here https://data.gov.uk/dataset/a1b25bcb-9d42-4227-9b3a-34782763f0c0/water-industry-national-environment-programme although an updated version is expected at the end of March 2019.

Thus the following five lines are included for Eels within NWL's PR19 WINEP3:

- Hanningfield Reservoir – investigate options for a trap and transport programme

- Abberton Reservoir – investigate options to facilitate eel ingress and egress and ensure compliance of Abberton Scheme with Eel Regs
- Wormingford – improvements to existing screens
- Ormesby – improvements to existing screens if other planned works are scheduled in PR19 planning / delivery window
- Barrasford raw water pumping station – eel screen

There are also lines covering improving fish passage at Hartthorpe Beck, Ireshopeburn (2 sites) and St John's Chapel.

The scope of each individual line will be further developed between now and December 2018 as Measures Specifications Forms are completed.

Customer engagement is less relevant for these enhancements as they derive from a statutory programme of work (the WINEP) and are therefore obligatory, regardless of customer opinion. However, various pieces of customer research carried out on behalf of NWL indicate that customers generally support NWL's environmental aspirations.

Focus group research (Explain, 2014) found that the vast majority of participants agreed with NWL going above and beyond government requirements and spending more of customers money on protecting wildlife and habitats (87% agreed). Further research called 'Defining the Conversation', carried out in 2016 and 2017 indicated that customers expect NWL to be speaking to and working with the Environment Agency and other expert environmental organisations on environmental issues and when considering how to manage our performance in the wider environment.

In March and April 2018, NWL conducted two phases of deliberative qualitative research with customers to explore their acceptability for a range of discretionary enhancement schemes. The schemes were presented in the context that in 2020 customers' bills would be reduced by 10% and that the schemes could be funded by making the 10% reduction smaller. When reviewing the results of the engagement, we considered customers' acceptability to be anything over 70%. This was based on CCWater's Threshold of Acceptability research that was carried out for PR14. The second phase of research was conducted because in the first phase a number of customers stated that they did not know if they accepted the schemes. We discussed this with our Water Forums and agreed that we should carry out additional engagement to understand why this was, and what information we would need to provide to customers to allow them to answer the acceptability question. The results from the acceptability engagement were discussed with our Water Forums, who welcomed the generally very high levels of customer support for the schemes. Members did not agree on a definitive threshold for support in percentage terms, however some views shared were that anything over about 60% would be acceptable. All our enhancements were included in our overall acceptability research, where our plan was supported by 91% of customers.

In 2016 NWL conducted customer research on River Water Quality. The outcome was that customers were strongly supportive of improvements in River Water Quality. Delivery of WINEP is a statutory requirement and hence not dependent on customer support, however our plan is stronger for knowing that customers do support this. Our Water Forums are supportive of our WINEP proposals which we shared with them in April 2018.

Therefore, the scope of the WINEP is in keeping with customers' expectations.

In summary, successful delivery in customer benefit terms, will be completion of the agreed WINEP programme.

4. Current and Historical Service Delivery and Expenditure

The vast majority of NWL intakes and barriers are being addressed during AMP6. The investment required during AMP7, arises from sites that were subject to AMP6 investigations, for which the outcome was investment schemes in AMP7, plus some sites which were not identified as requiring investment within the original AMP6 programme.

The AMP6 eel programme is ongoing. By the end of March 2020, NWL will have delivered:

- 10 intake screen schemes in ESW;
- 6 fish / eel pass schemes in ESW;
- 6 investigations in ESW;
- Schemes at 6 sites in NW

All six investigations have been successfully completed for a total budget of under £31k.

Work is progressing on the NW schemes, for which the total budget at target cost stage is at least £9m. New screens have been installed and signed off by the Environment Agency at Lumley during April 2018. Work on the screens at Blackwell Grange is progressing, with contractors on site and due to complete work in November 2018. Work to replace the screens at Warkworth, Riding Mill and Broken Scar is due to be completed by March 2019, October 2019 and December 2019 respectively. There is also a scheme for the Ovingham intake.

Work is also progressing on the ESW schemes, for which the total budget at target cost stage is in excess of £16m. Replacement screens were installed at the three intakes at Lound in October 2016. The screens at Brantham have been manufactured and are awaiting successful installation. Work to replace the screens at the River Chelmer is well advanced and all other screen schemes are planned in to meet the relevant deadlines.

Eel passes have so far been installed at four sites in the ESW area.

Given the size and complexity of NWL's Eel Regs programme of works in AMP6, the AMP7 programme is an order of magnitude smaller.

5. Forward Looking Analysis

The sites requiring investment to meet the Eel Regulations and other fish passage requirements during AMP7 have been identified by the Environment Agency and not completing the agreed programme of works at each site would leave NWL non compliant with the Eel Regulations. Non-compliance is considered an offence and, as such, is punishable by fine, both for responsible individuals and organisations.

Areas of uncertainty remain concerning the scope and timing of works, especially at Ormesby and Wormingford. At the former, works to improve intake screens may be avoided if the pumps are currently able, or can be upgraded, to provide a specified slow start, i.e. an acceptable 'Alternative Measure' as defined by the Environment Agency. At Wormingford work is currently ongoing to investigate whether the existing screens can be modified to meet requirements, rather than being completely replaced. These two schemes (Ormesby & Wormingford) are included within the cost adjustment mechanism so that customers are protected against these risks. If WINEP schemes are cancelled, the costs will be returned to customers, as set out in the cost adjustment mechanism.

6. Option Appraisal

Given that the WINEP sets out a mandatory programme of works, and that agreed approaches are in place following works in AMP6, NWL does not consider it appropriate to explore and validate alternative approaches for AMP7. NWL's emphasis is on ensuring that works undertaken in AMP7 are undertaken efficiently. The detailed design stage for the three AMP7 screen schemes will consider how to achieve best practice or close to best practice, where appropriate, screening most efficiently, e.g. through type of screens deployed.

7. Preferred Plan / Option

The preferred programme is to:

- Install best practice screens at Barrasford intake.
- Undertake an investigation into the feasibility of facilitating eel ingress and egress from Abberton Reservoir.
- Undertake an initial investigation and then trap and transport programme to remove eels from Hanningfield Reservoir. The initial investigation will be completed by 31/03/2022 with the trap and transport scheme expected to follow.
- Upgrade the pumps at Ormesby Broad intake, during the current AMP, i.e. before March 2020, to deliver a 'slow start' that would constitute an agreed 'Alternative Measure' and thus render improving the screens irrelevant. If this is not possible, the WINEP requirement is to improve the intake screens at Ormesby Broad only if the work is linked to another investment scheme on the intake structure (as this is a low priority site and this is the EA's agreed approach to such sites). Hence no costs are currently included for this.
- Upgrade the existing screens at Wormingford intake. However, costs for full replacement have been included, as current information suggests that this will be the most likely outcome.
- Remove the obstruction to fish passage, or else install an appropriate fish pass at Hartthorpe Beck, Ireshopeburn (2 sites) and St John's Chapel.

Costing

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach.

All costs for schemes in this business case were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[1]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

[1] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 costing methodology

APPENDIX 3.2
WINEP EELS

The assumed costs for schemes in this business case are £3.25 million capex. The detailed cost calculations for each line of the WINEP are provided below.

These costs were benchmarked and assured as follows:

- Assessment and forecasting of historical spend

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[2]. The cost confidence in each business case as a whole has been assessed using the following methodology:

- **Green** - Over 75% achieving Green RAG status
- **Amber** – Over 65% achieving Green or over 90% achieving Amber RAG status
- **Red** – Not achieving Green or Amber.

This review has assessed scheme costs as 99% Amber. NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

Costs have been built up for each line in the WINEP, based on historical spend on work carried out during AMP6, standard cost estimates used within the Asset Investment team, known day rates for ecological consultants, with adjustments for inflation, etc. The cost calculations are provided in table 1 below.

While the detailed scope of works at each site, and detailed design for screen projects, remains to be defined, all these are 'Green' or 'Amber' schemes within the WINEP so are 'confirmed' in that sense.

Table 1 – WINEP Eels cost calculations

[2] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

APPENDIX 3.2
WINEP EELS

Scheme name	ESW / NW	Description	Level of certainty	Completion date	Source of cost data	Cost data validation	Assumptions behind cost calcs	Cost calculation	Total companywide cost
Barrasford raw water pumping station	NW	Install eel screens.	Amber	22/12/2024	Pers. comm. information from Project Manager via John Gray (email 23/03/18) of same specification AMP6 screening project at Lumley raw water intake.	Costs from delivery of relevant historic scheme in AMP6.	Issues will be similar at Barrasford as at Lumley.	Similar no. & size Hydrolox screens installed at Lumley intake during AMP6 outturn cost £1.07m.	£ 1,070,943
Investigate options for natural eel ingress and escapement at Abberton Reservoir and compliance of Abberton Scheme with Eel Regs	ESW	Investigation and options appraisal	Green	30/03/2022	Standard figures used by Asset Investment.	Costs from AMP6 Asset Needs Statement for eel screens.	Asset Investment assumption that initial investigation is 3% of solution cost. AMP6 Asset Needs Statements for eel screen projects used estimated cost of £521,000 per screen. Assume inflation at 3% per year from 2015 to 2020, gives £604,000.	Investigation by combined engineering & ecological consultancy, initial design drawings for possible ingress and egress routes. Estimate at least £18,000 (3% of £604,000).	£ 18,000
Investigate options for trap and transport of eel population from Hanningfield Reservoir	ESW	Implement trap and transport programme and monitor outcomes.	Green	30/03/2022	Based on day rates & travel costs of Eel consultant used for PR14 Hanningfield eel survey work. 3 year trap & transport programme in Section 5.4 of 'Eel Investigations Summary Hanningfield_FINAL.pdf' report (Sep 2017).	Cost data from "ESW_Hanningfield_Quote_26_06_2016.pdf"	Assume 5% total increase on PR14 day rates. Assume Trap and transport for 3 years (based on final report recommendations from AMP6 investigation)	Assume 5 days field effort each autumn for 3 years for principal scientist at £450 x 1.05/day and field staff at £250 x 1.05/day = 11,025. Plus mileage allowance = £125. Plus fish health check = £500	£ 11,650
Improve screens at Ormesby Broad intake	ESW	Works to improve the eel screens if cost beneficial and tied into another investment work package on the intake	Amber	31/03/2025			Works on screens may not be required if modifications to pump start up regime can be implemented.		£ -
Replace FRR system at Wormingford Intake	ESW	Improve / replace existing FRR system.	Green	31/03/2025	Awaiting information on whether existing screens can be modified or whether screens need complete replacement.	Costs from AMP6 Asset Needs Statement for eel screens.	Worst case scenario is that screens need replacing - AMP6 Asset Needs Statements for other eel screen projects used standard estimated cost of £521,000 per screen. There are 2 x screens at Wormingford, giving £1.042m. Assume inflation at 3% per year from 2015 to 2020, gives £1,208,000.	Assuming 3% cost rise per year from AMP6 Asset Needs Statement costs of £521,000 per screen for similar eel screens. 2 screens at Wormingford.	£ 1,208,000
Improve fish passage at Harthope Burn, Ireshope (Wham pasture), Ireshope Burn (Greenwell Crags) & Wear (St Johns Chapel)	NW	Remove obstruction else install fish pass	Amber	22/12/2024	Based on quote from contractor for installation of fish pass on similar obstruction in current AMP at Wellhope Burn	Costs from AMP6 quotation for same work on similar asset.	Cost based on installing fish pass, quote from 2018, rather than removing obstruction.	Wellhope Burn fish pass quoted at £160,503.32 in 2018, multiplied by 4.	£ 642,013
									£ 2,950,606
								Plus 10% on-costs	£ 3,245,667

The cost expenditure profile is set according to Environment Agency deadlines for each line of the WINEP and presented in Table 2 below.

Table 2 – WINEP Eels cost expenditure profile

					Cost expenditure profile					
Code	WINEP3 unique code	Scheme name	ESW / NW	EA deadline for completion	2020/21	2021/22	2022/23	2023/24	2024/25	AMP7 TOTAL
EE_IMP	7NW10005	Barrasford raw water pumping station - Rede to Gunnerton Burn, Barrasford to S Tyne, Watersmeet to Tidal Limit - Eels Regs and MM3	NW	22/12/2024	£ 267,736	£ 267,736	£ 267,736	£ 267,736		**£ 1,070,943**
EE_INV	7ES200008	Investigate options for natural eel ingress and escapement at Abberton Reservoir and compliance of Abberton Scheme with Eel Regs	ESW	30/03/2022	£ 9,000	£ 9,000				**£ 18,000**
EE_INV	7ES200009	Investigate options for trap and transport of eel population from Hanningfield Reservoir	ESW	30/03/2022		£ 3,883	£ 3,883	£ 3,883		**£ 11,650**
EE_IMP	7ES200010	Improve screens at Ormesby broad intake	ESW	31/03/2025						**£ -**
EE_IMP	7ES200011	Replace FRR system at Wormingford Intake	ESW	31/03/2025		£ 604,000	£ 604,000			**£ 1,208,000**
WFD_IMP_ WRHMWB	7NW100011 7NW100012 7NW100013 7NW100014	Improve fish passage at Harthope Burn, Ireshope (Wham Pasture), Ireshope Burn (Greenwell Crags) & Wear (St Johns Chapel) respectively	NW	22/12/2024		£ 160,503	£ 160,503	£ 160,503	£ 160,503	**£ 642,013**

The investigation part of the Hanningfield work will be completed by 30/03/2022, with the trap and transport scheme following.

No performance commitment is proposed for this business case since it is a regulatory requirement.

8. Customer Protection

Any variations from the WINEP, not agreed via change protocol, would result in enforcement action being undertaken under the corresponding legislation. A number of areas of the WINEP are currently uncertain, and a cost adjustment mechanism will be used to protect customers if requirements change.

The WINEP lines within this Business Case to which the Cost Adjustment Mechanism is relevant are:

- Install screens at Barrasford intake.
- Undertake an initial investigation and then trap and transport programme to remove eels from Hanningfield Reservoir.
- Upgrade the pumps at Ormesby Broad intake.
- Remove the obstruction to fish passage, or else install an appropriate fish pass at Hartthorpe Beck, Ireshopeburn (2 sites) and St John's Chapel.

NWL is proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed. We are proposing a cost adjustment mechanism for enhancement costs that will protect customers against late or non-delivery of those enhancement schemes. Full details of our enhancements delivery incentive mechanisms are included in Chapter 4: Measuring and Incentivising Success of our final business plan. More detail specific to the cost adjustment mechanism proposed for WINEP schemes is also provided in Appendix 3.9 of our PR19 Business Plan. The latter sets out a proposed cost adjustment mechanism to be applied in the event of discrepancies in scale between the assumed Water Industry National Environmental Programme (WINEP) at the time of the Final Determination in December 2019 and the confirmed programme in 2021.

The document describes:

i. The requirements and guidelines that drive the need for this approach;
ii. The principles and assumptions applied in the calculation of the proposed unit costs and the proposed adjustment mechanism. This will include consideration of;
    a. What we will do if the scheme is no longer required. This applies to all green and amber schemes; and
    b. What we will do if the amber schemes deliver more or fewer outputs.
iii. The Governance and Assurance of the proposed mechanism.

WINEP Enhancement - Guidelines and Requirements for Cost Adjustment

A large portion of enhancement expenditure is driven by environmental requirements. These requirements are set out in the third and final release of the Water Industry National Environment Programme (WINEP) known as WINEP3.

The timeline differences between the PR19 planning and the third cycle river basin management planning for WFD introduce an ongoing level of uncertainty. This means that, despite the iterative approach, some requirements will remain uncertain when NWL submits its business plans in September 2018, and when Ofwat makes its final determinations in December 2019. The provisional ministerial sign off date for the 2021 river basin management plans is December 2021. There is therefore a need to continue with a 'managing uncertainty' approach that evolves based on the lessons learnt from that adopted in PR14.

The EA applied a traffic light system (red, amber, green) during development of the WINEP. The red, amber, green traffic lights system reflects the different levels of certainty (green being most certain) associated with the development of measures, economic appraisal and ministerial decisions.

At NWL, we recognise our role in meeting objectives for rivers and coastal waters, but we aim to ensure that our customers' money is spent on well justified cost beneficial schemes that will deliver real improvements to water quality and ecology. To achieve this, we have worked very closely with our local and national EA River Basin Management Service (RBMS) representatives, through smaller technical specialist areas and sharing of knowledge from work undertaken with other external groups and stakeholders, to agree the obligations included in the PR19 WINEP.

In the PR19 Final Methodology Ofwat has identified (Section 9.4.3) that the anticipated (uncertain) programme will be funded, as long as companies propose an appropriate cost adjustment mechanism to account for any potential discrepancy between the scale of the assumed and confirmed programmes. Companies will be required to link expenditure for unconfirmed requirements to a unit cost, which may relate directly to an outcome. Ofwat will use the unit cost to make an adjustment at the end of the control period, based on the volume of work that was eventually confirmed as required and delivered by the company.

Principles and Assumptions
WINEP development – improved level of certainty

The EA has stated it only expects to see cost allowances in company business plans for green and amber measures in WINEP3. NWL has not included red schemes in the plan.
We have established that we will treat **all WINEP ambers** as if they were 'green' i.e. we are committed to deliver all of the amber and green schemes and investigations unless better, more efficient delivery mechanisms can be identified to deliver the same environmental objective by alternative means. Any alternative proposals (such as delivery via catchment partnership projects) would need to be approved by the EA and logged via a formal change protocol procedure.

Cost adjustment mechanism – Unit cost

An appropriate cost adjustment mechanism will be proposed (in accordance with the Ofwat methodology reference section 9.4.3) in order to ensure our customers are not paying for schemes and outcomes that have not been delivered.

It is Ofwat's expectation that companies should link expenditure for unconfirmed requirements to a unit cost which must relate to a readily quantifiable measure. This may or may not be a specific performance commitment.

The Water WINEP comprises a range of schemes and investigations. **However, we do not believe that there is a single unit cost that could be applied across the whole of WINEP**.

Water enhancement schemes designated as amber in WINEP3 have lower monetary value than the wastewater amber schemes. These are largely where investigations will be undertaken prior to Options appraisal. This may mean that mitigation measures are no longer required, or that the measure differs from that assumed in the business plan estimate. Table 3 (below) provides comment on the individual lines from WINEP to indicate where cost adjustment may be possible on a line by line basis.

APPENDIX 3.2
WINEP EELS

Table 3 – Water WINEP schemes covered by proposed cost adjustment mechanism

Water Co.	Unique ID	Scheme Name/Name of Investigation/Site Name/License name	Driver Code (Primary)	Measure Type	Completion Date	Level of Certainty? (P= Purple, R=Red, A=Amber, G=Gree	Cost Estimate (£)	Cost Adjustment Mechanism: In Scope (Y/N)	Cost Adjustment Unit Rate	Comment
ESW	7ES200010	Eel measures at Ormesby Broad	EE_IMP	Eel Screen	31/03/2025	Amber	£0	Y	£9,200/scheme	The EA has indicated that it will accepted "soft start" pumps as the solution which will be delivered as part of an existing AMP6 pump upgrade. This scheme should be covered by the cost adjustment mechanism as the EA has still to formally confirm acceptance of the solution and in case the pump upgrade does not go ahead as currently planned. The unit cost will be £19,200/scheme.
ESW	7ES100130	LANGHAM A, B, C & E	WFD_IMP_WRHMWB	Sustainability Change	31/03/2024	Amber	£55,000	Y	£55,000 per scheme	This scheme is amber as the detailed scope has yet to be agreed with the EA. Following discussions with the EA, we have made an allowance for in-river channel measures to mitigate against low flow impact due to PWS abstraction (ESW, AWS, Affinity). This scheme should be covered by the cost adjustment mechanism in case this in-river channel measures are not suitable mitigation measures. The unit cost is £55,000 per scheme.
NW	7NW10005	Barrasford raw water pumping station - Rede to Gunnerton Burn, Barrasford to S Tyne, Watersmeet to Tidal Limit - Eels Regs and MM3	EE_IMP	Eel Screen	22/12/2024	Amber	£1,070,943	Y	£1,070,943 / intake screen	The eel screen cost is an estimates based on the cost of the AMP6 Lumley eel screens. The scheme is amber as EA guidance is that we do not actually have to install the screens until we next upgrade the pumping station. We currently intend to install the screens in AMP7. However, the scheme should be subject to the Cost Adjustment Mechanism in case NWL chooses to delay screen installation until a future upgrade. The unit cost is £1,070,943 / intake screen.
NW	7NW100011	Harthope burn catchwater - Water supply asset - MM1 and MM7	WFD_IMP_WRHMWB	Fish Passage	22/12/2024	Amber	176,554	Y	£176,544/ fish pass	The fish pass structure cost is an estimate based on the cost of the Wellhope Burn fish pass. This is an amber scheme and so should be subject to the Cost Adjustment Mechanism. If the scheme is not required, the unit cost is £176,544/ fish pass
NW	7NW100012	Wear Pipe crossing St Johns Chapel -fish passage MM1	WFD_IMP_WRHMWB	Fish Passage	22/12/2024	Amber	176,554	Y	£176,544/ fish pass	The fish pass structure cost is an estimate based on the cost of the Wellhope Burn fish pass. This is an amber scheme and so should be subject to the Cost Adjustment Mechanism. If the scheme is not required, the unit cost is £176,544/ fish pass
NW	7NW100013	Ireshope - Wham pasture MM1. MM7 Burnhope res supply	WFD_IMP_WRHMWB	Fish Passage	22/12/2024	Amber	176,554	Y	£176,544/ fish pass	The fish pass structure cost is an estimate based on the cost of the Wellhope Burn fish pass. This is an amber scheme and so should be subject to the Cost Adjustment Mechanism. If the scheme is not required, the unit cost is £176,544/ fish pass
NW	7NW100014	Ireshope Burn - Greenwell Crags - MM1, MM7 Burnhope res supply	WFD_IMP_WRHMWB	Fish Passage	22/12/2024	Amber	176,554	Y	£176,544/ fish pass	The fish pass structure cost is an estimate based on the cost of the Wellhope Burn fish pass. This is an amber scheme and so should be subject to the Cost Adjustment Mechanism. If the scheme is not required, the unit cost is £176,544/ fish pass
NW	7NW10006	Pont - channel d/s of sluice - MM6 and MM7	WFD_IMP_WRHMWB	Sustainability Change	22/12/2024	Amber	149,800	Y	Not known	The amount of channel restoration has yet to be defined and will be confirmed / agreed with the EA following an initial AMP7 survey. Consequently, the actual cost could change up or down and so the scheme should be covered by the cost adjustment mechanism. At this stage, it is not possible to confirm a unit cost.
NW	7NW10009	Burnhope Burn catchwater to River Derwent MM1 and MM2 , MM5, MM7	WFD_IMP_WRHMWB	Sustainability Change	22/12/2024	Amber	243,915	Y	£160,503 / fish pass	The scheme comprises an allowance for pre- and post-implementation monitoring plus £160,503K for fish pass construction costs. This is an amber scheme and so should be subject to the Cost Adjustment Mechanism. If the scheme is not required, the unit cost is £160,503 / fish pass
NW	7NW10088	BLACK BURN catchwater, feeds into Burnhope Burn d/s of Catchwater : 100% take. MM5, MM7	WFD_IMP_WRHMWB	Sustainability Change	22/12/2024	Amber	133,412	Y	£50,000/ fish pass	The scheme comprises an allowance for pre- and post-implementation monitoring plus £50K for fish pass construction costs. This is an amber scheme and so should be subject to the Cost Adjustment Mechanism. If the scheme is not required, the unit cost is £50,000/ fish pass
ESW	7ES200009	Investigate options for trap and transport of eel population from Hanningfield Reservoir	EE_INV	Investigation and Options Appraisal	30/03/2022	Green	£12,815	Y	Not known	The outcome from the AMP6 investigation (agreed with the EA) was a trap and transport scheme although WINEP3 is for further investigation. We are awaiting confirmation from the EA. Consequently, until confirmed, this scheme should be subject to the cost adjustment mechanism. At this stage, it is not possible to confirm a unit cost.
NW	7NW100001	Balder - d/s Hury Resvoir dam wall - - continue AMP 6 adaptive management trial putting seasonality to compensation release then implement end of AMP 7 - MM5, MM2, MM7 and MM8	WFD_IMP_WRHMWB	Adaptive Management	22/12/2024	Amber	£83,412	Y	£41,706/survey	This scheme is about changing the flows of reservoir releases. There is no capital cost associated with physically changing the flows. Therefore the scheme cost is environmental monitoring which will continue through out the AMP. The level of certainty in terms of spend is high. However, as the scheme is an amber scheme, for completeness, we propose that it should be subject to the cost adjustment mechanism. In the event more or less surveys are required, we propose a unit cost of £41,706/survey.
NW	7NW100002	Lune - Grassholme Res Dam wall - continue AMP 6 adaptive management trial putting seasonality to compensation release then implement end of AMP 7 - MM5, MM2, MM7 amd MM8	WFD_IMP_WRHMWB	Adaptive Management	22/12/2024	Amber	£83,412	Y	£41,706/survey	This scheme is about changing the flows of reservoir releases. There is no capital cost associated with physically changing the flows. Therefore the scheme cost is environmental monitoring which will continue through out the AMP. The level of certainty in terms of spend is high. However, as the scheme is an amber scheme, for completeness, we propose that it should be subject to the cost adjustment mechanism. In the event more or less surveys are required, we propose a unit cost of £41,706/survey.
NW	7NW100003	Waskerley Res - d/s dam wall - implement outcomes of Adaptive Management trials for end of AMP 7 - MM5, plus MM1, MM2, MM4, MM8	WFD_IMP_WRHMWB	Adaptive Management	22/12/2024	Amber	£83,412	Y	£41,706/survey	This scheme is about changing the flows of reservoir releases. There is no capital cost associated with physically changing the flows. Therefore the scheme cost is environmental monitoring which will continue through out the AMP. The level of certainty in terms of spend is high. However, as the scheme is an amber scheme, for completeness, we propose that it should be subject to the cost adjustment mechanism. In the event more or less surveys are required, we propose a unit cost of £41,706/survey.
NW	7NW100016	River Derwent - implement outcomes of Adaptive Management trials for end of AMP 7 - MM5	WFD_IMP_WRHMWB	Adaptive Management	22/12/2024	Amber	£83,412	Y	£41,706/survey	This scheme is about changing the flows of reservoir releases. There is no capital cost associated with physically changing the flows. Therefore the scheme cost is environmental monitoring which will continue through out the AMP. The level of certainty in terms of spend is high. However, as the scheme is an amber scheme, for completeness, we propose that it should be subject to the cost adjustment mechanism. In the event more or less surveys are required, we propose a unit cost of £41,706/survey.
NW	7NW100017	Smiddy Shaw and Hisehope reservoirs Surface Water Transfer , MM5, MM7 and MM8	WFD_IMP_WRHMWB	Investigation and Options Appraisal	22/12/2024	Amber	£83,412	Y	£41,706/survey	This scheme is an investigation. The level of certainty in terms of spend is high. However, as the scheme is an amber scheme, for completeness, we propose that it should be subject to the cost adjustment mechanism. In the event that more than two surveys are required, we propose a unit cost of £41,706/survey.

We propose the following scenarios:

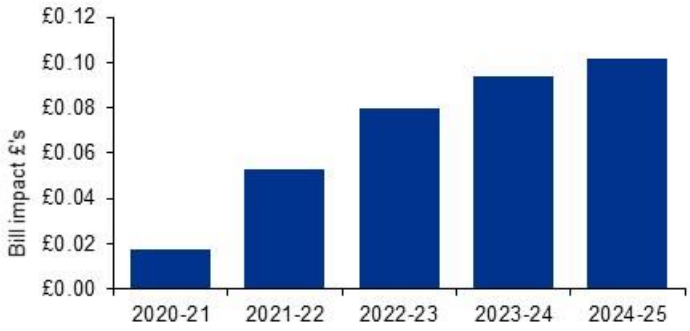
i. Where the scheme is no longer required. This applies to all green and amber schemes. We would propose to simply return the 2020-25 funding at the end of the 2020-25 period in a net present value neutral way. (A full breakdown of costs against each WINEP deliverable is available).

ii. Where the amber schemes deliver more or fewer outputs. We would propose making an adjustment to funding to reflect the actual change in outputs. This would be at the end of the 2020-25 period.
iii. The Berwick Fell Sandstone scheme allows for the relocation of the unsustainable Thornton Bog abstraction and for an options appraisal which will identify further sustainability and resilience measures. We propose that this scheme, although a green scheme, should be subject to the cost adjustment mechanism, given it is by far the largest scheme (in terms of cost). Like the amber schemes in point ii) above, we propose making an adjustment to the funding to reflect the actual change in outputs.

In all cases, there will be some initial spend prior to the decision not to invest e.g. feasibility study, modelling, or sampling programme. This initial spend would need to be accounted for in the adjustment.

Affordability

The impact of these enhancement investments on customer bills are shown below[3].



Overall the analysis shows that the bill impacts would rise to £0.10 a year in 2024/25.

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted to grow at between 0.8 - 1.2% per annum[4] driving significant improvements to average customer affordability.

Customer engagement is less relevant for this enhancement as it derives from a statutory programme of work (the WINEP) and is therefore obligatory, regardless of customer opinion. However, various pieces of customer research carried out on behalf of NWL indicate that customers

[3] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.

In 2016 we conducted customer research on River Water Quality. The outcome was that customers were strongly supportive of improvements in River Water Quality. Delivery of WINEP is a statutory requirement and hence not dependent on customer support, however our plan is stronger for knowing that customers do support this.

[4] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

generally support NWL's environmental aspirations. Focus group research (Explain, 2014) found that the vast majority of participants agreed with NWL going above and beyond government requirements and spending more of customers money on protecting wildlife and habitats (87% agreed). Further workshops (Explain, 2017) indicated that participants expect NWL to be speaking to and working with the Environment Agency and other environmental organisations on environmental issues.

Governance and Assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers". [7].

9. Alignment with Stakeholder Needs

NWL has ensured, through ongoing liaison with local Environment Agency fisheries specialists, that our plans meet their expectations. Improvements to the Wormingford screens were added into the PR19 programme following a site visit by the Environment Agency in 2017, which indicated that the current screens are not fit for purpose. Improvements to the pumps, and possibly screens at Ormesby, were included in the PR19 programme following discussion arising from the AMP6 investigation. Ultimately the Environment Agency as our regulator needs to be confident that our sites and assets comply with the Eel Regulations and the proposed PR19 programme of works under the WINEP Eel driver will ensure that is the case.

Customer focus groups, held across NWL supply areas, during 2017 indicated a high level of support in principle for our PR19 environmental objectives and general programme. Our Water Forum members expect that we will deliver these investigations and solutions promptly.

[7] See Board Assurance Statement

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WINEP INNS ENHANCEMENT BUSINESS CASE

WS2 - Wholesale water capital and operating enhancement expenditure by purpose Line 3

APPENDIX 3.2
WINEP INNS

Name of claim	PR19 ENHANCEMENT BUSINESS CASE: WINEP – Invasive Non-Native Species (INNS)	
Name and identifier of related claim submitted in May 2018	Not Cost Adjustment Claim	
Business plan table lines w here the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line A3	
Total value of enhancement for AMP7	£1.25 million	
Total opex of enhancement for AMP7	£0.00 million	
Total capex of enhancement for AMP7	£1.25 million	
Depreciation on capex in AMP7 (retail controls only)	[n/a]	
Remaining capex required after AMP7 to complete construction	Potentially as and when new INNS risks arise.	
Whole life totex of claim	N/A	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	Material	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		✓
Need for investment/expenditure	Investigations and schemes to ensure the company has assessed the risks of INNS to its operations and activities, put in place a companywide strategy to manage the risk of INNS, put in place a surveillance monitoring programme and implemented mitigation programmes.	
Need for the adjustment (if relevant)	N/A	
Outside management control (if relevant)	N/A	
Best option for customers (if relevant)	To complete works as outlined in this business case. Regulatory obligation and will ensure abstraction sustainability.	
Robustness and efficiency of claim's costs	See Section 7: All costs for schemes in this business case were provided and assured by the NW Cost Assurance team. These costs were benchmarked and assured (Traditional unit rate build up). The cost assurance process and associated costs generated for the water enhancement schemes have been	

	subject to third part assurance provided by Mott Macdonald in July 2018. The cost confidence in each business case as a whole has been assessed using the following methodology: • **Green** - Over 75% achieving Green RAG status • **Amber** – Over 65% achieving Green or over 90% achieving Amber RAG status • **Red** – Not achieving Green or Amber. This review has assessed scheme costs as 100% Amber. NWG have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.
Customer protection (if relevant)	See Section 8: WINEP cost adjustment mechanism
Affordability (if relevant)	See Section 8: The bill impacts would rise to £0.04 a year in 2024/25. This is set within an overall bill drop of more than 12% in AMP7.
Board Assurance (if relevant)	See Section 8: The full board have signed a revised Board Assurance Statement at the full board meeting on the 29th of March 2019 confirming that they have seen and are confident in the enhancement cases.

APPENDIX 3.2

WINEP INNS

1. Executive Summary

This enhancement scheme business case covers all named scheme in our part of the Water Industry National Environment Programme (WINEP) with an Invasive Non-Native Species (INNS) driver. As the WINEP is compiled by the Environment Agency, the inclusion of the schemes in the WINEP means that it is supported by the Environment Agency.

This enhancement is a statutory requirement, being part of the Environment Agency's WINEP, and specifically relates to the measures NWG needs to undertake to ensure compliance with new legal obligations on water companies in relation to INNS, including contributing to the UK's obligation to deliver the European Regulation on Invasive Alien Species and the GB Non Native Species Strategy, and contributing to prevention of deterioration within the Water Framework Directive.

The measures to be undertaken have been agreed with the Environment Agency and comprise investigations and schemes to ensure the company has:

- Assessed the risks of INNS to its operations and activities, including raw water transfers and leisure operations, and has appraised the options available to mitigate those risks;
- Put in place a companywide strategy to manage the risk of INNS;
- Put in place a surveillance monitoring programme for high risk aquatic 'alert' species identified by Defra;
- Implemented mitigation programmes to improve biosecurity for high risk NWG sites, assets and operations;
- A means to tackle INNS risks within the catchments where NWG operates, through partnership projects delivered via 'Branch Out'.

The total estimated cost to complete the required programme of works is £1.25m and covers eight schemes across Northumbrian Water's operating regions.

Customer engagement is less relevant for this enhancement as it derives from a statutory programme of work (the WINEP) and is therefore obligatory, regardless of customer opinion. However, various pieces of customer research carried out on behalf of NWG indicate that customers generally support NWG's environmental aspirations. Focus group research (Explain, 2014) found that the vast majority of participants agreed with NWG going above and beyond government requirements and spending more of customers money on protecting wildlife and habitats (87% agreed). Further workshops (Explain, 2017) indicated that participants expect NWG to be speaking to and working with the Environment Agency and other environmental organisations on environmental issues.

2. Context and Scope

There are new legal obligations on water companies in relation to INNS (Invasive Non Native Species) for PR19. INNS has been included by the Environment Agency within the PR19 WINEP as a separate driver for the first time, due to the increasing evidence and understanding of the risks posed by INNS, plus the need to deliver the European Regulation on Invasive Alien Species and the GB Non Native Species Strategy. The investigations and schemes will also contribute to the prevention of deterioration within the Water Framework Directive.

The presence and spread of INNS has the potential to cost water companies millions of pounds and new and existing INNS pose a threat to achieving Water Framework Directive (WFD) objectives for water bodies.

The investigations and schemes included within NWG's PR19 WINEP will ensure the company is compliant with its legal obligations in relation to INNS. The measures to be undertaken have been agreed with the Environment Agency and comprise investigations and schemes to ensure the company has:

- Assessed the risks of INNS to its operations and activities, including raw water transfers and leisure operations, and has appraised the options available to mitigate those risks;
- Put in place a companywide strategy to manage the risk of INNS;
- Put in place a surveillance monitoring programme for high risk aquatic 'alert' species identified by Defra;
- Mitigation programmes in place to improve biosecurity for high risk NWG sites, assets and operations;
- A means to tackle INNS risks within the catchments where NWG operates, through partnership projects delivered via 'Branch Out'.

This enhancement will contribute towards the 'We help to improve the quality of rivers and coastal waters for the benefit of people, the environment and wildlife' business outcome.

This expenditure is classified as enhancement rather than base maintenance because it is part of the Environment Agency's WINEP, and is related to compliance with new statutory obligations in relation to INNS.

This Business Case relates to the Business Plan table WS2, line 1. There is a slight overlap in terms of development work to the Branch Out software, which is shared with the NERC driver line in Table WS2 – the costs for this work have been apportioned between the two lines.

3. Customer and Stakeholder Expectation

The expected scope of INNS measures to be included within the PR19 WINEP is set out in the Environment Agency's 'PR19 Driver Guidance – INNS' (Environment Agency, Nov 2017).

This document states the Environment Agency's minimum expectation that in PR19:

- All companies with water transfers must include the risk assessment of the prioritised water transfers and subsequent options appraisal for mitigation;
- All companies must include the risk assessment of their activities and options appraisal for risk reduction / mitigation.

NWG has ensured, through liaison with local Environment Agency Fisheries, Biodiversity & Geomorphology Teams, and via escalating issues to the Environment Agency national consistency panel, that our plans meet their expectations. We work with staff from two different Environment Agency areas, and we have aligned the ambition of our INNS programme across our two company operating areas. In particular we have agreed to use the company's existing 'Branch Out' fund as a vehicle for delivering schemes to reduce the risks of spread of INNS along other pathways within catchments where NWG operates, working with other stakeholders at the catchment level to increase the effectiveness and cost efficiency of delivery.

In addition, from discussing the WINEP INNS programme with other water company representatives on the WaterUK Hydroecology and INNS Networks, we are confident that the scale and scope of our proposed WINEP INNS programme is consistent with those proposed by other water companies

and at a level appropriate to the size of the NWG business and the scale of INNS challenge we face in our catchments and operating areas.

The latest version of the WINEP3, issued 30th March 2018, confirms the Environment Agency's acceptance of our programme. A full version of the current WINEP can be viewed here https://data.gov.uk/dataset/a1b25bcb-9d42-4227-9b3a-34782763f0c0/water-industry-national-environment-programme although an updated version is expected at the end of March 2019.

In addition, NWG has worked with local Environment Agency Fisheries, Biodiversity & Geomorphology Teams to agree and complete Measures Specification forms for each INNS line in the WINEP. These set out the scheme objectives, the details of work to be carried out, short, mid- and long term actions, timescales for delivery including key milestones, how the company intends to measure the benefits and outcomes and success measures. The costs put forward for each INNS line in the WINEP are based on these agreed Measures Specifications. Therefore NWG can be confident that our programme of works is at an appropriate level (consistent across the two Environment Agency areas we operate in and consistent with other similar water companies).

Customer engagement is less relevant for these enhancements as they derive from a statutory programme of work (the WINEP) and are therefore obligatory, regardless of customer opinion. However, various pieces of customer research carried out on behalf of NWG indicate that customers generally support NWG's environmental aspirations.

Focus group research (Explain, 2014) found that the vast majority of participants agreed with NWG going above and beyond government requirements and spending more of customers money on protecting wildlife and habitats (87% agreed). Further research called 'Defining the Conversation', carried out in 2016 and 2017 indicated that customers expect NWG to be speaking to and working with the Environment Agency and other expert environmental organisations on environmental issues and when considering how to manage our performance in the wider environment.

In March and April 2018, NWG conducted two phases of deliberative qualitative research with customers to explore their acceptability for a range of discretionary enhancement schemes. The schemes were presented in the context that in 2020 customers' bills would be reduced by 10% and that the schemes could be funded by making the 10% reduction smaller. When reviewing the results of the engagement, we considered customers' acceptability to be anything over 70%. This was based on CCWater's Threshold of Acceptability research that was carried out for PR14. The second phase of research was conducted because in the first phase a number of customers stated that they did not know if they accepted the schemes. We discussed this with our Water Forums and agreed that we should carry out additional engagement to understand why this was, and what information we would need to provide to customers to allow them to answer the acceptability question. The results from the acceptability engagement were discussed with our Water Forums, who welcomed the generally very high levels of customer support for the schemes. Members did not agree on a definitive threshold for support in percentage terms, however some views shared were that anything over about 60% would be acceptable. All our enhancements were included in our overall acceptability research, where our plan was supported by 91% of customers.

In 2016 NWG conducted customer research on River Water Quality. The outcome was that customers were strongly supportive of improvements in River Water Quality. Delivery of WINEP is a statutory requirement and hence not dependent on customer support, however our plan is stronger for knowing that customers do support this. Our Water Forums are supportive of our WINEP proposals which we shared with them in April 2018.

Therefore, the scope of the WINEP is in keeping with customers' expectations.

In summary, successful delivery in customer benefit terms, will be completion of the agreed WINEP programme.

4. Current and Historical Service Delivery and Expenditure

As this is a new requirement for PR19, there is limited historical service delivery and expenditure information to draw on. Historically tackling INNS has been carried out by the Conservation Team as part of their operational business as usual activities, where specific populations / infestations have been identified on operational sites or through surveys.

NWG has also contributed funds to specific external partnership projects, e.g. through catchment partnerships and Rivers Trusts, to address INNS more broadly in catchments where NWG operates. An example is the Tweed Invasives Project, which is addressing Giant Hogweed, plus Japanese Knotweed, Himalayan Balsam and American Skunk Cabbage throughout the catchment. The project is supported by a range of organisations and volunteers, and NWG contributes £2k of funding per year.

In the company's ESW area, previous work has included the removal of Crassula helmsii at Layer Pits. In addition a multi-year programme of Floating Pennywort removal at Langham ponds appears to have eradicated this species from the site, and monitoring is ongoing to ensure this remains the case. A further project to remove Floating Pennywort from the Langford Cut is ongoing and ESW is seeking partners to work with on this project going forwards.

In terms of current demand by external partners for match funding to tackle INNS issues within catchments where NWG operates, across the period of 2016, 2017 & the first application round of 2018 the total value of INNS related projects that have applied to Branch Out equates to £41k pa (pro-rated). This is without NWG specifically requesting INNS related projects. Setting up a bespoke category in Branch Out for INNS & being prepared to be the sole funder is likely to attract a significantly higher rate of applications for INNS work in our catchments. We know there is already a demand of circa £41k pa for this work in our operating areas for projects that fit the Branch Out rules.

For existing raw water transfers, a prioritisation exercise has been carried out following the Environment Agency's methodology (Annex 1 of the EA's 'PR19 Driver Guidance – INNS' (Environment Agency, Nov 2017), ahead of the development of the WINEP. This has helped to prioritise the various raw water transfers for risk assessment and options appraisal within the WINEP.

5. Forward Looking Analysis

As this is a new requirement for PR19, a major part of the WINEP PR19 programme for INNS is to undertake surveillance monitoring, baseline site surveys, risk assessments and investigations on NWG's raw water transfers, activities and operations (including the company's leisure sites), to understand the size of the issue and the scale of mitigation required in AMP8 and beyond.

Some funding has been allocated to implement biosecurity measures on NWG leisure sites and to contribute to the delivery of catchment-wide INNS eradication programmes, via Branch Out. The former, especially, is a known area where NWG lags behind other water companies and needs to be addressed urgently.

6. Option Appraisal

Two options have been considered for undertaking the risk assessments and options appraisals of INNS risk due to raw water transfers and other company activities and operations (including leisure operations). These were:

- NWG uses in-house expertise within the Water Resources and Conservation Teams to lead on the development of appropriate risk assessment methodologies, and to work with other relevant teams, including local Water Supply teams and the Leisure and Distribution teams, to carry out the risk assessments and options appraisals of available mitigation measures;
- NWG contracts out all or part of this work to consultants.

In both cases (for raw water transfers and for the appraisal of all other company activities and operations), NWG has selected to complete this work using in-house expertise as far as possible. This has the benefit of building knowledge and understanding of these issues within the business and is a far lower cost option than the alternative of using consultants.

Two options were considered for delivering INNS control and eradication works within catchments where NWG operates. These were:

- NWG contracting appropriate contractors to undertake works directly;
- NWG contributing to the delivery of catchment scale mitigation measures via NWG's Branch Out initiative, in partnership with other organisations.

In this case, NWG considers it more innovative, cost effective, efficient and more likely to result in the desired outcome (of INNS control and ultimately eradication), to work with other stakeholders at the catchment level. We know there is already a demand of circa £41k pa for INNS control work in our operating areas for projects that fit the existing Branch Out rules, including those on match funding. This is without NWG specifically requesting INNS related projects. Setting up a bespoke category in Branch Out for INNS & being prepared to be the sole funder, if necessary, is likely to attract a significantly higher rate of applications for INNS work in our catchments and contribute to more efficient and cost effective delivery.

In terms of biosecurity measures on NWGs own sites and landholdings, while the exact programme of works required will be dependent on the outcome of the earlier risk assessments and options appraisals, NWG has used our contacts within the WaterUK INNS Network and liaison with those water companies who received funding for INNS work during PR14 (specifically Wessex Water, South West Water and Welsh Water), to understand some of the outcomes of their risk assessments and they types of biosecurity measures that are currently being installed at high risk operational and leisure sites, e.g. boat and fishing equipment washdown facilities. As NWG operates many leisure sites in a similar fashion to other water companies and does not yet have its own washdown facilities, it is reasonable to assume that this investment need is highly likely to arise out of the risk assessments. The Environment Agency itself is also investing in fixed and mobile equipment wash down infrastructure, and is likely to expect water companies undertaking similar tasks to do the same.

7. Preferred Plan / Option

The total projected cost of the PR19 WINEP INNS programme is £1.25m. This will deliver:

- Risk assessments of the risks of transferring INNS via raw water transfers and options appraisals of available mitigation measures. The output will be a mitigation plan for delivery in AMP8 and beyond.

- Risk assessments of the risks associated with all NWG activities and operations (including at leisure sites) and options appraisals of available mitigation measures. The output will be a mitigation plan for delivery in the later years of AMP7 and beyond.
- A companywide strategy to manage the risk of INNS;
- An ongoing surveillance monitoring programme in catchment where NWG operates for high risk aquatic 'alert' species identified by Defra;
- Baseline INNS surveys for key / high risk NWG landholdings and operational sites;
- A targeted programme of mitigation measures to improve biosecurity on high risk NWG sites, assets and operations, including boat and fishing equipment wash down facilities;
- A suite of partnership projects delivered via 'Branch Out' to tackle INNS risks within the catchments where NWG operates.

Costing

Efficient costs

NWG has assessed the costs for this and other enhancement claims through a structured and robust approach.

All costs for schemes in this business case were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[1]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed costs for schemes in this business case are [£1.25 million Capex and £0 million Opex]. The detailed cost calculations for each line of the WINEP are provided below.

These costs were benchmarked and assured as follows:

- Traditional unit rate build up

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[2]. The cost confidence in each business case as a whole has been assessed using the following methodology:

- **Green** - Over 75% achieving Green RAG status
- **Amber** – Over 65% achieving Green or over 90% achieving Amber RAG status
- **Red** – Not achieving Green or Amber.

This review has assessed scheme costs as 100% Amber. NWG have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

[1] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology
[2] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

APPENDIX 3.2
WINEP INNS

Costs have been built up for each line, based on the Measures Specifications for each WINEP INNS line, agreed with the Environment Agency, and using known costs for NWG staff recharge, standard current day rates for ecological consultants, e.g. for ecological surveys, with adjustments for inflation, etc. The cost calculations are presented in table 1 below.

APPENDIX 3.2
WINEP INNS

Table 1 – WINEP INNS cost calculations

APPENDIX 3.2
WINEP INNS

Scheme name	ESW / NW	Description	Level of certainty	Completion date	Source of cost data	Cost data validation	Assumptions behind cost calcs	Cost calculation	Total companywide cost
Water transfer pathways investigation, incorporating risk assessments, pathways options appraisal and mitigation measures assessment	ESW	Develop methodology, pilot at ESW & NW sites, refine methodology. Work with local WS teams to complete RA's (ESW x 7). Investigate options available and complete options appraisal. Write up NWG action plan / report. Carried out by NWG staff - costs reallocated to capex	Green	31/03/2022	Internal staff recharge rates provided by Antony Braun, current as of 21/03/18, from Engarde / MyTime. Estimate of staff time required to develop, pilot & refine methodology, then complete work for all ESW sites, and undertake options appraisal.	Internal recharge rates are under review and may increase markedly before the start of AMP7.	Staff recharge rates rounded up to nearest £. No inflation assumption due to ongoing review of rates.	1 Water Resources Environmental Scientist x 234 hours x £40 = £9358 1 Water Supply Area Manager x 50 hours x £50 + 1 WTW Supervisor x 50 Hours x £42 = 4600	£ 13,958
Water transfer pathways investigation, incorporating risk assessments, pathways options appraisal and mitigation measures assessment	NW	Support development of methodology, pilot at NW sites, refine methodology. Work with local WS teams to complete RA's (NW x 7 approx.). Investigate options available and complete options appraisal. Carried out by NWG staff - costs reallocated to capex	Green	31/03/2022	Internal staff recharge rates provided by Antony Braun, current as of 21/03/18, from Engarde / MyTime.	Internal recharge rates are under review and may increase markedly before the start of AMP7.	Staff recharge rates rounded up to nearest £. No inflation assumption due to ongoing review of rates.	1 Water Resources Specialist x 129 hours x £48 = £6192 1 Water Supply Area Manager x 50 hours x £50 + 1 WTW Supervisor x 50 Hours x £42 = 4600	£ 10,792
Other pathways biosecurity investigations, incorporating risk assessments, options appraisal and mitigation measures assessment	Both (NWG)	Develop methodology (based on Wessex & YW examples), pilot at ESW & NW sites, refine methodology. Work with local Water Supply / Leisure / Estates teams to complete RA's. Investigate options available & complete options appraisal. Write up NWG Action Plan. Carried out by NWG staff - costs reallocated to capex. Ecological consultant / Contractor - baseline surveys for INNS on key sites.	Green	31/03/2022	Internal staff recharge rates provided by Antony Braun, current as of 21/03/18, from Engarde / MyTime. Ecological consultant costs based on average day rates from recent contracts from Miranda Cooper pers. comm.	Internal recharge rates are under review and may increase markedly before the start of AMP7.	Other team staff - assume average hourly recharge rate of £40. Staff recharge rates rounded up to nearest £. No inflation assumption due to ongoing review of rates.	Conservation Advisor (1) x 353 hours x £28 = £9884 Other team staff x 107 hours x £40 = £4290 Ecological consultant INNS baseline surveys - assume 50 sites, baseline survey taking 2 people 3 days per site at consultant rate of £400 per day plus one day data analysis & write up per site = 50 x ((2x400) x 3 +400) = £140,000	£ 154,174
Biosecurity schemes on NWG estate and for key assets and operations to mitigate the risk of spread of INNS along other pathways	Both (NWG)	Incl. boat washing facilities at 10 key leisure sites (Hann, Rollesby Sailing Club, Filby Sailing Club, Kielder x4, Derwent, Grassholme, Scaling Dam). 'Small' equipment, clothing & footwear wash facilities at relevant sites (11 x ESW, 15 x NW). Communications campaign (incl. relevant signage, literature and / or contribution to national Check Clean Dry campaign each year if relevant. Additional mitigation / eradication actions on NWG estate, e.g. possible trial of biocontrol with CABI.	Green	31/03/2025	Email from David West at Thames Water (08/08/2017) with cost estimates for similar installations at Thames Water sites. WaterUK funding formula for Check Clean Dry suggests NWG's 'fair' contribution should be £18,165 pa. Actual 2017/18 NWG contribution was £10k until we see what outputs the campaign produces (Miranda Cooper pers. comm email 22/03/18). 2017 CABI biocontrol proposal gave cost estimate of £10k for trial of biocontrol for Crassul Helmsii.	No validation.	Assume our sites are likely to have similar set up to Thames Water sites and therefore costs are comparable.	Based on costs for jet washes and associated civil work of £50k per site (for 2 lane jet wash for boats and small kiosk for 'small' equipment), provided by Thames Water. Gives 10 x £50k = £500,000. 'Small' equipment kiosk at additional six sites, i.e. 6 x £3k = £18,000. Communications campaign incl. signage, literature, Check Clean Dry contribution at £15k per year of AMP = £75,000 Additional control of INNS on NWG estate at £10k per year of AMP = £50,000	£ 643,000
Produce a companywide INNS strategy (*covering aspects including training, communications, surveillance, company processes & procedures*).	Both (NWG)	Carried out by NWG staff - probably before start of AMP7, with any remaining staff costs within AMP7 reallocated to capex. Would be more expensive if external provider required to produce e-learning module etc.	Green	31/03/2025		Internal recharge rates are under review and may increase markedly before the start of AMP7.	Other team staff - assume average hourly recharge rate of £40.	3 staff x 37.5 hours x £40 = £4500	£ 4,500
Support key partnership projects which are aiming to prevent introduction and spread of invasive species in catchments where NWG operates and especially where the aim of the project is to prevent deterioration of a protected site / waterbody i.e. where INNS threaten the conservation objectives of a SSSI or HD site.	ESW Not currently on NW WINEP3	Delivered companywide via Branch Out - amend objectives to specifically include INNS, amend Branch Out website, forms and reporting, and look to support projects meeting INNS, NERC biodiversity and water quality drivers.	Green	31/03/2025	Modifications to Branch Out software in report by Cost Estimation Team - Proposal: Branch Out Changes, by Brenton Horne, 30/01/2018. Branch Out £40k pa - Miranda Cooper pers. comm. (email 22/03/18) Across the period of 2016, 2017 & the first application round of 2018 the total value of INNS related projects that have applied to BranchOut equates to £41k pa (pro-rated). This is without NWG specifically requesting INNS related projects. Setting up a bespoke category in BranchOut for INNS & being prepared to be the sole funder is likely to attract a significantly higher rate of applications for INNS work in our catchments. We know there is already a demand of circa £41k pa for this work in our operating areas for projects that fit the BranchOut rules so having a fund of £40k pa available will have a significant impact with regards to what can be achieved.	Cost estimate for modifications to Branch Out software validated by NWL Cost Estimation Team.	Cost of modifications to Branch Out software shared between INNS and NERC WINEP lines.	Increase annual Branch Out budget by £40k each year in AMP, gives £200,000, across whole of NWG. Cost estimation amends to Branch Out (for INNS & Priority Habs) = £17,662. INNS share taken to be £7662. £10k against NERC driver (MC).	£ 207,662
Establishing surveillance programmes based on NNSS Alert Species.	Both (NWG)	NWG staff - design surveillance monitoring programme for NNSS Alert species. Contractor - ongoing surveillance surveys for key species at high risk sites.	Green	31/03/2022 for NW 31/03/2021 for ESW	Internal staff recharge rates provided by Antony Braun, current as of 21/03/18, from Engarde / MyTime. Ecological consultant costs based on average day rates from recent contracts from Miranda Cooper pers. comm.	Internal recharge rates are under review and may increase markedly before the start of AMP7. Ecological consultant average day rates based on contracts awarded during AMP6.	Staff recharge rates rounded up to nearest £. No inflation assumption due to ongoing review of rates.	1 x Conservation team staff x 37.5 hours x £28 = 1050 Ecological consultant INNS surveillance spread over rest of AMP - assume half cost of baseline surveys = £70,000	£ 71,050.00
North Tyne Crayfish Investigation	NW	Research project to understand current abstraction regime and what could be altered to minimise the risk of transferring crayfish and / or crayfish plague virus.	Green	31/03/2022	Example figures obtained from Claire Gowdy (pers. comm.) 20/03/18.	Known costs of PhD studentships based on existing arrangements.	Costs based on recent examples of NWG contribution to various technical PhDs.	Assume £30k - based on part-funding a PhD studentship. Might be more if need Specialist Consultant. Might be less if can attract additional sources of student match funding, e.g. from NERC.	£ 30,000.00
									£ 1,135,136
								With 10% on-costs	£ **1,248,650**

The costs are efficient because in-house expertise within the Water Resources and Conservation Teams is being used as far as possible, e.g. to design and deliver the risk assessments and options appraisals of INNS spread via raw water transfers and 'other' pathways, such as NWG operations, activities and leisure facilities. This is far more cost effective than using consultants. The number of days has been built up based on the known number of raw water transfers and sites that require risk assessment and survey.

The use of NWG's Branch Out initiative, to deliver measures to control the spread of INNS in catchments where NWG operates, is cost effective, as external organisations who successfully bid for Branch Out funding will use it to match their own external sources of funding. Providing match funding to partner organisations in this way allows NWG's money to go further and ensures that NWGs objectives are met via projects, alongside those of the delivery organisations. The delivery risk is that insufficient high quality project proposals are received on which to allocate Branch Out grants. However, this risk is considered low, given that the proposed expenditure on Branch Out grants during AMP7 is set at the same level as recent demand. If fewer suitable external partnership projects are received via Branch Out than expected, then funds will be re-allocated to tackling more biosecurity measures on NWG's landholding.

The cost expenditure profile is set according to Environment Agency deadlines for each line of the WINEP and presented in Table 2 below.

Table 2 – WINEP INNS cost expenditure profile

Code	WINEP3 unique code	Scheme name	ESW / NW	EA deadline for completion	2020/21	2021/22	2022/23	2023/24	2024/25	AMP7 TOTAL	Comments
INNS_INV	7ES200012, 13, 14, 15, 16, 17, 19	Water transfer pathways investigation, incorporating risk assessments, pathways options appraisal and mitigation measures assessment	ESW	31/03/2022	£ 9,305	£ 4,653				**£ 13,958**	
INNS_INV	7NW100045	Water transfer pathways investigation, incorporating risk assessments, pathways options appraisal and mitigation measures assessment	NW	31/03/2022	£ 7,195	£ 3,597				**£ 10,792**	
INNS_INV	7ES200001 7NW200003	Other pathways biosecurity investigations, incorporating risk assessments, options appraisal and mitigation measures assessment	Both (NWG)	31/03/2022	£ 37,449	£ 32,725	£ 28,000	£ 28,000	£ 28,000	**£ 154,174**	
INNS_ND	7ES200002 7NW300109	Biosecurity schemes on NWG estate and for key assets and operations to mitigate the risk of spread of INNS along other pathways	Both (NWG)	31/03/2025	£ 25,000	£ 25,000	£ 197,667	£ 197,667	£ 197,667	**£ 643,000**	Most investment follows on from outcomes of risk assessments
INNS_ND	7ES200018 7NW200002	Produce a companywide INNS strategy (*covering aspects including training, communications, surveillance, company processes & procedures*).	Both (NWG)	31/03/2025	£ 4,500					**£ 4,500**	
INNS_ND	7ES200003	Support key partnership projects which are aiming to prevent introduction and spread of invasive species in catchments where NWG operates and especially where the aim of the project is to prevent deterioration of a protected site / waterbody i.e. where INNS threaten the conservation objectives of a SSSI or HD site.	ESW Not currently on NW WINEP3	31/03/2025	£ 47,662	£ 40,000	£ 40,000	£ 40,000	£ 40,000	**£ 207,662**	Share of modifications to Branch Out software in Year 1 (shared with NERC driver). Actual spend profile will depend on timing of project proposals received & accepted via Branch Out
INNS_MON	7ES200006 7NW200005	Establishing surveillance programmes based on NNSS Alert Species.	Both (NWG)	Establish survey plan by 31/03/21. Start surveys from 01/04/2021.	£ 1,050	£ 17,500	£ 17,500	£ 17,500	£ 17,500	**£ 71,050**	
INNS_INV	7NW200006	North Tyne Crayfish Investigation	NW	31/03/2022		£ 10,000	£ 10,000	£ 10,000		**£ 30,000**	

If the risk assessments and other investigations suggest that more investment in biosecurity measures is needed than has been allowed for in the above cost estimation, then the available funding will be allocated in order of decreasing risk. In addition, it is expected that some mitigation measures will be held over to AMP8, including all those relating to the mitigation of risks from

existing raw water transfers. This is in line with the Environment Agency's expectations, as stated in the 'PR19 Driver Guidance – INNS' document.

It is unlikely that less funding will be needed, as the above costs have been built up to cover the expected minimum investment required at key NWG leisure sites to achieve parity with similar sites where investment is already taking place at other water companies. However, we have based our biosecurity measures costs as follows: allowing for boat washing facilities at 10 key leisure sites (Hanningfield, Rollesby Sailing Club, Filby Sailing Club, Kielder x4, Derwent, Grassholme, Scaling Dam) and 'small' equipment, clothing & footwear wash facilities at the same 10 key leisures sites, plus a further 6 smaller sites. The assumed unit costs are £50k at the 10 main sites, based on costs for jet washes and associated civil work (for a 2 lane jet wash for boats and small kiosk for 'small' equipment), and £18k at the remaining 6 smaller sites for a 'small' equipment kiosk.

No performance commitment is proposed for this business case since it is a regulatory requirement.

The consequences of non-delivery would be mainly reputational, with our regulators and with our customers. Any WINEP non-compliance for the Northumbrian Water part of the business would be reported in the Environment Agency's Annual Performance Review. As this review only covers Water and Sewerage Companies (WASCs) it would not be relevant to Essex & Suffolk Water.

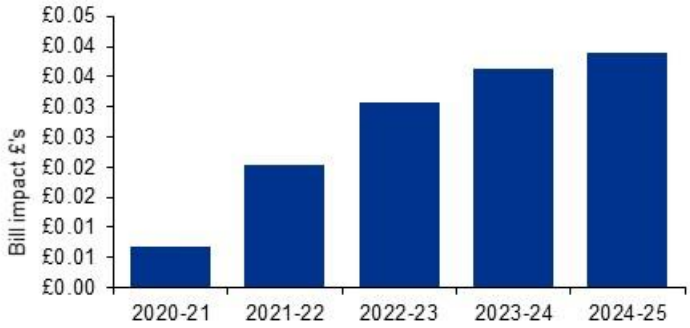
8. Customer Protection

NWG is proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed. We are proposing a cost adjustment mechanism for enhancement costs that will protect customers against late or non-delivery of those enhancement schemes. Full details of our enhancements delivery incentive mechanisms are included in Chapter 4: Measuring and Incentivising Success of our final business plan. More detail specific to the cost adjustment mechanism proposed for WINEP schemes is also provided in Appendix 3.9 of our PR19 Business Plan. The latter sets out a proposed cost adjustment mechanism to be applied in the event of discrepancies in scale between the assumed Water Industry National Environmental Programme (WINEP) at the time of the Final Determination in December 2019 and the confirmed programme in 2021.

Affordability

The impact of these enhancement investments on customer bills are shown below[3].

[3] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.



Overall the analysis shows that the bill impacts would rise to £0.04 a year in 2024/25.

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted to grow at between 0.8 - 1.2% per annum[4] driving significant improvements to average customer affordability.

Customer engagement is less relevant for this enhancement as it derives from a statutory programme of work (the WINEP) and is therefore obligatory, regardless of customer opinion. However, various pieces of customer research carried out on behalf of NWG indicate that customers generally support NWG's environmental aspirations. Focus group research (Explain, 2014) found that the vast majority of participants agreed with NWG going above and beyond government requirements and spending more of customers money on protecting wildlife and habitats (87% agreed). Further workshops (Explain, 2017) indicated that participants expect NWG to be speaking to and working with the Environment Agency and other environmental organisations on environmental issues.

Governance and Assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers"[7].

9. Alignment with Stakeholder Needs

[4] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast
[7] See Board Assurance Statement

APPENDIX 3.2

WINEP INNS

NWG has followed the guidelines for the expected scope of INNS measures to be included within the PR19 WINEP, as set out in the Environment Agency's 'PR19 Driver Guidance – INNS' (Environment Agency, Nov 2017). NWG has further ensured, through ongoing liaison with local Environment Agency Fisheries, Biodiversity & Geomorphology Teams, and via escalating issues with the Environment Agency national consistency panel, that our plans meet their expectations. For example, at meetings in September and December 2017, we agreed with the EA to group our raw water transfers into appropriate 'systems' to make the risk assessment process more logical. We also agreed to complete the risk assessment of the Environment Agency's Ely Ouse to Essex Transfer System (EOETS) as a joint initiative as, although the EA holds the licence for and operates the transfer, ESW is a key beneficiary of it. We also agreed to retain the INNS_MON line for surveillance monitoring of Defra alert species because of the known existing risks on watercourses in catchments NWG operates in, and to deliver INNS mitigation measures in catchments where we operate through partnership with other stakeholders and our Branch Out initiative.

The latest version of the WINEP3, issued 30th March 2018, confirms the Environment Agency's acceptance of the programme.

Customer focus groups, held across NWG supply areas, during 2017 indicated a high level of support in principle for our PR19 environmental objectives and general programme. Our Water Forum members expect that we will deliver these investigations and solutions promptly.

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MEETING LEAD STANDARDS ENHANCEMENT BUSINESS CASE

WS2 - Wholesale water capital and operating enhancement expenditure by purpose Line 6

APPENDIX 3.2

MEETING LEAD STANDARDS ENHANCEMENT BUSINESS CASE

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MEETING LEAD STANDARDS ENHANCEMENT BUSINESS CASE

Name of claim	Water Quality- Meeting Lead standards Enhancement	
Name and identifier of related claim submitted in May 2018		
Business plan table lines where the totex value of this claim is reported	WS2 line 6 for 'Meeting lead standards'.	
Total value of enhancement for AMP7	**£10,270,741**	
Total opex of enhancement for AMP7	£0	
Total capex of enhancement for AMP7	**£10,270,741**	
Depreciation on capex in AMP7 (retail controls only)	n/a	
Remaining capex required after AMP7 to complete construction	None as all schemes expected to be delivered in AMP 7	
Whole life totex of enhancement	n/a.	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	Material	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	**Yes**	**No**
		No
Need for investment/expenditure	Statutory revision of the lead standard from 10ug/l to 5ug/l. Long term goal to be 'lead free'.	
Need for the adjustment (if relevant)	n/a	
Outside management control (if relevant)	n/a	
Best option for customers (if relevant)	Refer to option appraisal p8-11	
Robustness and efficiency of claim's costs	Refer to p11-14	
Customer protection (if relevant)	Refer to p17	
Affordability (if relevant)	Refer to p18	
Board Assurance (if relevant)	Refer to p19-20	

APPENDIX 3.2

MEETING LEAD STANDARDS ENHANCEMENT BUSINESS CASE

1 Executive Summary

At Northumbrian Water Group (NWG) we have a clear vision on how to reduce customers' exposure to lead and work towards our long-term ambition to be 'lead free' by 2050. Parliament's Environment Committee has approved a report to tighten the lead standard in drinking water from 10µg/l down to 5µg/l. The Drinking Water Inspectorate (DWI) have concerns that water companies will be unable to meet this standard with phosphate dosing for plumbosolvency control. We recognise that dosing phosphate during treatment is not a permanent solution to the risks posed by lead pipes. Furthermore, phosphate is a limited resource with consequences to the treatment of wastewater. Customer awareness and barriers to supply pipe replacement is a challenge to the water industry. Cost, disruption and finding a reliable contractor are customer concerns and deterrents. The only sustainable solution to ensure customers are protected from lead exposure whilst meeting the new lead standard is to accelerate our lead replacement through prioritised schemes replacing both the communication pipe and supply pipe.

The benefits of becoming 'lead free' relate to health outcomes for our customers. The World Health Organisation (WHO) state there is no safe level of lead, and lead has been shown to have several negative health consequences. This includes affecting cognitive development in children, and thus reducing average expected lifetime earnings. We will enhance lead pipe replacement by going beyond our responsibility of the communication pipe and replace the customer's supply pipe in prioritised areas. Our priorities will focus on protecting our most vulnerable communities and those areas at highest risk to lead exposure. Going beyond our responsibility by replacing the full service pipe mitigates the risk of lead exposure in drinking water for those customers and future generations. In some rural areas we will enhance the scope of communication pipe replacement by replacing the full lead service pipe to negate the need for phosphate, a finite resource with an environmental impact.

This enhanced business case is expected to deliver immediate performance improvements, supporting our customers and protecting health whilst striving to achieve a more stringent lead water quality level in advance of changes to the Regulatory Standards. It aligns us with our long-term ambition and supports WaterUK's strategy to be 'lead free' by 2050. Lead replacement is key to meeting the revised water quality standard. We have been ambitious with our scale of replacement whilst balancing deliverability and affordability. Customer research identified that customers were highly supportive of lead pipe replacement with 88% of customers voting yes to the enhanced package. DWI have assessed our strategy and issued a letter of support (Annex A).

The enhanced business case will deliver the replacement of 3,730 service pipes (communication and supply pipes) at a total cost of £10,270,741. The Performance Commitment is the number of lead service pipes replaced. In the event of late or non-delivery of the Performance Commitment by the end of AMP7 i.e. if the number of replacements differs, customers will be protected in line with section 4.5 of the business plan.

2 Context and Scope

Enhancement Description

The purpose of this document is to describe the approach NWG will take to determine the interventions and investment required to manage the risk of customers' exposure to lead from 2020 to 2025 and its long term vision.

Our current policy for meeting the DWI lead standard of 10µg/l is through plumbosolvency (the dissolution of lead into water) control and our lead pipe replacement policy. Plumbsolvency control has the main benefit of providing a level of protection against all lead pipework, including that owned by the customer and throughout the property. This is currently achieved through phosphate

dosing and pH control with sodium hydroxide. We currently replace our lead communication pipe following a sample result at the customer tap greater than 4µg/l; ad hoc replacement at the request of the customer; and when 'opportunistically' found during mains structural rehabilitation schemes. Our current policy is considered business as usual and is covered by base maintenance. This document describes how we intend to enhance our policy further and how the associated expenditure will take us beyond our current obligations and further protect public health.

Parliament's Environment Committee has approved a report to tighten the lead standard in drinking water from 10µg/l down to 5µg/l. In addition, WaterUK have stated that its members will be 'lead free' by 2050. To achieve the new lead standard and the strategic policy, we need to make the pace of intervention (removal) sustainable and at an appropriate level to meet our 2050 goal. The DWI are discussing resolving the lead issue by 2050. Welsh and Scottish Governments have enhanced lead strategies culminating in similar dates that are likely to become models for the next DWI lead strategy. DWI have commented in early 2018 that they are opening the supply pipe adoption debate with the rest of government, which represents a significant change in their approach.

We will work towards our long-term strategy to remove all of our lead communication pipes and WaterUK's ambition to be 'lead free' by 2050 through a risk-based approach to managing lead by prioritising both those customers most vulnerable to its effects and those properties at highest risk of non-compliance. We will mitigate the risk of lead exposure in those prioritised areas by going beyond our current responsibility and replacing the full service pipe including that of the customer's lead supply pipe. This has the added benefit of replacing an aging asset, reducing the risk of asset failure (including leakage) and future maintenance intervention.

To support a sustainable strategy, we will reduce our phosphate dependency through full lead service pipe replacement in discrete rural areas enabling the elimination of phosphate dosing in those areas. This will provide savings on operation, maintenance and future asset replacement of dosing units and chemical storage. Whilst still in place, phosphate dosing will continue to incur costs and due to its environmental impact require its removal from waste.

This Business Case relates to Table WS2 line 6 for 'Meeting lead standards'.

3 Customer and Stakeholder expectation

In 2016/17, household and non-household customers that live in properties that were likely to live in properties with lead pipes were contacted through telephone surveys and deliberative events in both operating areas, Northumbrian Water and Essex and Suffolk Water. The objectives of the research were as follows:

- Measure customers' understanding of water supply pipe ownership & responsibilities, and the presence and impact of lead pipes in their property
- Understand the impact that making customers more aware of the dangers and presence of lead has on their perceptions of the quality of drinking water and the knock on effects of this
- Explore customers' likelihood to replace lead pipework
- Understand customers' drivers and barriers to replacing or lining lead pipes
- Present a range of arguments/incentive schemes to customers in favour of lead pipe removal to gauge the appeal and persuasiveness of each
- Understand the best way to communicate such messages

Cost and disruption (and the stress associated with that) were seen as the main barriers for lead replacement. Finding a reliable contractor was also a concern. Involvement of other parties (such as neighbours or landlords) were also seen as a deterrent. Finally, there was also doubt whether replacement is really necessary or that the situation could be worse afterwards (because the work is not done properly or the replacement material is found to be also harmful in some way).

Lead lining technology comprises of spraying the internal wall of the lead pipe to create a barrier. Customers across both regions did not find pipe lining an appealing option as it is only a temporary solution. If they chose to do something about their pipes they would all opt for a full replacement instead. In consideration of this outcome, the decision was made to not conduct any wholesale lead lining schemes and instead focus on lead pipe replacement.

In 2018 the Water Forum was consulted on our Lead Enhancement options. The Forum was in support of the options A-D described in this document, however they felt further customer research was required to validate customer views. As a result customer research was arranged in April 2018. Explain, a market research consultancy were commissioned for the research. Research sessions were held in Newcastle, Durham and Chelmsford with a total of 1298 customers in attendance. Customers were taken through each of the options including the associated impact to bills and asked to vote on their acceptance. Some questions were raised at the sessions over the impacts of phosphate dosing on health and the environment. As a future strategy customers' preferred option is to replace lead pipework. Option D has not been carried forward for Enhancement. Overall acceptability for the lead package of options A-C was 88% across NWG indicating customer support.

4 Current and Historical Service delivery and expenditure

Lead control is currently achieved through a source to tap approach via chemical (water conditioning) and physical (replacement) intervention.

Virtually all our WTWs are dosed with orthophosphoric acid with 99.6% of our input into the network receiving a dose. During the current AMP, new sodium hydroxide dosing plants for pH control are being installed for water conditioning and to further support plumbosolvency control. The work is completed at two WTWs (Broken Scar and Mosswood) with the work at two other WTWs (Warkworth and Wear Valley) is due for completion within AMP6. Sodium hydroxide dosing at these sites, once implementation is complete is estimated to be £204,000 OPEX per annum. In 2017, phosphoric acid was dosed across NWG at £1,001,208 OPEX (cost of chemical). Both these costs at the current target dose are considered base maintenance. Figures 1 and 2 illustrate the lead levels in distribution have been stable since 2003 and highlights the benefits achieved from dosing with phosphate.

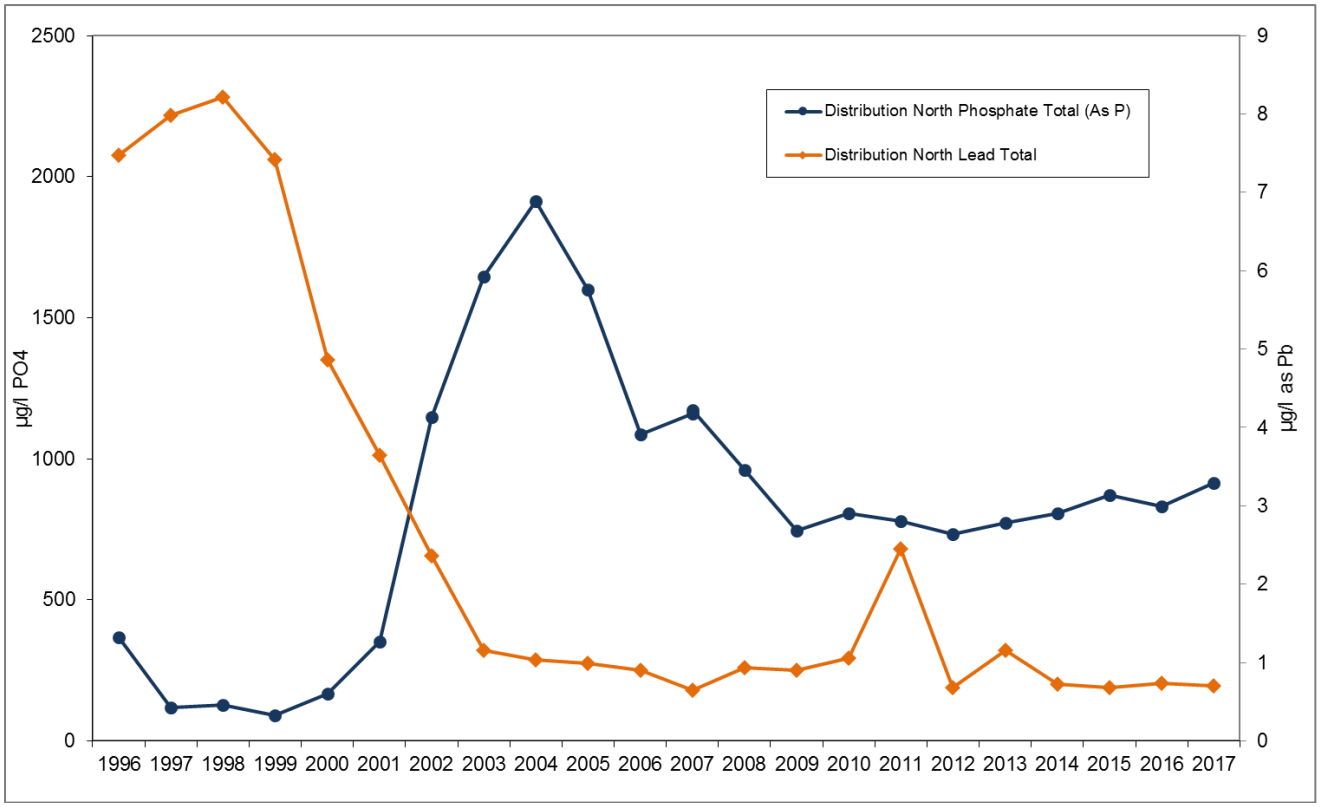

Figure 1. Average lead levels in distribution versus average phosphate levels in the NW region

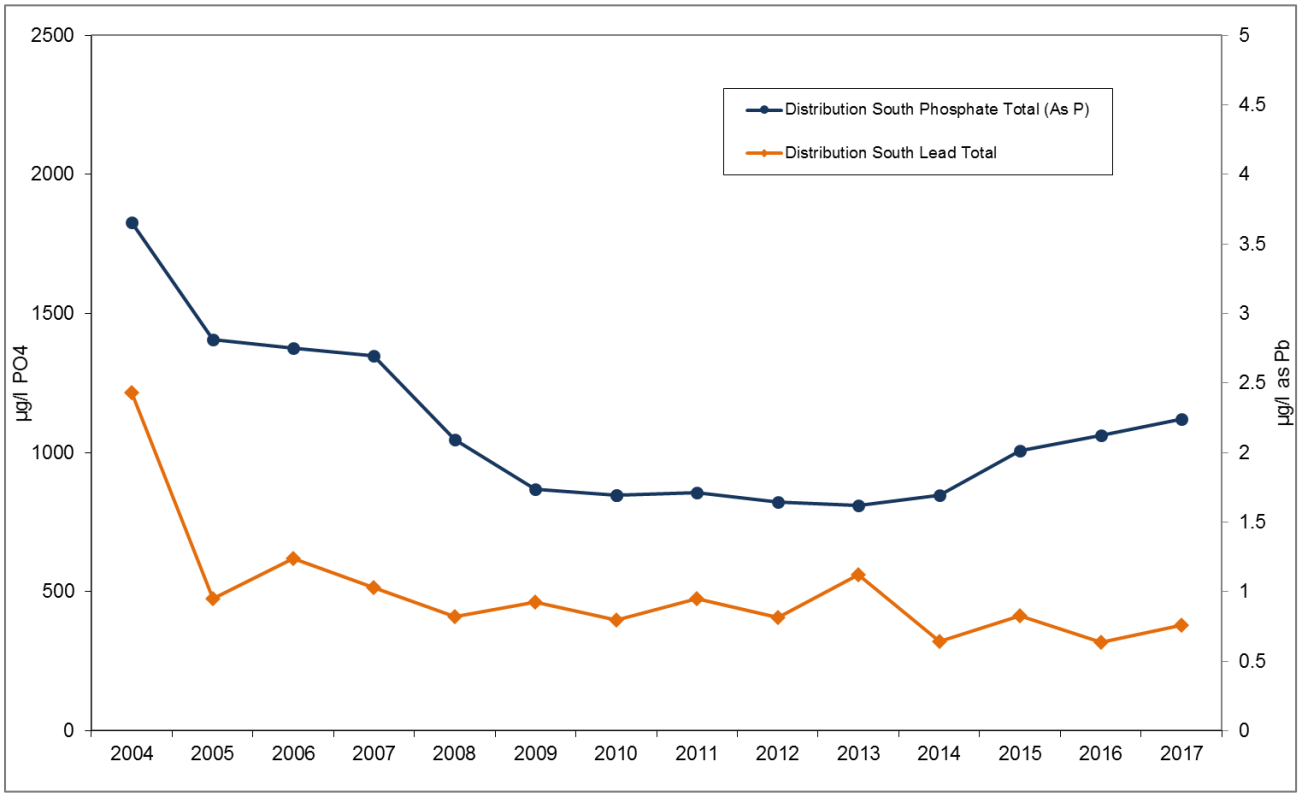

Figure 2. Average lead levels in distribution versus average phosphate levels in the ESW region

Current policy interventions to control lead include:

- Replacement of communication pipes when the sample result (any sample type) is >4µg/l.
- Replacement of all lead pipes when carrying out mains structural rehabilitation (opportunistic replacement).
- Ad hoc replacement of lead communication pipes at customer request.
- Informing customers when their property has exceeded the 10µg/l level and recommending they replace their supply pipe. Provision of health advice by advising customers flush water to waste before consumption/cooking purposes.
- A role within the business to ensure delivery of lead policy and engage with health authorities to continue to raise awareness of lead pipes with vulnerable groups.

In 2017/18 in NW we replaced 1,024 lead pipes as a result of our lead policy (base) at a cost of £1,215,548.78. In ESW we estimate we replaced 200 lead pipes at a cost of £200,000 (from historic sub-programme). During mains replacement schemes we 'opportunistically' replace circa 2000 lead communication pipes annually and these costs are accounted for within each scheme. The role of the Network Performance Coordinator – Plumbosolvency has an annual cost of £39,830 plus a budget of £9,000 for adhoc costs such as marketing.

All of the above are current policy and considered base maintenance.

Hot-spot DMA replacement has been carried out over previous AMPs. This primarily focused on communication pipe replacement, leaving behind a risk from the customer's supply pipe. Two DMAs (DS060 and ST039) in NW have had lead communication pipe replacement following their identified risk to lead compliance at PR14. In DS060, 245 lead communication pipes were replaced at a project cost of £161,578. In ST039, 26 lead communication pipes were replaced at a project cost of £32,394. One DMA (DMA 2925) in ESW was also identified at PR14. The scope of this particular scheme has now been extended to include the replacement of both the lead communication pipe (our responsibility) and the lead supply pipe (customer's responsibility). This is to further understand the process, all associated costs and customer response to this level of service. This DMA is on schedule for completion by the end of AMP6 and no costs have been carried over into AMP7. By undertaking full service pipe replacement in DMA2925 will provide us with valuable learning enabling us to confidently deliver our enhancement options in AMP7.

Lead pipes can be found throughout the NWG geographical area but 'hot spots' are generally found where properties are older than 1970. NWG are currently conducting a detailed study to understand in greater detail which properties are at highest risk.

5 Forward looking analysis

Phosphate dosing is not a sustainable solution in the long term and will not provide adequate protection to meet the tightening of the lead standard in drinking water from 10µg/l down to 5µg/l. The DWI have commented in early 2018 that they are opening the supply pipe adoption debate with the rest of government, which represents a significant change in their approach.

The DWI are also discussing resolving the lead issue by 2050. Welsh and Scottish Governments have enhanced lead strategies culminating in similar dates that are likely to become models for the next DWI lead strategy. WaterUK have also stated that its members will be 'lead free' by 2050. At our current rate of lead replacement estimates suggest it will take us 138 years to remove our lead communication pipes. However this still leaves a significant risk from the customer lead supply pipe. Figure 3 illustrates the percentage of communication pipes we estimate to be lead and how this relates to other UK Water and Sewerage Companies. We need to make the pace of intervention (removal) sustainable and at an appropriate level to meet our 2050 goal and WaterUK's strategic policy.

The DWI have commissioned a research project into the 'sustainability of phosphate dosing for control of lead' in their 2018/19 research programme. Although phosphate provides a level of protection against lead leaching from pipes into the water, it is not a sustainable solution and has an environmental impact. As a finite resource, phosphate will become scarcer no long cost effective. It has to be our strategy to work towards a sustainable rate of lead removal to meet our goals and work towards tightening regulatory standards.

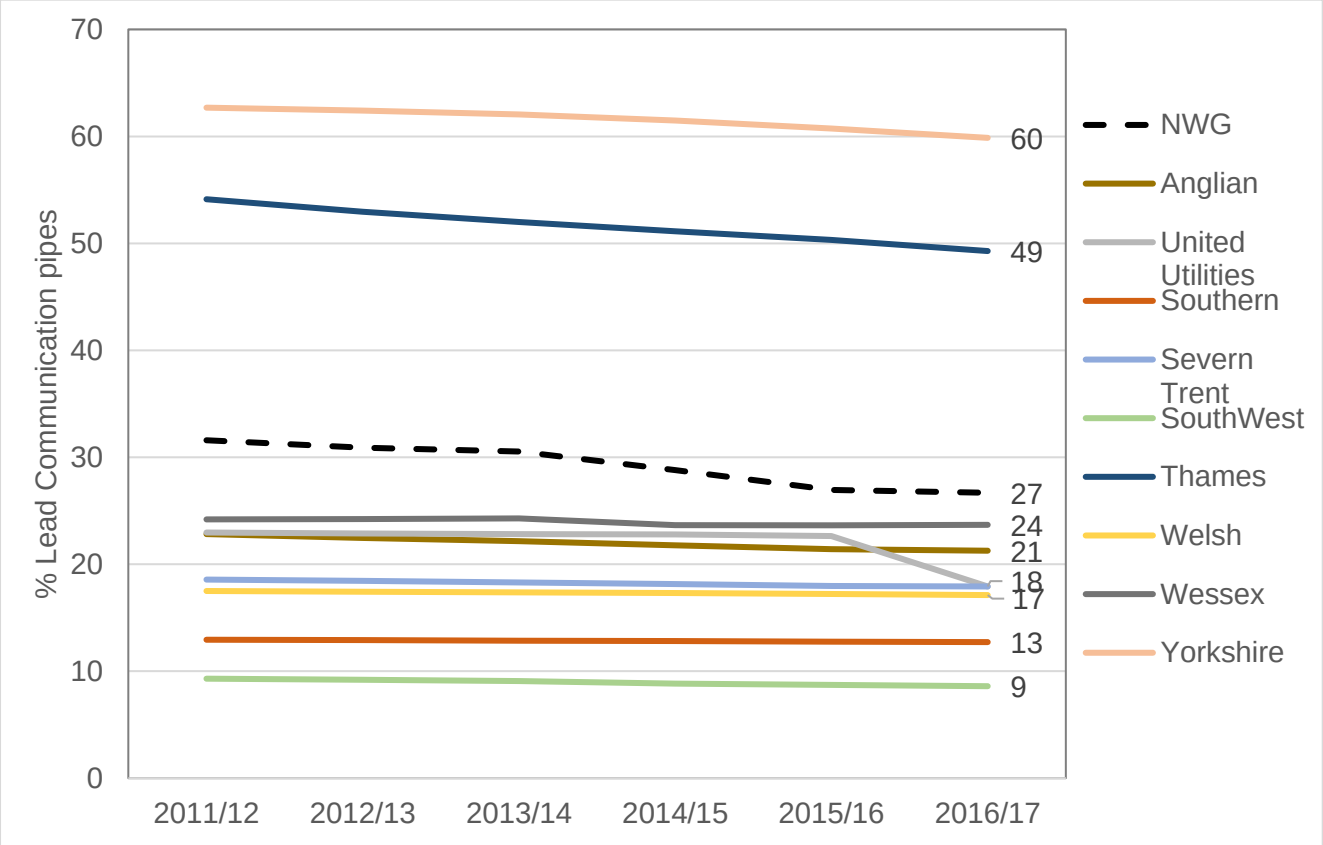

Figure 3 Industry comparison of the percentage of communication pipes which are lead

6 Option Appraisal

Table 1. Summary of option appraisal

OPTION	DESCRIPTION	SUMMARY	INCLUDED IN ENHANCEMENT PLAN (Y/N)
A	Vulnerable groups	Replacing the full lead service pipe in public buildings frequented by children – protecting those most vulnerable to the effects of lead.	**Y**
B	Rural supplies strategy	Replacement of the full lead service pipe in discrete rural areas to remove phosphate dosing and understand the impact of this on a controlled scale.	**Y**
C	'Hot spot' replacement	Replacement of the full lead service pipe in areas identified as the highest risk to lead in drinking water.	**Y**
D	Enhanced plumbolsolvency control	Increase phosphate dosing to an enhanced level – option discounted as this has now been implemented and considered a 'base' cost.	N
E	Lead pipe lining	Lining lead pipes insitu – option discounted as this is not a long term solution and not supported by customers.	N
F	Berwick lead free zone	An estimated circa 2200 properties to have full lead pipe replacement to allow phosphate dosing to be switched off in this area – option discounted on scale and options A-C considered higher priority. Option B will provide learning so Option F can be considered for AMP8.	N

Option A: Vulnerable groups strategy

As a priority, we want to protect those most vulnerable from the effects of lead in drinking water by focusing on lead pipe replacement in public buildings frequented by children. The scope of this option will cover educational and community establishments.

Where we find a presence of lead we will go beyond our responsibility by replacing the lead communication pipe along with the supply pipe up to one tap, such as the kitchen tap, within the establishment. This ensures that there is at least one supply of wholesome water within the building. It is considered that full replacement of lead pipework throughout the building would have a significant impact on costs and deliverability and therefore a reasonable restriction to the extent of replacement would apply. To those premises where some lead pipework remains, advice will be given such as flushing and to use only those taps where lead had been replaced for drinking and food preparation. Lead replacement will be in the first instance but if this is not feasible due to practical restraints or excessive costs, alternatives will be considered such as pipe lining technologies and other emerging innovative technologies.

The delivery of the programme will be established through a combination of risk-based prioritisation of water quality supply zones, collaboration with local authorities to identify those properties most at risk and sampling to confirm the presence of lead. To ensure delivery, activities will be coordinated through two dedicated roles, one based in the NW region and one based in the ESW region. The roles will sit within the Water Regulations team using their expertise of internal plumbing to support

establishments in recognising the extent of lead present and potential remedial action. The roles will undertake water quality sampling in support of investigations to indicate the severity of the lead levels, the interim actions, necessary remedial work and timescales of actions. Post remedial work monitoring through sampling at regular intervals will ensure vulnerable groups are protected and the success of the scheme measured.

The number of establishments with vulnerable groups have been identified across the company through the description field held in Netbase for Non-household customers. The number of those establishments we anticipate will require our support is based on an estimated percentage assumed to have lead pipework. Our latest work with schools and nurseries suggests 20% have a presence of lead. This programme of work extends to places of worship and community centres where we expect age of property to be higher and historical replacement to be much lower and therefore anticipate the percentage of those establishments requiring lead replacement to be 30%. We estimate there are 2482 establishments requiring our support. In AMP7 we will address 60% of that total number which will be prioritised through our lead risk assessment study.

Option B: Rural supplies sustainability strategy

The DWI state 'consideration of alternatives to plumbosolvency measures for lead pipework should assume a duration of up to 50 years to minimise affordability issues' (DWI, 2017). Phosphate is a finite resource with an environmental impact. We want to replace the full lead service pipe up to the first draw tap for those customers in discrete rural water quality supply zones to allow the cessation of phosphate dosing in those areas. It is considered that full replacement of lead pipework throughout the building would have a significant impact on costs, customer disruption and deliverability, therefore a reasonable restriction to the extent of replacement would apply. Advice would be given to the customer such as using only those taps where the lead pipework has been replaced for drinking and food preparation. Lead replacement will be in the first instance but if this is not feasible due to practical restraints or excessive costs, alternatives will be considered such as pipe lining technologies and other emerging innovative technologies.

Termination of phosphate dosing will partially offset the cost of replacing lead pipework through savings from the cost of chemical supplies; operation and maintenance of the plant. There would also be a potential cost offset from end-of-life replacement of dosing equipment (monitors and pumps) and chemical storage facilities. In addition, with more stringent permits being set for phosphate under the Water Framework Directive (WFD) there is an increasing pressure to reduce the amount of phosphate received at the wastewater treatment works (WwTW). It is possible that in the future, the contribution of phosphate from water supplied could require an upgrade or an additional treatment process at the receiving WwTW.

Making a change now around phosphate usage is fundamental to our long-term strategy. A further advantage of managing lead in smaller, discrete supply zones is that the impact and success of this approach can be measured more quickly, informing future decision and policy. In AMP7 we estimate 415 properties will benefit from full lead service pipe replacement.

Option C: Risk assessed 'hot spot' replacement

We are currently working on extensive source-to-tap modelling to gain greater insight into where our lead hot-spots are and why some areas are more at risk than others, allowing us to identify and implement bespoke solutions. Where previously we have worked on lead 'hot spots' at DMA level we want to be smarter with our investment by working at a much lower defined level to target a larger number of our highest risk properties through lead replacement. To mitigate this risk effectively and working towards a sustainable approach for the future we want to replace both the communication pipe and the supply pipe to the customer's first draw tap. We expect the number of properties with internal lead plumbing, beyond the first draw tap to be minimal due to modernisation. Full internal plumbing replacement has not been included in the scope due to the challenges of

working within the property and reinstatement. Should internal lead pipework be identified beyond the first draw tap, the customer will be educated on the risks and advised they should use their first draw tap for drinking water and food preparation.

Options discounted

Option D: Enhanced plumbosolvency control

In the UK, drinking water is dosed with orthophosphoric acid or phosphates to prevent the dissolution of lead from pipes (plumbosolvency). The phosphates react with the lead and with hardness ions to form an insoluble coating on the pipe surfaces. Dosing needs to be continuous to maintain the coating. Phosphate dosing has been found to significantly reduce the risk of lead leaching into the water from pipe work.

Orthophosphoric acid is dosed at virtually all of our WTW with 99.6% of our distribution input receiving a dose. This dose has been optimised since implementation in AMP2 & AMP3. A study is currently in progress to understand in more detail the combined effect of the supplied water chemistry and orthophosphate dose with a view to further enhance plumbosolvency control to well below the lead standard of 10µg/l. By optimising to our internal target of 4 µg/l of lead we are going beyond our mandatory obligations, providing customers with further protection and preparing ourselves for a possible future tightening of the lead standard.

The enhanced expenditure to achieve lower lead levels is OPEX associated with increased chemical dosing rates of phosphoric acid and the consequential increase to sodium hydroxide costs to balance pH. This will have a benefit to a population of 2,471,741 which equates to approximately 99% of our customers in the NW region.

Option D has been reviewed and discounted as an Enhancement. At the end of 2018 an operational decision was made to increase phosphate dosing to a new target level of 1.8mg/l. As this was implemented earlier than planned and within AMP6, we can no longer consider this an Enhancement to AMP7 and the additional costs have been transferred to Base.

Option E: Lead pipe lining

An alternative to lead pipe replacement is the use of a pipe lining technology. Epoxy lining is a technology which sprays a coating on the internal wall of pipes creating a barrier between the pipe and water running through it. Where pipe replacement requires excavation work and reinstatement, pipe lining has the advantage of minimising disruption.

We are aware other water companies have utilised this technology but found mixed results. Our customer research indicated our customers were not in favour of lining lead and preferred the option of removing lead pipes. As lead lining has a limited lifespan it still leaves the problem in place for future generations. For these reasons our preferred strategy is replacement of lead pipes and the option of wholesale lead lining schemes was discounted.

Option F: Full service pipe replacement during ‘opportunistic’ lead replacement

During mains structural rehabilitation schemes, if we find lead communication pipes, they are replaced in conjunction with the scheme. We considered the option of extending this further to include customer supply pipes. For AMP7 we decided in balance of the OPEX cost, customer disruption and deliverability to discount this option. For AMP7 we want to focus on prioritising those customers most at risk.

Option G: Berwick lead free zone

Berwick Water Quality Supply Zone is a 'discrete' zone fed solely from Murton WTW. We considered the option of making Berwick a completely lead free zone. Replacing the full lead service to within the customer's home would mitigate the risk of lead in water both to health and water quality compliance. Phosphate dosing would no longer be required at Murton WTW and supports our commitment to a sustainable strategy. It is estimated circa 2200 properties would require full service pipe replacement. This option was discounted on the basis of lead risk. Berwick is not considered a high risk to lead and the decision was made that the scale of investment required for this scheme should be prioritised to high risk areas and those most vulnerable.

7 Our Preferred Plan/Option

If nothing is done, we will not be in a position to comply with the future lead standard whilst continuing to expose customers to health risks. Our preferred option is to do options A-C which is also the 'do optimum' approach to work towards our ambition and WaterUK's strategy of 'lead free' by 2050 and striving to achieve a more stringent lead water quality level in advise of the revised standard.

The Performance Commitment relating to this enhanced package (options A-C) is the number of lead service pipes replaced. This will be measured over the AMP but will be reported on annually (milestones) as part of the Annual Performance Review (APR). Failure to meet an annual milestone will have a reputational impact. Details in the event of failure to meet the Performance Commitment by the end of AMP7 can be found in the section 'Customer protection in the event of late or non-delivery'.

8 Costing of Options

To estimate the Totex enhancement cost associated with the PR19 business plan submission we have taken four primary approaches to scheme costing, including the allocation of a RAG assessment score as described below:

1. Full iMod cost estimate using business as usual processes
   a) Green - Cost Estimate has been produced using iMod, utilising Engineering Scoping Engine and Costing Database
   b) Amber - Cost Estimate has been largely produced using iMod, utilising Engineering Scoping Engine and Costing Database, with partial costs from other sources
   c) Red - Not Applicable - Approval processes built into iMod would ensure that no RED estimates could be produced
2. PR19 Costing Tool created from iMod base estimates
   a) Green - Cost Estimate has been produced using PR19 Costing Tool and has been correctly applied
   b) Amber - Cost Estimate has been largely produced using PR19 Costing Tool, with partial costs from other sources, and has been correctly applied
   c) Red - PR19 Costing Tool has been used, but not correctly applied
3. Traditional unit rate build up estimates
   a) Green - Unit rates are valid historical NWG costs or current Framework Rates and the rates build up is sufficient and appropriate to the scope
   b) Amber - Unit rates are largely valid historical NWG costs, current Framework Rates or Industry available rates and the rates build up is sufficient and appropriate to the scope
   c) Red - No cost evidence available for rate source and/or rates build up is insufficient or does not appropriately reflex anticipated scope
4. Assessment and forecasting of historical spend

a) Green - Historical spend in relevant area has been assessed and appropriately applied in forecast calculation
b) Amber - Historical spend in similar area has been assessed and appropriately applied in forecast calculation
c) Red - No cost evidence available and/or inappropriately applied in forecast calculation

Whilst the Cost Assurance team will use the most appropriate costing method for each scheme the default position is always to use a full iMod estimate or iMod based tool where possible as this best reflects NWG's business as usual cost estimating process.

iMod

iMod is a Client focused Engineering Scoping and Cost Estimating software system, developed for Northumbrian Water, bringing project scope definition, whole life costing and tender evaluation together in one integrated system. iMod comprises a suite of 50 engineering scoping models and a cost database, which with a minimum of input criteria that is readily known at project inception, can provide a detailed CAPEX, OPEX and whole life costing for a range of business issues. Supplier tender submissions can be entered directly into the system to allow tenders to be automatically checked against the iMod asset based cost database, enabling tender evaluation to be carried out with a limited resource requirement as well as providing an enhanced confidence in a project's affordability. On completion outturn costs are captured in the system as part of the agreed project closeout procedure.

The purpose of iMod is to form the cornerstone of our Capital Delivery Model allowing us to embed a 'should-cost' culture as the entry point to working collaboratively with our delivery partners. It also supports Northumbrian Water's strategic outcome to ensure that our finances are sound, stable and achieve a fair balance between customers and investors.

iMod CAPEX Cost Estimating

The iMod system uses a Process and Component costing hierarchy. The relevant processes are selected for each estimate, with the engineering scoping model run for each process. This produces a quantified Work Breakdown Structure (WBS), with detailed attribute tags, with costs applied via the iMod cost database. The process models are then supplemented with individual components and/or unit rates to complete the estimate as appropriate.

Contract overheads are then applied from a selection of 19 sub-categories that are chosen based on site specifics or work type specific considerations. Each sub-category consists of historical data cost curve and is generated using the value of the measured works. Project overheads are then applied to the combined value of the measured works and the contract overheads, based on a selection of 21 sub-categories.

All cost estimated have been produced using APG specific cost curves for Process, Component, Contract and Project Overheads.

PR19 costing tools

PR19 Totex costing tools have been created specifically for the Water Treatment and Waste Water Treatment enhancement schemes. The costing tools consist of tables where the user can input individual site data, giving site specific yardsticks (i.e. PE or M/ld) and can then select which processes will be required to fulfill the enhancement output needed. The tool will then calculate the Totex costs for the specific site. The costs are generated from a series of PR19 specifically generated cost curves, which are based on estimated points. These estimated points have been produced using the iMod system previously described, using NWG's business as usual estimating processes.

Unit costs build up
Traditional unit cost build up have been carried out for enhancement areas where either iMod system does not have coverage or is not appropriate. In this approach traditional bills of quantities have been produced and costed using unit cost rates. Unit cost rates have been sourced from the following:

- Actual historical costs
- Framework rates
- Industry Data (SPONS etc)
- Quotes

The above list order represents the order of preference that has been applied to the selection of rates used for costing. Contract and Project Overheads have been applied using the same methodology as previously described.

OPEX costs have not been calculated for the enhancement areas where unit costs have been used as it has been assumed that there would be no significant increase in OPEX costs in the areas applied.

Historical spend

For issues not covered by the previous costing methodologies, a historical spend approach has been used. Assessments of historical spending for programmes of work or unit costs have been completed, benchmarked and applied to forecasts of the activities proposed in PR19.

PR19 Scheme costs

The assumed costs for the Lead Enhancement Package are £10,270,741 Capex.

PR19 lead enhancement has been costed following the costing approach described previously. A RAG score was given following an assessment from the Cost Assurance Team as shown in Table 2. This assessment of a 'Green' status indicates that the unit rates we have used are cost efficient.

Table 2. PR19 Enhancement Cost Assurance Review

Lead		100% Green Cost Assurance RAG	**Traditional unit rate and historical spend composite cost**

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[1]. This review has assessed the Lead Enhancement costs as Green that is NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

A summary of the CAPEX and TOTEX for each of the Enhancement options is shown in Table 3.

The NWL PR19 Costing methodology is included in full in Appendix 3.2.

[1] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

Table 3. Summary of Enhanced costs for options A-C

DESCRIPTION	NW/ ESW/ NWG	CAPEX	TOTEX
Vulnerable groups (NW&ESW)	NWG	£7,006,592	£7,006,592
Rural supplies strategy (NW only)	NW	£821,329	£821,329
'Hot spot' replacement (NW&ESW)	NWG	£2,442,820	£2,442,820
AMP7 Total	**NWG**	**£10,270,741**	**£10,270,741**

Success will be measured for Options A-C by the number of lead replacement jobs.

Table 4. Annual performance commitment (milestones) – replacement numbers

DESCRIPTION	NW/ ESW/ NWG	2020	2021	2022	2023	2024	AMP7 TOTAL
Vulnerable groups (NW&ESW)	NWG	212	320	320	320	320	1,492
Rural supplies strategy (NW only)	NW	30	100	100	100	85	415
'Hot spot' replacement (NW&ESW)	NWG	363	365	365	365	365	1,823
AMP7 Total	**NWG**	**605**	**785**	**785**	**785**	**770**	**3,730**

Table 5. Annual estimated annual costs to deliver performance commitment

DESCRIPTION	NW/ ESW/ NWG	2020	2021	2022	2023	2024	AMP7 TOTAL
Vulnerable groups (NW&ESW)	NWG	£993,983	£1,503,152	£1,503,152	£1,503,152	£1,503,152	£7,006,592
Rural supplies strategy (NW only)	NW	£59,740	£197,815	£197,815	£197,815	£168,143	£821,329
'Hot spot' replacement (NW&ESW)	NWG	£486,420	£489,100	£489,100	£489,100	£489,100	£2,442,820
AMP7 Total	**NWG**	**£1,540,143**	**£2,190,068**	**£2,190,068**	**£2,190,068**	**£2,160,395**	**£10,270,741**

Stretch

Lead replacement work in NWG has historically comprised of replacement of the communication pipe only. Including the customer's supply pipe within the schemes will be a new a challenge for NWG. Supply pipe replacement adds a number of steps to a project which adds a significant amount of time. Customer communications (including literature) to obtain consent from the customer, arranging appointments and property surveys are just some of those additional steps. Pipework arrangements for individual properties present a risk to both unit costs and replacement time. This is further compounded when working within buildings such as schools and nurseries which may have restrictions for health and safety e.g. working periods (out of term time only) and structure of the building (asbestos, challenging layout etc).

In AMP6 we will have replaced approximately 900 communication pipes as part of our lead schemes (lead 'hot spots'). In AMP7 the schemes in this Business Case will equate to the

replacement of 3,730 lead communication and supply pipes. This is a significant stretch for NWG particularly with the addition of the challenges of working on the customer side.

Benefits assessment

Ultimately the main benefit of our proposed investment is to reduce the incidence of lead ingestion, which will lead to health benefits. We have also carried out customer research to gauge whether our customers support our proposed investments. These points are described in turn below.

Health benefits

Various studies have shown that the consumption of lead has adverse effects on health, especially in young children and foetuses. According to the WHO, "There is no known level of lead exposure that is considered safe"[2], and this aligns with NWG's ambition to become lead free by 2050.

According to the DWI, "Lead remains an area of concern and a significant contributor to compliance failures" due to a "considerable" number of connecting lead pipes in the older housing stock. [3]

Currently the DWI determines that levels of lead in water above 10 µg/l[4] are unsafe, and it is monitored as part of the Compliance Risk Index (CRI), and previously as part of Mean Zonal Compliance (MZC). The CRI is a composite measure which assigns weights to different agents being found in water using a score of 1 to 5, where 5 is the worst, on the grounds that it is a health risk. Lead has a score of 5.[5]

Lead effects in children

Children are especially at risk of health effects from ingesting lead, including having their cognitive development affected. There have been many studies which have tried to quantify the health effects on children and attempt to provide an overall cost in monetary terms. One approach is to estimate the reduction in IQ caused by ingesting lead and to then link this to lost lifetime earnings. The overall results are sensitive to the assumed values for the level of lead in blood, the percentage reduction in IQ points and average lifetime earnings.

One study in California found that lead ingestion in children could result in a 2.39% reduction in lifetime earnings[6]. Applying this to estimates of lifetime earnings in the UK from the ONS implies a loss of lifetime income of £13,500 - £18,300 per child affected.[7]As mentioned, the level of lead in the blood is a critical and sensitive parameter. For simplicity we use the results from California to provide an estimate of benefits.

Our proposed investments include replacing communication and supply pipes for 1,492 'vulnerable group' properties. This includes day care nurseries, communities / youth groups and places of worship where young children are present and likely to be consuming tap water. However, it is difficult to estimate how many children would be impacted through this programme. Separately, another component of our proposed investment is to replace lead pipes for 2,238 households. We

[2] http://www.who.int/en/news-room/fact-sheets/detail/lead-poisoning-and-health
[3] http://www.dwi.gov.uk/about/annual-report/2016/Drinking_water_2016_Public%20_water_supplies_England.pdf
[4] http://dwi.defra.gov.uk/consumers/advice-leaflets/standards.pdf
[5] https://www.ofwat.gov.uk/wp-content/uploads/2017/12/DWI-Compliance-Risk-Index-CRI-definition.pdf
[6] In the study in California, the blood level lead was enough for a mean loss of 0.51 to 0.69 IQ points, and a reduction of IQ by one point has been estimated to reduce lifetime earnings by 2.39%. https://www.phi.org/uploads/files/2015ROI_CEHTP.pdf
[7] This was calculated using weekly gross median income for 2016 (£550) from the ONS and a working lifetime of 38.8 years in 2016 from Eurostat.
https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2017provisionaland2016revisedresults
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfsi_dwl_a&lang=en

estimate that this may impact around 353 children under the age of five at home[8]. Applying this figure to the lifetime earnings figure above could imply combined losses of lifetime earnings in the region of £4.8m to £6.5m – and again we would note that this does not include the vulnerable group properties which is likely to have a more significant impact.

Lead incident in Flint, Michigan

The lead crisis in Flint made international headlines, after a switch from the water supply from Lake Huron to the Flint River resulted in tainted water entering the drinking water system. Lead levels in children were estimated to be three times the average of the previous decade.[9] It is estimated in 2016 that to replace all the city's hazardous water lines will cost over $57m dollars and Michigan has already spent $60m on medical care and bottled water. The social costs could reach nearly $400m, according to one estimate.[10]

Lead spikes in Washington DC

In 2001, Washington DC changed its water disinfection technology to chloramination which had the unintended consequence of releasing lead into the drinking water in the city.[11] This presents a natural experiment to look at the effect a change in lead can have. Between 2001–2004 there was a significant spike in the lead in water: 5% of children had blood lead concentrations of at least 10mg/l and before this was only 0.5% of children. It is noted that it is unclear exactly which children were affected but that "on average, these children experienced elevations in lead exposure that are indicative of harm".[1213] Additionally, the foetal death rate was 32-63% higher during this time, compared to 1997–1999. There was no similar change in foetal death rates in neighbouring Baltimore, where there was no lead spike.[14]

Lead effects in adults

In all people, children and adults, continued exposure to lead can damage the nervous system, kidneys, brains and fertility, as well as cause anaemia.[15] Ingesting lead is affected by inadequate levels of calcium, iron and zinc and by higher levels of dietary fat. [16] It is difficult to robustly monetise the benefits of preventing these health issues through zero lead exposure, as there is often a large number of underlying health factors to consider, as well as different medical options and impacts for individuals.

Risks

The main risks to the programme of work for options A-C are the uncertainties around individual properties, their plumbing network and the accessibility of pipework. This could impact costs and timescales. However, best estimates have been used and the full lead service pipe replacement scheme in DMA 2925 delivered this AMP will help us understand and mitigate that risk for future work. We will learn more as we do more which will enable us to manage that risk.

Customer protection

[8] ONS shows 65% of all households are occupied by families, that 42% of all families have dependent children and that families have an average of 1.7 dependent children. Statista evidences that 34% of all children aged 0-14 (proxy for dependent children) are aged 0-4. These were used to convert 2,238 properties affected by new pipes into 353 children under five. (i.e. 2,238 x 65% x 42% x 1.7 x 34% = 353)
[9] https://www.sciencedaily.com/releases/2018/03/180326090313.htm
[10] https://www.mailman.columbia.edu/public-health-now/news/lead-poisoning-flint-could-cost-400-million
[11] The previous method of chlorination had bound the lead to interior pipes but had potentially carcinogenic side effects.
[12] https://www.sciencenews.org/blog/science-public/water-cleanup-experiment-caused-lead-poisoning?mode=magazine&context=3765
[13] https://pubs.acs.org/doi/pdf/10.1021/es802789w
[14] https://www.sciencenews.org/article/stillbirth-rates-tied-lead-drinking-water
[15] https://www.health.harvard.edu/diseases-and-conditions/lead-poisoning-
[16] https://cot.food.gov.uk/sites/default/files/2016leadlaysummaryfinal.pdf

This scheme is supported by the Drinking Water Inspectorate (Annex A), it will become a legally binding commitment (Undertaking or Regulation 28 Notice) to deliver and milestones will be developed with DWI. Annual reports to DWI will detail progress with the scheme.

Customer protection in the event of late or non-delivery

Our commitment is to deliver a total replacement of 3,730 lead service pipe (the communication and supply pipe) by 31/03/2025. The estimated unit costs for each of the business case options are as follows:

	No. of lead communication and supply pipes to be replaced	Estimated unit cost
Option A	1492	£4,696.11
Option B	415	£1,978.15
Option C	1823	£1,340.00

We are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed. To protect our customers we will apply a penalty rate for underperformance against this enhancement. As this enhancement targets a number of specified units as an output, we have based our penalty on a per unit basis. We will incur a penalty to the value of the number of units we achieve below our Performance Commitment (PC). For example, a PC of 10 and an actual performance of 9 would incur a penalty of 1/10th the value of customer funding received.

Any penalty will be calculated as a net present value neutral adjustment as part of the PR24 true up process of the relevant 2019 Final Determination cash flows should the outcome be delivered partially or not at all. The discount rate used will be 3.3% real, the CPIH stripped cost of capital.
Further details of our enhancements delivery incentive mechanisms are included in Chapter 4: Measuring and Incentivising Success of our final business plan.

The unit rates payable in the event of non-delivery are summarised above. (No adjustment would be made in the event of delivering any more than we have planned for.)

9 Alignment with stakeholder needs

We cannot ensure compliance of the future lead standard of 5µg/l with phosphate dosing. Replacing the full lead service pipe in priority areas is a commitment to water quality compliance and our long term strategy to be lead free.

Lead is a cumulative general poison, with infants, children up to 6 years of age, the foetus and pregnant women being the most susceptible to adverse health effects. Its effects on the central nervous system can be particularly serious (WHO, 2011). The WHO state they are unable to establish a threshold of lead which is protective to health. In response to this, as a priority, we want to protect those most vulnerable from the effects of lead in drinking water by focusing on lead pipe replacement in public buildings frequented by children. This scheme had the highest acceptability across all three customer research sessions.

Through our strategy of full lead service pipe replacement in prioritised areas we are addressing those most at risk and removing the issue of cost for customers, identified as their most significant barrier to replacement. This supports our current and future customers, helping to safeguard their health from lead in drinking water. This supports WaterUK's strategy to be 'lead free' by 2050. The Enhancement options have been designed to balance customer disruption, cost and deliverability. The Water Forum and customers indicated their support for our Enhanced Lead Package.

10 Affordability

The impact of these enhancement investments on customer bills are shown below[17].

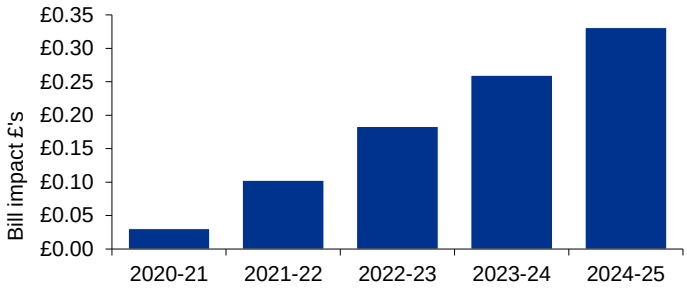

Figure 4. Bill impact from lead enhancement package

Overall the analysis shows that the bill impacts would be around £0.03 in the first year, rising to £0.33 by the end of the AMP7.

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[18] driving significant improvements to average customer affordability.

We commissioned Explain to consult households on our proposed enhancement schemes, to see if they would support them (voting 'yes', 'no' or 'unsure'). Customers in Durham, Newcastle and Chelmsford were consulted to get a diverse view.

For the full lead scheme the average yes vote was 88%. To express these results in terms of cost and benefit we have translated the research results in to benefit-cost ratios. To do this we assume that the 'demand curve' is linear and we consider price elasticities ranging from 0.5 (inelastic) to 2.0 (elastic).

The table[19] below shows that all of the proposed elements of the programme have very strong support from customers and implied benefit cost ratios of materially over 1.0. The highest BCR is for replacing lead pipes in buildings children under six visit regularly, and replacing lead pipes in some rural areas.[20]

Lead proposal	Location	Low	High
Replacing lead pipes in hot spot homes	Durham - NW	1.20	1.81

[17] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.
[18] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast
[19] Weighting based on responses 44 responses from Durham, 38 from Newcastle and 33 from Chelmsford. Excludes all votes for unsure.
[20] Rural pipe replacement applies only to NW.

	Newcastle - NW	1.22	1.87
	Chelmsford - ESW	1.24	1.97
	Average	*1.22*	*1.88*
Replacing lead pipes in buildings children under 6 visit regularly	Durham - NW	1.22	1.87
	Newcastle - NW	1.25	2.00
	Chelmsford - ESW	1.24	1.97
	Average	*1.24*	*1.95*
Replacing lead pipes in some rural areas	Durham - NW	1.22	1.87
	Newcastle - NW	1.25	2.00
	Average	*1.23*	*1.93*

Our Water Forums were supportive of our proposals and particularly supportive of helping vulnerable customers.

11 Board assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers"[21].

References

World Health Organisation (2011) *Lead in Drinking-water - Background document for development of WHO Guidelines for Drinking-water Quality.* WHO/SDE/WSH/03.04/09/Rev/1

Drinking Water Inspectorate (2017) *Guidance to Water Companies. Guidance note: long term planning for the quality of drinking water supplies.*

[21] See Board Assurance Statement

Annex A - DWI Letter of Support (sent to Jon Ashley and Kevin Ridout by DWI)

guardians of drinking water quality

DRINKING WATER INSPECTORATE
Area 1A
Nobel House
17 Smith Square
London
SW1P 3JR

Enquiries: 030 0068 6400

E-mail: milo.purcell@defra.gsi.gov.uk
DWI Website: http://www.dwi.gov.uk

30 May 2018

Mr Ceri Jones
Assets and Assurance Director
Northumbrian Water Ltd
Boldon House
Wheatlands Way
Pity Me
Durham
DH1 5FA

Dear Mr Jones

PERIODIC REVIEW 2019: Northumbrian Water Ltd
DWI Scheme reference: NNE_ESK 1- Lead strategy - Lead

FINAL DECISION LETTER

The Inspectorate has completed its detailed assessment of the scheme proposed by Northumbrian Water Ltd to provide lead reduction measures to secure or facilitate compliance with the lead standard for drinking water quality reasons in the Northumbrian Water area.

The detailed assessment also took in to consideration the outcome of the risk assessment reports submitted to the Inspectorate as required by regulation 28(1) of the Water Supply (Water Quality) Regulations 2016 for supply systems across the Northumbrian Water area.

A summary of the outcome of our assessment of this scheme is attached. Based on the information submitted by the Company, the Inspectorate supports the need for a scheme to reduce lead concentrations in treated water for water quality reasons, and the supported scheme shall be included by the Company in its Final Business Plan, subject to the caveats listed in the attachment.

In this instance the Inspectorate intends to issue a Notice under Regulation 28(4) of the Water Supply (Water Quality) Regulations 2016, as amended, that requires the Company to mitigate the risk of lead that has been identified as a potential danger to human health from the water supplied from Northumbrian Water.

It is expected that the Company will continue to monitor treated water lead concentrations, and that it will take all reasonable steps to prevent contraventions of the lead standard.

I am copying this letter to:

- Jon Ashley and Kevin Ridout at Ofwat;
- Elinor Smith and John Collins at the Environment Agency;
- Rob Light (CCW Chair, Northern)
- Bernard Crump (CCW Chair, Central and Eastern)
- Jim Dixon (Chair of Northumbrian and Essex & Suffolk Water Forums)

Please contact Sue Pennison (Sue.Pennison@defra.gsi.gov.uk) with any queries relating to this letter.

Yours sincerely

Milo Purcell
Deputy Chief Inspector

PERIODIC REVIEW 2019

SUMMARY OF DWI ASSESSMENT – LETTER OF SUPPORT

	Comment
Water company:	Northumbrian Water Ltd
DWI scheme reference(s):	NNE_ESK 1
Scheme name:	Lead Strategy - Lead
Proposal:	Provision of an integrated strategy across the Northumbrian Water area to secure or facilitate compliance with the lead standard for drinking water quality reasons.
Supporting evidence:	Letter reference- ESK –NNE PR19 Annex A- Lead
Conclusion:	Subject to the caveats listed below, the Inspectorate supports the need for the following scheme: A lead reduction strategy consisting of the following elements: 1) Replacement of the communication and customer supply pipe in properties or buildings relating to vulnerable customers. 2) Full service pipe replacement (if lead) in discrete rural zones to understand the implications of terminating phosphate dosing.
Timescale:	Completion date: Timescale: 7-8 years for vulnerable customers programme. Programme of lead pipe replacement in rural supplies will be delivered over AMP7.
Estimated cost:	Estimated capital costs: A total capital expenditure of £13, 751,763 Estimated net additional operating costs: N/A
Legal Instrument Required:	Notice under Regulation 28 (4)
Caveats:	- Continuation and continuous development of the Company's Lead Strategy in line with the Inspectorate's guidance. - Comply with regulations 18(1), 18(6), 18(11) and 30 with regards to lead; and in the case of public buildings (with reference to Regulation 19A), the requirements of S75 of the Water Industry Act 1991.
Comment:	DWI has no role in determining proportional allocation of expenditure. Where DWI technical support is given, this should not be taken by the company to imply that the scheme will be partially or wholly funded as a

NORTHUMBRIAN WATER living water | ESSEX&SUFFOLK WATER living water

Water Growth Enhancement Business Case

WS2 - Wholesale water capital and operating enhancement expenditure by purpose
Lines 11, 12 and 25

APPENDIX 3.2

WATER GROWTH

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WATER GROWTH

Executive summary

The need for enhancement investment comes from housing developers building in areas which are at or near capacity with regards to water supply. Development plans are submitted to determine if the current infrastructure is sufficient to supply the proposed development, or if any enhancements are needed to ensure a reliable supply.

Developments that go beyond the capacity of the supplying water supply system are at risk of, or at risk of causing elsewhere, low pressure events during periods of high demand. They are also at risk of, and put other areas at risk of, prolonging interruptions to supply events and creating areas that are more susceptible to them.

Supplying our customers with a sufficient water supply is a regulatory requirement under the Water Industry Act. In addition, customers have registered concerns about when interruptions occur and the length of the interruption. There is strong evidence this is a high priority.

Our final plan will ensure that housing and economic growth across our operating areas can be supported first time, upon the submission of the planning application. This is consistent with central government policy, Ofwat regulatory guidance and the requirements of our local planning authorities and our developer customers.

The requirement for water companies to calculate their own infrastructure charges was included within Ofwat's charging rules. This followed lobbying by national trade bodies representing developers to Central Government, through Defra who claimed that their members were being "double charged" for network reinforcement. They were required to fund necessary network reinforcement to support their development through the mains requisitioning process and then again via infrastructure charges collected by companies.

Our analysis confirms the potential need for approximately £14.39 million of enhancement funding to support a programme of infrastructure reinforcement works resulting from developer activity.

Name of claim	Water Growth
Name and identifier of related claim submitted in May 2018	Water Growth Enhancement
Business plan table lines where the totex value of this claim is reported	Line 25
Total value of enhancement for AMP7	£14.39m
Total opex of enhancement for AMP7	£0
Total capex of enhancement for AMP7	£14.39m
Depreciation on capex in AMP7 (retail controls only)	[n/a]

APPENDIX 3.2

WATER GROWTH

Remaining capex required after AMP7 to complete construction	The ongoing need for enhancement investment comes from housing developers building in areas which are at or near capacity with regards to water supply. Development plans are submitted to determine if the current infrastructure is sufficient to supply the proposed development, or if any enhancements are needed to ensure a reliable supply.	
Whole life totex of claim	£14.39m	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	Material	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		✓
Need for investment/expenditure	The ongoing need for enhancement investment comes from housing developers building in areas which are at, or near, capacity with regards to water supply. Developments that go beyond the capacity of the supplying water supply system are at risk of, or at risk of causing elsewhere, low pressure events during periods of high demand. Developments that go beyond the capacity of the supplying water supply system are at risk of, or at risk of causing elsewhere, low pressure events during periods of high demand. They are also at risk of, and put other areas at risk of, prolonging interruptions to supply events and creating areas that are more susceptible to them.	
Need for the adjustment (if relevant)	n/a	
Outside management control (if relevant)	n/a	
Best option for customers (if relevant)	The cost of this investment (£14.39m) is born by developers wishing to connect to our network.	

	At this stage our ability to determine an appropriate range of options with robust cost–benefit analysis is limited to the information we have been supplied with by developers in regards to housing types and densities. Development is externally driven and the final site designs are only known once the developer finalises their site development plan. At this stage each site is only considered as a 'block' of new demand, based on the information from the developer and LPA.
Robustness and efficiency of claim's costs	All costs for Water Growth were provided and assured by the NW Cost Assurance team and overall assessment of these costs is green. As stated above, at this stage our ability to determine an appropriate range of options with robust cost–benefit analysis is limited to the information we have been supplied with by developers in regards to housing types and densities. Development is externally driven and the final site designs are only known once the developer finalises their site development plan. At this stage each site is only considered as a 'block' of new demand, based on the information from the developer and LPA.
Customer protection (if relevant)	The need for enhancement investment comes from housing developers building in areas which are at or near capacity with regards to water supply. Development plans are submitted to determine if the current infrastructure is sufficient to supply the proposed development, or if any enhancements are needed to ensure a reliable supply. The cost of this investment (£14.39m) is born by developers wishing to connect to our network and is levied by the Infrastructure charges as set out in the Charges scheme rules issued by the Water Services Regulation Authority under sections 143(6A) and 143B of the Water Industry

	Act 1991
Affordability (if relevant)	Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases.
Board Assurance (if relevant)	The full board have signed a revised Board Assurance Statement at the full board meeting on the 29th of March 2019 confirming that they have seen and are confident in the enhancement cases

APPENDIX 3.2

WATER GROWTH

Context and scope

This business case is consistent with calls from Central Government for the need to ensure that the right utility infrastructure is in place to enable developments to connect in a timely and cost-effective manner[1].

Section 37 of the Water Industry Act 1991 set out NWL's 'General duty to maintain water supply system etc' and states that:

> (1) It shall be the duty of every water undertaker to develop and maintain an efficient and economical system of water supply within its area and to ensure that all such arrangements have been made:
> (a) for providing supplies of water to premises in that area and for making such supplies available to persons who demand them;
> (b) for maintaining, improving and extending the water undertaker's water mains and other pipes, as are necessary for securing that the undertaker is and continues to be able to meet its obligations under this Part.

Section 41 of the Water Industry Act also states that:

> (1) It shall be the duty of a water undertaker to provide a water main to be used for providing such supplies of water to premises in a particular locality in its area as (so far as those premises are concerned) are sufficient for domestic purposes.

In addition to this, there is increasing Central Government on housing delivery and it should not be held up by delays in the provision of critical infrastructure by utility providers. In the foreword to 'Fixing our broken housing market' the Prime Minister said:
"We need to ensure that homes are built quickly once planning permissions are granted. We will invest in making the planning system more open and accessible, improve the co-ordination of public investment in infrastructure, support timely connections to utilities, and tackle unnecessary delays. We're giving councils and developers the tools they need to build more swiftly."

Historically housing availability is a prominent feature of government policy:

- Sustainable Communities: Building for the Future 2003 - "Recognition of 30 years of under-delivery of housing by all governments";
- Housing Green Paper 2007 - "3 million homes by 2020";
- National Planning Policy Framework – "aims to simplify planning policy with a view to promoting economic and housing growth";
- Conservative Party - "200,000 houses per year by 2017";
- Labour Party - "200,000 houses per year by 2020 and predicting a 1.3 million national housing shortfall";
- North East Chamber of Commerce 2014 report 'Solving the Housing Conundrum' - "the North East's housing market has under-performed for the past decade and last year built only half of the number of homes needed".

By ensuring there is sufficient water infrastructure across the Northumbrian and Essex & Suffolk Water areas of supply to satisfy projected growth, NWL can meet Government expectations in

[1] HM Government (2014) 'Better Connected – A practical guide to utilities for home builders'

providing the infrastructure necessary to reduce barriers to housing development and catalyse growth[2].

The need for enhancement investment comes from housing developers building in areas which are at, or near, capacity with regards to water supply. Development plans are submitted by the developer to our Developer Services Team who liaise with our Strategic Network Team to determine if the current infrastructure is sufficient to supply the proposed development or if any enhancements are needed to ensure a reliable supply.

In addition to this, water companies were required to publish their 2018 Charges Scheme for Developer Services following the charging guidance and rules set by Defra and Ofwat respectively. An important part of this was for companies to review their network reinforcement needs for the period 2018-23 and to calculate company-specific infrastructure charges based upon actual reinforcement requirements, rather than continuing with the standard infrastructure charge set many years ago which was annually inflated by RPI.

New Ofwat rules regarding developer charges for requisitioned mains and self-laid mains must:

- Only relate to site specific work
- Not relate to network enhancements unrelated to the requirements of the requisitioned or self-laid asset.

Infrastructure charges must be used to fund network enhancements and evidenced. This ensures all funding is directed to carrying out the enhancements needed to continue to supply customers with a reliable and sufficient water supply.

Customer and stakeholder expectation

Whilst we have an obligation to provide a full range of service levels to both our customers and developers, we believe it is essential to engage with all parties to ensure we continue to fulfil expectations. These include:

Customer measures:

- Existing customers – engagement on service levels.

Developer service delivery:

- Developers;
- Local Authorities;
- Central Government.

Discretionary enhancements customer research

In March and April 2018, we conducted two phases of deliberative qualitative research with customers to explore their acceptability for a range of discretionary enhancement schemes. The

[2] DCLG (2017) 'Fixing our broken housing market'

schemes were presented in the context that in 2020 customers' bills would be reduced by 10% and that the schemes could be funded by making the 10% reduction smaller.

When reviewing the results of the engagement, we considered adequate customers' acceptability to be anything over 70%. This was based on CCWater's Threshold of Acceptability research that was carried out for PR14.

A second phase of research was conducted because, in the first phase, a number of customers stated that they did not know if they accepted the schemes. We discussed this with the Water Forums and agreed that we should carry out additional engagement to understand why this was, and what information we would need to provide to customers to allow them to answer the acceptability question.

The results from the acceptability engagement were discussed with the Water Forums, who welcomed the generally very high levels of customer support for the schemes. Members did not agree on a definitive threshold for support in percentage terms, however some views shared were that anything over 60% would be acceptable.

All our enhancements were included in our overall PR19 acceptability research, where our plan was supported by 91% of customers.

Specifically related to growth, we have a statutory duty to respond to requests for new water and wastewater connections for domestic purposes. Because of this we have not engaged with customers specifically on our growth plans across our areas. Instead, we have extensively engaged our customers on service levels and service improvements. Our customers have been consistently clear that they do not wish to see any deterioration to the standard of services they receive, either as a result of accommodating growth or otherwise. The Water Forums were very supportive of our service level research.

Developers

As part of new charging arrangements, for this AMP and onwards, we were required by Ofwat to develop new charges by engaging with our developer customers. We arranged a series of consultation events, as well as an online survey which allowed us to develop cost-reflective infrastructure charges which incentivised sustainable water management.

We receive positive feedback from major house builders, such as Persimmon Homes, who said of our North Morpeth Strategic Sewerage project:

> "Persimmon are a national house builder and thus we have much experience of working with drainage authorities. In our experience NWL stand head and shoulders above other partners as the most proactive authority we work with …. As an authority, they positively plan for the future and seek to secure deliverable solutions. Crucially they have a strong understanding of the delivery issues surrounding new development and they genuinely aid us in boosting housing supply. North Morpeth is a good example of the work which they do in the North East."

Our positive work within the forward planning arena was also recognised in 2017 when we were the overall winner of The Royal Town Planning Institute's award for planning excellence.

Our proactive consultation with customers and stakeholders has received plaudits from Steve Wielebski, of the Home Builder Federation, following an infrastructure planning day with 125 developers and their supply chain.

"The positive and helpful attitude towards developers within NWL is very much in evidence and combined with United Utilities, we are a fifth of the way forward towards demonstrating what 'good' can look like".

Local authorities

We are also fully engaged with the local planning authorities across the region and share data with each other to inform and develop the evidence based documents which inform the development of their local plans. This gives us the best possible data upon which to make informed decisions upon the timing and scale of infrastructure needs across the region.

The local plan evidence based documents include:

- Strategic housing land availability assessments
- Water cycle studies
- Strategic flood risk assessments
- Infrastructure delivery plans

Central government

At a national level there are clear expectations from Central Government with regard to the provision of infrastructure to support development.

In the foreword to 'Better Connected' published in December 2014, Brandon Lewis, Minister for Housing and Planning, said:

> "To build the homes we need and deliver the local growth and jobs to go with them, we must have a smooth and collaborative process to make sure the right utility infrastructure is in place to enable developments to connect in a timely and cost effective manner.
>
> We want to help create a shared understanding between utility companies and developers about utilities connections. We want to enable growth by ensuring utilities are in the right location, at the right time and at the right cost.
>
> To make this a reality, developers, utilities companies and regulators must all work together to continuously reduce the complexities, uncertainties and the length of time faced when connecting to utilities. This document is a starting point. It has been produced jointly between departments and the regulators responsible for electricity, gas, the water sector (water and sewerage companies) and telecoms."

This message was reinforced by the Prime Minister in her foreword to 'Fixing our broken housing market' where she stated:

> "We need to ensure that homes are built quickly once planning permissions are granted. We will invest in making the planning system more open and accessible, improve the co-ordination of public investment in infrastructure, support timely connections to utilities, and tackle unnecessary delays. We're giving councils and developers the tools they need to build more swiftly."

We have been actively involved in provision of infrastructure as a policy priority at a national level.

Our Wastewater Director led the Infrastructure Policy Group, where major strategic infrastructure issues are discussed with stakeholders including Ofwat, Defra and the Cabinet Office. We have utilised this opportunity to understand the expectations of these stakeholders at a national level and to shape our investment plans.

In addition to this, two of our senior managers were members of the Defra task and finish groups set up to consult with the development sector and to implement the new developer services charging arrangements. Our Developer Services Manager sat on the Pre-Development Group, and our Regulation Manager on the Charges Steering Group.

Current and historical service delivery and expenditure

Ofwat's new rules for this AMP and onwards, requires companies to calculate their network reinforcement requirements for the period 2018/23 and that this should be sufficient to support development. Charging for reinforcement via the mains requisitioning process ceased on 1 April 2018.

Our ability to charge for network reinforcement at a development site level means that previous years' investment is negligible as developers have been funding these solutions. We were not required to collect data on the allocation of growth investment in our mains renewals programme, so have limited data on actual investment, but it is most unlikely to match the infrastructure charges we have collected.

Forward looking analysis

The following section details how a list of schemes have been identified which require network enhancements.

Scheme list identification

A number of activities to identify the investment requirements to deliver the required level of service, and minimise risk to quality and quantity, were carried out as follows:

- Review of schemes identified for PR14 that haven't progressed due to lack of growth, to assess whether the need originally identified was still relevant. This was carried out with the New Development and Network teams [3];
- Review of issues in investment plans to identify schemes that need to be progressed due to growth planned in those areas. These were reviewed against regional council plans for development and confirmed with the New Development and Network teams;
- Sprint workshops were held for each growth area to review any network / zonal study outputs, known issues with supply / resilience and network capabilities. Short and long term options were discussed at these meetings and an action plan produced on preferred timescales for delivery. Water resource management plans were also discussed where a potential deficit or minimal headroom was identified.[4]

Scheme identification and review

The Strategic Network team own and maintains a suite of network models which represent the operation and behaviour of all of the distribution networks throughout the Company's area of supply. The models are primarily used for scheme design, contingency planning and operational support purposes. They are constructed to represent a series of demand conditions and the most appropriate model available is used as the basis for identifying future growth related issues.

Predictions of growth in demand were made by an appropriate external consultancy for household properties and populations. These were converted to household water demands by the Technical Strategy and Support team.

Growth factors

Household factors were derived initially at post code sector level and were combined into a single growth factor for each district metered area (DMA).

Leakage factors were also derived at DMA level.

Non household demands were derived, initially by analysing all of the non-household customers. The largest customers were applied to the model directly. The remaining non-household customers were combined in a similar manner to the households at DMA level.

Growth predictions are included within our water resource management plan including the latest consultation version[5]. This covers the periods 2020 to 2060. This ensures that we are able to maintain an acceptable security of supply index (SSI) and maintain the supply demand balance for our customers whilst allowing and accommodating economic growth across our regions. Our plans ensure we are managing the impact of growth on our future water resource requirements and mitigate the environmental impact from increased abstraction in the future. We will maintain an SSI score of 100 up to 2060 across all our regions without the need for significant additional water resources being secured. We also make allowances for an expected reduction in per capita consumption and improved water efficiency by customers when determining future water resource requirements.

[3] AMP6 Infrastructure Growth
[4] Sprint Outputs
[5] https://www.nwl.co.uk/your-home/environment/water-resources-management-plan-2019-consultation.aspx

APPENDIX 3.2

WATER GROWTH

Individual factors were derived for each five year timescale to represent the specific time period 2010 to 2035. The 2035 factors were applied to generate the equivalent overall 2035 demand condition. Some specific amendments to the identified growth predictions will be made where more detailed information is already known of significant development schemes.

Each of the derived 2010 - 2035 models were run and adjustments were incrementally made to the various modelled configurations to ensure that the arrangement represented a satisfactory, and typical, operational arrangement. In addition, areas were then identified where the pressure was observed as breaching the low pressure standard of below 15m at any of the individual supply nodes. These were recorded as 'areas with growth issues'.

As part of a wider 'zonal studies' project, additional processes identified further 'issues' associated with strategic mains and crossings, reservoirs and towers, pumping plant and distribution system. These issues can be classified as risk, performance or cost issues.

Issues recorded from all of the study processes were then collated, reviewed and any common linkages identified. Schemes were then identified to resolve individual and combinations of issues, including growth. This process ensured that any identified schemes, wherever possible, provided the solution to more than one issue. All individual schemes were recorded and an initial assessment of the key investment drivers, primary & secondary, made.

An assessment of the required timing for the individual growth schemes was made using a combination of factors:

- Known timings of specific developments;
- The magnitude of the failure at the 2035 demand condition in comparison to the known condition in the existing model, utilising demand scenarios at intermediate years if necessary;
- The known requirements and timings of other linked factors were considered at a high level:
    - Rationalization;
    - Optioneering;
    - Optimisation.

All schemes identified were defined as far as possible and passed to the Investment Delivery Asset Planning team for cost estimations to be derived. A brief description of each individual scheme was written to enable the issue and scheme to be fully understood. Expert panels evaluated the final investment splits, particularly the split between growth and capital maintenance. All confirmed issues were recorded in the corporate AMPS system. An example of the typical analysis undertaken can be seen in Appendix 1.

At this stage our ability to determine an appropriate range of options with robust cost–benefit analysis is limited to the information we have been supplied with by developers in regards to housing types and densities. Development is externally driven and the final site designs are only known once the developer finalises their site development plan. At this stage each site is only considered as a 'block' of new demand, based on the information from the developer and LPA.

Technical appraisal is undertaken and judgement made as to whether this block of demand is carried forward for more detailed analysis. Final design and growth impact can only be determined once the developer commits to construct and confirms the housing mix.

Our finalised list of growth schemes, shown in Table 1 – List of 2020-2025 water growth schemes **Error! Reference source not found.**, is our best assessment of those schemes which we believe will be required to support developments we believe will proceed between 2020 and 2025.

We will only invest in infrastructure reinforcements once a development is confirmed as starting. Modifications to our finalised list of AMP7 schemes is therefore likely as a result of developer's alternative demands or proposals.

Regular technical reviews were undertaken and attended by Operational and New Development team experts to determine if the schemes selected to proceed were driven by growth and if any betterment would materialise when the scheme was eventually delivered. Not all proposed growth schemes would proceed beyond these stages of technical scrutiny. For AMP7, the Technical Review Group concluded that the final schemes were to fully address the impact from growth caused by new development within the local area and did not include any material betterment. Therefore scheme costs shown in Table 1 have been allocated as 100% enhancement.

Throughout this process all key internal stakeholders have been involved to identify issues and potential linkages to ongoing projects, discuss solutions to these issues and provide information to ensure robust costs have been sought and provided for inclusion in the business plan for PR19. See Appendix 3 – Growth Workshop Agenda.

As a result of this exercise CP0's are raised into the AMPs system to flag up the potential need for investment.

Costing of options

All costs included were provided and assured by our Cost Assurance team. There are four primary approaches to costing as described below:

- Full iMOD cost estimate using business as usual processes
- PR19 Costing Tool created from iMOD base estimates
- Traditional unit rate builds up estimates
- Assessment and forecasting of historical spend.

The most appropriate costing method will be chosen for each scheme.

The cost assurance process and associated costs generated for the water growth schemes have been subject to third party assurance, provided by Mott MacDonald, in July 2018. This review has assessed all water growth costs as 'Green', meaning we NWL have evidenced that the costs we have used are robust and consistent with good industry practice.[6]

[6] PR19 Enhancement Programme Business Case Assurance. Summary Report. Mott Macdonald, June 2018

APPENDIX 3.2

WATER GROWTH

Whilst the company acknowledge the Ofwat report "Cost assessment for PR19: a consultation on econometric cost modelling" issued in March 2018, no comparator model has yet been issued to compare our new development costs against. Therefore no further action has been taken in regards to cost comparison at this time other than through our usual cost assurance approach.

Option appraisal

Accurately predicting the actual timing, location and build out rates for new development can be difficult so we have taken a balanced risk-based approach using our experience of the development market. Our assessment uses data regarding actual sites within the development pipeline and the results of detailed network analysis using our library of models.

We have calculated our infrastructure charge based upon the average annual network reinforcement needs for the period from 1 April 2018 to 31 March 2023. We have also assumed the following in terms of housing delivery:

- 7,800 new properties will be connected each year within the north east. see Appendix 2;
- 5,400 new properties will be connected each year to the Essex and Suffolk networks of which around 200 will be via bulk supply connections in NAV areas. see Appendix 2.

We have used a wide range of data sources on future development to identify areas where network reinforcement schemes will be required. We have then estimated the total cost of the provision of new infrastructure. Where we are replacing existing water networks or carrying out refurbishment of water pumping stations, in areas of high growth, we have included a percentage allowance for growth to future proof them. That calculation is based upon the relevant percentage increase in future housing when compared to the existing number of connected houses.

In terms of housing delivery we have used a variety of data sources which include:

- Our Water Resources Management Plan;
- Office of National Statistics data;
- Pre-development enquiries;
- Local Plan data;
- Planning approvals;
- NAV applications.

We are confident that we have a good sense of the most likely location of development over the next five years and through our modeling an equally good understanding of those areas with network reinforcement requirements. In terms of actual housing delivery, our current assumption is that annual build rates will be approximately 70% of that within the local plans. We will use this as our default where capacity is needed, only after so many houses are completed, rather than at the actual commencement of the development. Supported by the data in Appendix 2.

Review and shortlisting

Stage One: Initial filtering

Initially any obvious duplicates were removed from the list.

In terms of timings, the list only extended from 2018 to 2023, so has no projects identified for the last two years of AMP7, however it is deemed likely that newly emergent issues will require similar levels of investment for the final two years of AMP7.

Projects where it was known that they would be completed during the final two years of AMP6 were also excluded from further investigation but the five year analysis acts as a good surrogate for AMP 7, as 2018-2020 fills the void of 2023-2025 data.

Stage Two: Growth investigations

All issues recorded from all of the study processes were then collated, reviewed and any common linkages identified. Schemes were then identified to resolve individual and combinations of issues, including growth. This process ensured that any identified schemes, wherever possible, provided the solution to more than one issue. All individual schemes were recorded and an initial assessment of the key investment drivers, primary and secondary, were made.

Working with internal stakeholders, the long-list candidates were assessed against the following criteria:

- That network reinforcement was required to supply future growth in domestic water supply and not to deal with existing DG2 low pressure issues;
- Certainty of development to ensure that only those housing schemes most likely to proceed were considered;
- Removal of schemes where pumping systems were running excessively but proposed growth was negligible;
- Removal of schemes for network reinforcement associated with the supply of process or cooling water eg Sizewell;
- For those network reinforcement projects supplying a mix of domestic and process water, a proportional allocation has been identified eg Hartismere Study;
- Network reinforcement includes for increasing the capacity of pipes, booster stations and service reservoirs. It specifically excludes investment to improve water resources, reservoirs, boreholes and water treatment works.

An assessment of the required timing for the individual growth schemes was made using a combination of factors:

- Known timings of specific developments;
- The magnitude of the failure at the 2035 demand condition in comparison to the known condition in the existing model, utilising demand scenarios at intermediate years if necessary;
- The known requirements and timings of other linked issues.

Efficient costs

As stated earlier, at this stage our ability to determine an appropriate range of options with robust cost–benefit analysis is limited to the information we have been supplied with by developers in regards to housing types and densities. Development is externally driven and the final site designs

are only known once the developer finalises their site development plan. At this stage each site is only considered as a 'block' of new demand, based on the information from the developer and LPA. Our finalised list of growth schemes, shown in Table 1 – List of 2020-2025 water growth schemes, is our best assessment of those schemes which we believe will be required to support developments we believe will proceed between 2020 and 2025.

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

Costs for Water Growth were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[7]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed costs for Water Growth are £14.39m Capex and £0 Opex.

The majority of these costs (94.36%) were benchmarked and assured using the full iMod cost estimate using business as usual processes.

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[8]. This review has assessed Water Growth costs as overall Green. This means that NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

Affordability

The scheme proposed is material to the long-term stability and health of the customer service, and will contribute to a robust future network. This is in the context of an AMP7 plan which customers fully support.

The cost of this investment (£14.39m) is born by developers wishing to connect to our network. However, we recognise that affordability will remain a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 2030[9] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

[7] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology

[8] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

[9] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

APPENDIX 3.2

WATER GROWTH

Our preferred plan

As stated earlier, accurately predicting the actual timing, location and build out rates for new development can be difficult so we have taken a balanced risk-based approach using our experience of the development market.

The outcome of our review exercise is the identification of potential need for approximately £14.39 million of infrastructure reinforcement resulting from developer activity. A list of expected growth schemes is shown in Table 1 – List of 2020-2025 water growth schemes below.

APPENDIX 3.2

WATER GROWTH

Table 1 – List of 2020-2025 water growth schemes

Scheme name	Scheme description	Total scheme cost - Enhanced Capex	Total scheme cost - Base Capex	Cost Assurance - RAG Review
Aykley Heads link mains	Lay 335m of 180mm reinforcement main.	£203,804	£0	GREEN
Monkton Fell, Hebburn	Install 329m of 125mm pipeline and upgrade 166m of 90mm main to secure supplies to new housing from Mill Lane DMA.	£153,523	£0	GREEN
John Street, Boldon Colliery (Boldon Colliery DMA)	Install 10m road crossing with 100mm reinforcement main onto new development site.	£14,413	£0	GREEN
Charles Street, Boldon Colliery	Extend existing 4" cast iron main by 70m onto 90mm new development main.	£61,360	£0	GREEN
Medomsley Road, Consett pressure	Lay 1100m of 250mm main.	£712,126	£0	GREEN
Water Mains Reinforcement Hexham Road, Throckley	Lay 200mm of 355mm HPPE diameter from the 18" STBL strategic water main at Walbottle Pumping Station.	£136,932	£0	GREEN
Camphill WPS, Alnwick	WPS requires upsizing to support growth in the area.	£150,000	£0	RED
Highcliffe WBS	Replace WBS to support growth in the area.	£195,201	£0	RED
Shildon to Cobblers Hall main	Replace 2.5km of 600mm main.	£2,419,960	£0	GREEN
Rimswell growth	New WBS to supply the top half of Rimswell DMA to support growth in the area.	£150,000	£0	RED
Frys growth	Upgrade WPS and inlet main to meet future predicted demand	£233,141	£0	GREEN
Liverton WBS growth	Upgrade WBS to deliver 2.6l/second at 60m pumped head.	£234,768	£0	GREEN
Midridge growth	Replace 2.5km of 15" water main.	£1,978,589	£0	GREEN
East View WBS	Upgrade Booster pumps, install PRV and flow meter and lay 770m of 315mm main.	£665,314	£0	GREEN
Burtree Lane, Darlington	Replace 1100m of 225mm main.	£506,369	£0	GREEN
Distribution. Mains - Growth Schemes -	Reinforcement Main - 190m x 180mm PE in road.	£224,785	£0	GREEN

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WATER GROWTH

Wantz Road, Maldon				
Growth - Maldon Tower Booster	Install a new booster pump on the outlet of Maldon Tower to boost the pressure at the peak hours of the peak days. 34 litres/sec at a lift of 10m, required for new pump.	£258,212	£0	GREEN
(Growth) - Silver End Reinforcement	Lay 1.6km of 180mm PE pipe from Broomfield to Western Road, Silver End.	£626,124	£0	GREEN
Marginal Low Pressure - Oxley Green Reinforcement	Lay approx. 1.3km of 180mm PE main in Kelvedon Road.	£733,855	£0	GREEN
Growth - Fair Close, Beccles	Install a new SV to enable Fair Close to be rezoned onto the HL system - close a 2nd (existing) SV to complete the zone.	£57,924	£0	GREEN
Growth - Banham Road Area, Beccles	Lay 2 x sections of main to link Banham Road to Russet Close & Tower Hill to Coxs Close - approx. 230 m in total (130 + 100) of 100mm ID main.	£40,000	£0	RED
Growth - Bungay HL reinforcement	Lay 800m x 150mm.	£479,304	£0	GREEN
Growth - Bungay LL reinforcement	Mains scheme to reinforce the existing Bungay Low Level system. Lay 600m of 250mm and 230m x 150mm.	£555,564	£0	GREEN
Broadland Sands Holiday Park	Additional 500 caravan, holiday park in Suffolk. Corton Booster to be replaced as it is currently up to max capacity.	£68,442	£0	GREEN
Growth North Leiston Conn.	200m x 100mm PE.	£37,913	£0	RED
Growth Halesworth reinforcement	Reinforcement of network by installing 200m of 150mm main in road.	£282,373	£0	GREEN
Growth - Ilketshall to Ringsfield	Lay 2.9km of 150mm.	£777,768	£0	GREEN
Growth Metfield Common	Lay 650m x 150mm.	£209,743	£0	GREEN
Fresh Wharf Road Barking	Lay 500m of 180mm PE main from London Road connecting into the existing 6”main.	£396,654	£0	GREEN
High Lodge Country Park, Hinton, Suffolk	Install 6,300m of 200mm PE main; 200m of 200mm between the 14” AC main at Sibton to Hemp Green and another 4,300m of 200mm PE between Yoxford and the development site.	£1,826,746	£0	GREEN
	Total	**£14,390,907**	**£0**	

APPENDIX 3.2

WATER GROWTH

Incentivising delivery

We are proposing appropriate mechanisms to incentivise delivery of our enhanced growth schemes across the next AMP. We will deliver 30 growth schemes so that housing and economic growth across our operating areas can be supported first time, upon the submission of the planning application and does not result in a reduced level of service for our existing long term customers.
If actual growth differs from that forecast, an adjustment to the annual infrastructure charge will be made to account for under/over delivery using the appropriate infrastructure charge adjustment mechanism agreed with Ofwat.

Full details of our enhancements delivery incentive mechanisms are included in Chapter 6: Measuring and Incentivising Success of our final business plan.

Alignment with stakeholder needs

Above all, the plan is designed to protect existing customer service measures, so that development and meeting local and national housing development needs does not result in a reduced level of service for our existing long term customers.

Our final plan will ensure that housing and economic growth across our operating areas can be supported first time, upon the submission of the planning application. This is consistent with Central Government policy, Ofwat regulatory guidance and the requirements of our local planning authorities and our developer customers.

The requirement for water companies to calculate their own infrastructure charges was included within Ofwat's charging rules. This followed lobbying by national trade bodies representing developers to Central Government, through Defra, who claimed that their members were being "double charged" for network reinforcement. They were required to fund necessary network reinforcement to support their development through the mains requisitioning process and then again via infrastructure charges collected by companies.

Customer protection

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed. We are proposing a cost adjustment mechanism for enhancement costs that will protect customers against late or non-delivery of those enhancement schemes.

The need for enhancement investment comes from housing developers building in areas which are at or near capacity with regards to water supply. Development plans are submitted to determine if the current infrastructure is sufficient to supply the proposed development, or if any enhancements are needed to ensure a reliable supply.

The cost of the investment for Growth (£14.39m) is born by developers wishing to connect to our network and is levied by the Infrastructure charges as set out in the Charges scheme rules issued by the Water Services Regulation Authority under sections 143(6A) and 143B of the Water Industry Act 1991

Full details of our enhancements delivery incentive mechanisms are included in Chapter 4: Measuring and Incentivising Success of our final business plan.

APPENDIX 3.2

WATER GROWTH

Board assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers"[10].

[10] See Board Assurance Statement

APPENDIX 3.2

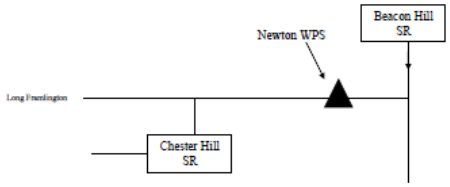
WATER GROWTH

Appendices

Appendix 1 – Example of Growth Methodology Scheme Documentation

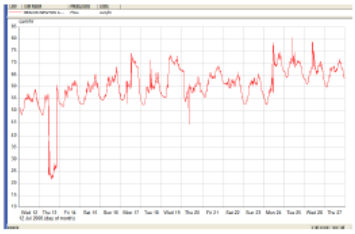
Example scheme detail

Scheme 71 – Newton on the Moor WPS



Problem: During times of peak demand Newton WPS has to run at capacity to attempt to maintain levels in Chester Hill SR.

Supporting Data:
The graph below illustrates that during July 2006 Newton on the Moor WPS ran for up to 24 hours per day.



No of Props Affected:
Peak 06 model highlights a total of 8 potential DG2 failures.
(1 < 5m < 2 < 10m < 5 < 15m)

DM Growth: HH growth factors of 5% for the two DMAs supplied from Chester Hill SR, AN032 & AN045.

Model (Location & Name)

H / Piccolo / PR09 / 2006 Pk Model / SZ02

Node (Locating Reference)

N53593667

Options Available:

1) Mains reinforcement in the order of 6km of 200mm UPVC main to replace 6"CI running from Newton WPS to Long Framlington Village. This has the effect of lifting min pressure to 17m and enabling us to maintain levels in Chester Hill SR whilst running 1 pump for 20hrs.

2) Upgrade Newton WPS and only 3km of mains reinforcement will be required

Example scheme summary report

NORTHUMBRIAN WATER LIMITED NORTHERN OPERATIONS

BUSINESS PLAN TABLE 5.2 LINE 6

GROWTH SCHEMES – CANDIDATE SCHEME SUMMARY

Scheme 71 – Newton on the Moor WPS

System When operating Newton on the Moor WPS supplies Chesterhill S.R. and the DMAs of Newton Pumps and Overgrass. When the pumps are not running water gravitates back from Chesterhill S.R to supply the DMAs.

Problem: During times of peak demand Newton WPS has operated up to 24 hours to maintain levels in Chester Hill SR.

Supporting Data: Beacon Newton DM trace indicating 24 hour operation in July 2006.

No of Props Affected: If the reservoir was to run empty approx 800 properties are at risk of going without supply.

Growth: Predicted household growth of 5% for the area supplied from Chester Hill S.R.

Methodology This is in line with the companies methodology for Table 5.2 line six:- Capital expenditure on infrastructure assets associated with meeting or offsetting changes in demand from new and existing customers, while maintaining existing levels of service.

Option:

1) Preferred Mains reinforcement in the order of 6km of 200mm UPVC main to replace 6"CI running from Newton WPS to Long Framlington Village. This has the effect of lifting min pressure to 17m and enabling us to maintain levels in Chester Hill SR.

2) Upgrade Newton WPS and only 3km of mains reinforcement will be required

APPENDIX 3.2

WATER GROWTH

Appendix 2 – Source of new connections estimates

Northumbrian connections 2017/18 - 7804 new connections

Month	Cumulative connections
Apr-17	598
May-17	1339
Jun-17	2102
Jul-17	2865
Aug-17	3370
Sep-17	4016
Oct-17	4831
Nov-17	5733
Dec-17	6204
Jan-18	6678
Feb-18	7240
Mar-18	7804

Data source NW New Development, May 2018

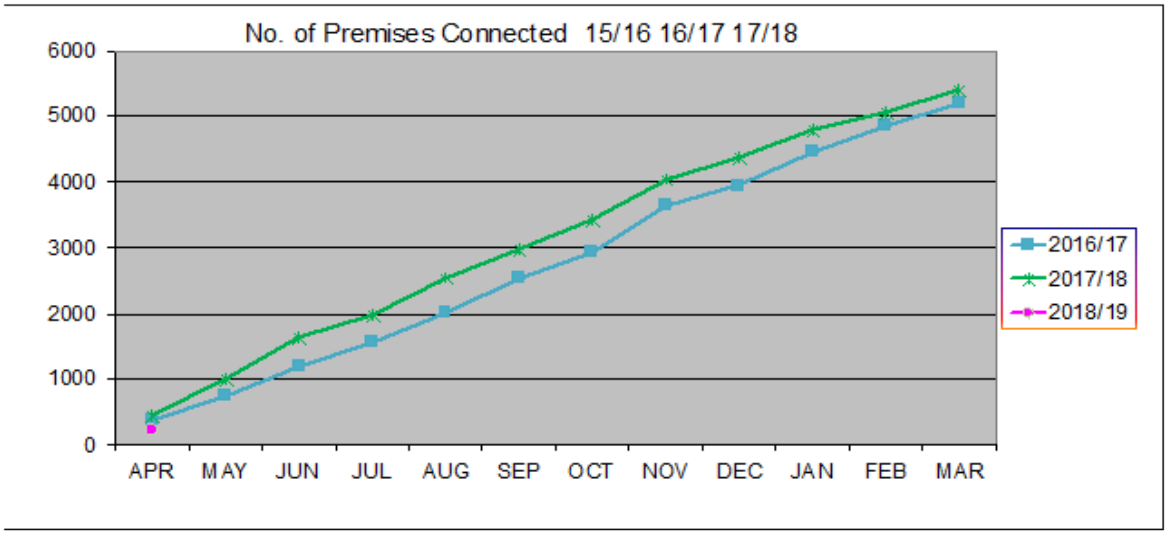
APPENDIX 3.2

WATER GROWTH

ESW New Connections 2017/18 - 5400 new connections

YTD	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
2018/19	218											
2017/18	460	1010	1639	1974	2542	2974	3429	4044	4380	4784	5055	5398
2016/17	381	759	1185	1556	2012	2541	2948	3652	3945	4452	4847	5186

	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
Monthly 18/19	218											
Monthly 17/18	460	550	629	335	568	432	455	615	336	404	271	343
Monthly 16/17	381	378	426	371	456	529	407	704	293	507	395	339



Data source ESW New Development, May 2018

Appendix 3 – PR19 Growth Workshop

Date:	2nd November 2017
Location:	Event Room – Leat House, Washington
Attendees:	Stephen Clifford, John Douglass, Kieran Walker, Chris Steele, Katherine Reed, David Walsh, Les Hall, Ian McCrickard, Matthew Summers
Apologies:	Brian Plemper

PR19 Growth Workshop

1. Meeting Objectives/Overview of issues — 09.00 – 09.10
Stephen Clifford

2. Ofwats new charging rules — 09.10 – 09.30
Ian McCrickard

3. Known Issues Geographically — 09.30 – 10.15
All
- **Teesside**
- **Central**
- **Northumberland and Tyne**

4. Next Steps and Action Review — 10.15 – 10.25
All

5. AOB / Future Requirements — 10.25 – 10.30
All

NORTHUMBRIAN WATER living water | ESSEX&SUFFOLK WATER living water

WATER RESILIENCE ENHANCEMENT BUSINESS CASE

WS2 - Wholesale water capital and operating enhancement expenditure by purpose Lines 13 (raw water deterioration) and 14 (resilience)

Contents

APPENDIX 3.2
WATER RESILIENCE

Name of claim	Water resilience and raw water deterioration enhancements
Name and identifier of related claim submitted in May 2018	n/a
Business plan table lines w here the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line 13 and Line 14
Total value of enhancement for AMP7	£163,966,853
Total opex of enhancement for AMP7	£0
Total capex of enhancement for AMP7	£163,966,853
Depreciation on capex in AMP7 (retail controls only)	n/a
Remaining capex required after AMP7 to complete construction	None as all schemes expected to be delivered in AMP 7
Whole life totex of enhancement	n/a.
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	Yes £31m from base capital to fund element of the Lartington mains renewal scheme
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	13.6%
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	No
Need for investment/expenditure	Raw water deterioration – Refer to Annex B & E Resilience - Refer to Annex A,C,D,F & G
Need for the adjustment (if relevant)	n/a
Outside management control (if relevant)	n/a
Best option for customers (if relevant)	p11, p13 and Annexes A,B,C,D,E,F and G
Robustness and efficiency of claim's costs	p7/8, p26-30 and Annexes A,B,C,D,E,F and G
Customer protection (if relevant)	p8, p37/38 and Annexes A,B,C,D,E,F and G
Affordability (if relevant)	p8/9 and Annexes A,B,C,D,E,F and G
Board Assurance (if relevant)	p9 and Annexes A,B,C,D,E,F and G

Addendum March 2019: Initial Assessment of Plan, Ofwat, January 2019.

Following an initial assessment of the business plan (IAP) a number of areas have been highlighted by Ofwat in regards to our proposals and allocation of funding as detailed in below.

These points have been addressed within this updated business case and signposted accordingly to aid quick reference and review.

1. IAP - Scheme 1 was reallocated to Line 8 supply side enhancements as the need was considered to relate to SDB risks.

   Scheme 1 is returned to WS2 Line 14 with additional evidence provided to support this action.

2. IAP - Scheme 2 was reallocated to Line 13 investments to address deteriorating raw water quality. No likelihood assessment is presented. Table 8 also states that the schemes is linked to a DWI scheme (NNE_ESK03 - Springwell SR), however, it is not clear how the schemes are linked? .It is not clear that this investment relates to a high consequence low probability occurrence and thus is not clearly resilience investment.

   No change to proposal to move to Line 13 but additional evidence provided to support the case for investment based on raw water deterioration. The DWI are minded to support this scheme and are undertaking further assessment of our application for support.

3. IAP - Scheme 3 was reallocated to Line 13 investments to address deteriorating raw water quality however, no likelihood assessment is presented. It is not clear that this investment relates to a high consequence low probability occurrence and thus is not clearly resilience investment.

   No change to proposal to leave in Line 13 but additional evidence provided to support the case for investment based on raw water deterioration. The DWI are minded to support this scheme and are undertaking further assessment of our application for support.

4. IAP -Scheme 4, 5 and 6 were accepted in full as the schemes resolve single source of supply risks at large urban centers with relatively low cost interventions. Further likelihood of failure analysis would have provided a stronger evidence of criticality of the investment.

   Accepted and no further action taken as cost of scheme not deemed material.

5. IAP - Schemes 7 to 12 were accepted. The company did identify a need for these schemes but because of the scale of the proposed schemes the evidence to support the need is considered insufficient. Further details of analysis undertaken to understand likelihood of failures and likely duration of failures for these schemes would need to provide a stronger case for schemes proposed. As a result an efficiency challenge was applied (20%).

   Further evidence has been provided to support these schemes including stronger evidence on the analysis undertaken to determine the likelihood and consequence of such failures. We propose that the 20% efficiency applied is no longer applicable and the full scheme cost claim allowed. Schemes 9, 10 and 11 are dependant upon the investment planned for Scheme 17 in order to realise the resilience benefit.

6. IAP - Scheme 13 & 14 was not accepted as there was insufficient evidence of the specific risk it is expected to resolve.

   Further supporting evidence provided to clarify the specific risk the schemes are expected to resolve. The proposals for Schemes 13 and 14 needs to be considered alongside the investment planned for Schemes 4 and 7.

7. IAP - Scheme 15 was not accepted as it related to utilise existing water resources to protect against outages and this type of known outage risk is seen to be as part of managing existing risk under base costs.

Further supporting evidence provided to clarify the specific risk the scheme is expected to resolve. The proposals for Scheme 15 need to be considered alongside the investment planned for Scheme 16.

8. IAP - Scheme 16 was not accepted as although the risk of a supply interruption at Barsham works is identified, no magnitude or likelihood assessment is provided. It is also not clear how this links with scheme 15 and how this combination provides best value resilience. Further detail should be provided on the risk analysis undertaken looking at the overall resilience of properties served by Ormesby, Lound and Barsham WTWs and how the proposed schemes provide the best option. The analysis should identify that the schemes provide resilience against low probability, high magnitude events.

   Further supporting evidence provided that provides clarity on the points raised in regards to risk analysis and the likelihood and consequence of a failure. Details provided as to how the proposals for Scheme 15 need to be considered alongside the investment planned for Scheme 16 in order to deliver the resilience benefit from both investments.

9. IAP - Scheme 17 was not accepted as it is not clear which of the risks identified in the central catchment this additional storage is targeted at and why 2 - 3 days is an appropriate amount. . Without further detail and evidence on the nature of the risk of failure at Mosswood or the Derwent North main. The spend cannot be justified under enhanced resilience expenditure.

   Further supporting evidence provided to clarify the specific risk the scheme is expected to resolve and the rationale used to determine the appropriate size of the proposed service reservoir. The proposals for Schemes 9, 10 and 11 needs to be considered alongside the investment planned for Scheme 17.

10. Scheme 18, Resilience to natural and manmade hazards at the 63 Too Critical to Fail sites had been incorrectly allocated to WS2 Line 48 (Enhancement Opex).

    Further supporting evidence provided for this resilience investment. Reallocated total scheme costs to WS2 Line 14 as this was an error in the table during September plan submission.

11. There was no detailed evidence found on scheme costs, therefore it was not possible to judge cost efficiencies of these schemes in detail. A company specific efficiency challenge was applied.

    Further supporting evidence provided on our costing approach for each scheme and the external assurance provided on this approach. Cost efficiencies are reflective in our costs unless stated.

12. Along with the common resilience PCs the water resilience enhancement programme is covered by a performance commitment with a penalty only ODI to protect customers against late or non-delivery of the overall resilience programme.

    Further clarity provided on how we intend to incentivise delivery of our resilience plan and protect customers from late on non delivery of schemes.

Table 1 – Ofwat Initial Assessment of Plan (IAP) feedback on scheme support and cost allocation, January 2019.

Further analysis Water resilience schemes after reallocations to other lines	Requested (£m)	Allowed (£m)
1) Batch 1: Abberton to Hanningfield RW transfer main at 50 Mld capacity	Reallocated	
2) Batch 1: Install new UV treatment at Mosswood WTW to manage Kielder cryptorisk	Reallocated	
3) Batch 1: DAF treatment at Layer WTW	Reallocated	
4) Batch 1a: Cross connections into C60/60a for Darlington	0.21	0.21
5) Batch 1: 315m of 700mm main to duplicate Chirton SR outlet main	0.40	0.40
6) Batch 2: 30m of 900mm main @Herongate SR	0.23	0.23
7) Batch 1a: Replace 37.5km of 600mm with single 800mm St main	14.08	11.26
8) Batch 1c: 16km of 800mm main from Whorley to Shildon [link to Batch 2 - Central]	19.20	15.36
9) Batch 1: 1.5km of 600mm main Carr Hill Link to Springwell SR	3.00	2.40
10) Batch 1: 7km of 1000 mm main from Springwell to Pikes Hole plus EOV control	14.86	11.89
11) Batch 1: 4km of 1000mm main between Heworth and Pikes Hole plus EOV control	8.52	6.82
12) Batch 2: New 55Ml WPS at Shildon SR [Link to Batch 1c - Tees]	2.86	2.29
13) Batch 1b: New inlet/outlet arrangement at Maltby SR (6km 800mm main)	5.40	0
14) Batch 2: Mods to Ormesby WPS and abandon 3 SRs	0.70	0
15) Batch 1: Enabling mains schemes at North Cove and S Lowestoft	4.10	0
16) Batch 2: New treated water storage and WPS.	10.14	0
17) Batch 1: Springwell SR - 62Ml capacity	16.20	0
Total Requested (excluding reallocations to other lines)	**99.90**	**50.86**

Executive Summary

Our resilience plan seeks to reduce the risk of critical service failure that would affect a large number of our customers, where we are either required to do so, or where there is strong customer support for a reduction in risk.

One scheme within the programme has full DWI support and a Regulation 28 Notice will be issued in due course. Two additional schemes have DWI support in principle (Layer DAF and Mosswood UV), DWI are assessing our application and as soon as final dicision letters are issued these will be supplied to Ofwat:

1. DWI Scheme reference: NNE ESK 4 – Tees Discolouration
2. Layer DAF – DWI minded to support
3. Mosswood UV – DWI minded to support

The DWI also commends for support, but not under a Regulation 28 Notice the following scheme:

4. NNE_ESK03 – Springwell SR

We have assessed all sites where there would potentially be a sustained loss of supply to 10,000 customers in rural areas, and 20,000 in urban areas from a single point of failure. These thresholds have been set with reference to our ability to provide suitable alternative arrangements while supplies are offline (it is easier to provide replacement supplies to urban areas). Out of the sites above these thresholds, we have conducted further analysis on the ones that have a credible risk of sustained service failure.

We have undertaken and commissioned from third parties a significant amount of research, investigations and studies to inform our proposals. This analysis (covered in more detail later in this report) has been used to help inform the discussions we have had with our customers. By understanding the likelihood or tendency of events such as asset failure, resource restrictions, and service we can have developed options that will deliver for our customers the most appropriate and cost beneficial solutions.

APPENDIX 3.2
WATER RESILIENCE

All the schemes proposed for inclusion within our business plan, both the ones required by the DWI and the discretionary ones has a high level of customer acceptability. In addition to the regulatory requirements, as informed by our customer research, we are proposing a number of investment schemes which remove high impact single points of failure within our network, and address risks at assets that have been assessed as being 'too critical to fail'.

Our customers have shaped our resilience plan and support the delivery of the schemes we are proposing in this plan. Full details of our customer engagement and acceptability testing are set out in p11; Customer and Stakeholder Expectations but in summary we have directly engaged with over 430 of our customers and Water Forum on our resilience plans. 94% of NW customers and 96% of ESW customers indicated they were supportive of our resilience plan. We also shared our resilience plans with 2,150 customers as part of the overall acceptability research which customers again strongly supported.

Our customers have shaped our resilience plan and support the delivery of the schemes we are proposing in this plan.

We have undertaken and commissioned a significant amount of research, investigations and studies to inform our proposals. This analysis (p12: Forward looking analysis and options appraisal) has been used to help inform the discussions we have had with our customers. By understanding the likelihood or tendency of events such as asset failure, resource restrictions and impacts to service we have developed options that will deliver for our customers the most appropriate and cost beneficial solutions.

In developing our schemes, we have undertaken an assessment of the different options available to us. Full details of the optioneering undertaken for each scheme are contained in Annex A to G.

A summary of our resilience and raw water deterioration schemes is set out below.

Scheme	Description	Enhancement totex [£m]
1 – Lartington Mains and Tees strategic mains reinforcement – DWI Regulatory 28 Notice		
Lay 37.5km of single 800mm main between Lartington WTW and Longnewton service reservoir	This main increases reliability of supply and improved water quality to over 250,000 customers as well as an increase in strategic transfer capacity. It is a key enabler for the schemes set out in the three lines below. The total cost of this scheme is £45.1m; we have not included the costs relating to base expenditure in the enhancement case. This scheme is covered by a DWI Regulation 28 Notice NNE ESK 4.	**14.08**
16km of 800mm main from Whorley to Shildon	This provides a connection to address a potential single point of failure issue that could affect 70,000 customers. This scheme covered by a DWI Regulation 28 Notice NNE ESK 4.	**19.20**
New mains and modifications to service reservoirs	This provides an improvement in water quality and increase in the reliability of supply to over 250,000 customers by utilising the full capability provided by the new main. This scheme covered by a DWI Regulation 28 Notice NNE ESK 4.	**6.10**
New water pumping station and cross connections	This provides new water pumping station and cross connecting main to address two potential single point of failure issues that could affect 98,000 customers. This scheme covered by a DWI Regulation 28 Notice NNE ESK 4.	**3.37**
2 – Springwell SR and South Tyneside strategic mains reinforcement – single point of failure		
Springwell service reservoir -62Ml capacity	This is a new service reservoir to address a number of potential single points of failure that could affect 100,000 customers. It is a key enabler for the schemes shown below. The DWI has shown support for these schemes under NNE ESK03.	**16.20**

11km of 1000mm main from Springwell to Pikes Hole to Heworth and supporting works	This addresses the risks from a number of single points of failure that could affect 100,000 customers utilising the resilience benefits from the new strategic storage at Springwell SR and provides an additional source of supply to Tyneside. The DWI has shown support for these schemes under NNE ESK03	**14.86**
1.5km of 600mm main Carr Hill Link to Springwell service reservoir	This provides a secondary source of supply to Springwell SR independent of the Derwent North strategic main and addresses a number of potential single points of failure. The DWI has shown support for these schemes under NNE ESK03.	**3.00**
3 – Abberton to Hanningfield pipeline – single point of failure		
Abberton to Hanningfield RW transfer main at 50 Mld capacity	This provides a connecting main to address a potential single point of failure issue that could affect 421,000 customers.	**20.35**
4 – Barsham SR/WPS and North Suffolk strategic mains - single point of failure		
New treated water storage and pumping station	This will reduce the impact and duration from a loss of supply event caused by a single point of failure impacting up to 27,000 customers and is a key enabler for the scheme in the line below.	**10.44**
Enabling mains schemes at North Cove and South Lowestoft	This provides a connecting main to address a potential single point of failure issue that could affect a further 90,000 customers.	**4.10**
5 - Low value-high impact single point of failure schemes		
315m of 700mm main to duplicate Chirton service reservoir outlet main	This provides a connecting main to address a potential single point of failure issue that could affect 43,000 customers.	**0.4**
30m of 900mm main at Herongate service reservoir	This provides a connecting main to address a potential single point of failure issue that could affect 110,000 customers.	**0.23**
6 - 63 Too Critical to Fail sites – high impact single points of failure		
63 Too Critical to Fail Sites	Provides risk mitigation at 63 too critical to fail water sites for natural and man-made hazards to address potential single point of failures that could affect 942,000 customers	**8.34**
Water quality - these schemes were developed as part of our resilience programme, we have reallocated them to raw water deterioration (line 13 in data table WS2) and DWI are minded to Support, we are awaiting Final Decision Letters		
Dissolved air flotation treatment at Layer WTW	This addresses raw water deterioration (turbidity and algae) issues at the WTW that have the potential to lead to supply restrictions impacting up to 420,000 people. The DWI has shown support.	**26.87**
Improved treatment at Mosswood WTW to manage Kielder crypto risk	This addresses cryptosporidium risk due to the changing quality in the catchment that has the potential to impact up to 170,000 customers. The DWI has shown support.	**7.90**

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

All costs for our resilience and raw water deterioration schemes were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[1]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed Totex costs for our resilience and raw water deterioration schemes are £163,966,853,

These costs were benchmarked and assured using a combination of full iMod cost estimates, PR19 costing tools and traditional unit rates benchmarked against similar schemes.

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[2]. This review has assessed our resilience and raw water deterioration schemes costs as Green, which is NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

Customer protection

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed. To protect our customers we will apply a penalty rate for underperformance against this enhancement. As this enhancement targets a specific output by a date in the future, we have based our penalty on a per day late of delivery basis. This uses the same principle as our Performance Commitment for R-F1 Delivering a consolidated customer information and billing system, penalty rate 2 at PR14.

Any penalty will be calculated as a net present value neutral adjustment as part of the PR24 true up process of the relevant 2019 Final Determination cash flows should the outcome be delivered late, partially or not at all. The discount rate used will be 3.3% real, the CPIH stripped cost of capital.

Additionally a number of the resilience schemes have full DWI support and the raw water deterioration schemes have support in principle pending further assessment by DWI. All DWI supported schemes will be transferred into legally binding programmes of work. Milestones will be agreed with DWI in due course and annual reports will be provided documenting progress.

Further details of our enhancements delivery incentive mechanisms are included in Chapter 4: Measuring and Incentivising Success of our final business plan.

Affordability

The impact of these enhancement investments on customer bills are shown below[3].

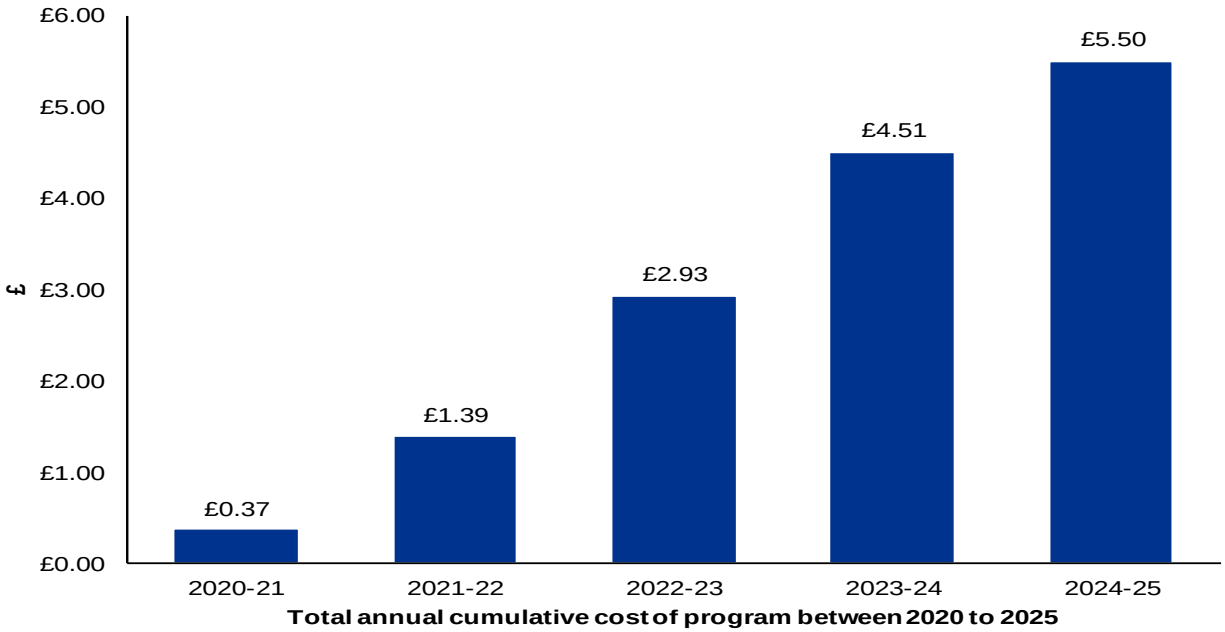
Overall the analysis shows that the bill impacts would be a rise in bills of around £1.10 per year over the AMP with a final one off cost to customers of £5.50 on the overall bill by Year 5.

[1] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology.

[2] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

[3] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[4] driving significant improvements to average customer affordability.



The resilience and raw water deterioration plan proposed is material to the long-term stability and health of the customer service, and will contribute to a robust future network. This is in the context of an AMP7 plan which customers fully support.

Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remain a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 2030[5] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

Board assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers".

[4] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

[5] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

APPENDIX 3.2
WATER RESILIENCE

Context and Scope

Resilience is one of the key themes of PR19. Ofwat's definition of resilience is the ability to cope and recover from disruption and anticipate variability, to maintain services for people and protect the natural environment now and in the future. Ofwat has developed seven resilience principles which set out its expectations for resilience which have been used to propose schemes for water resilience. Delivering resilient services to customers is at the heart of everything NWL does, from our day to day operations to making the right long-term investment choices, all balanced against risk and customer affordability. Customers have said that they accept that things will go wrong from time to time and that every eventuality cannot be covered. NWL understands what matters to our customers and what their priorities and expectations are in the short, medium and long term. NWL seeks to introduce both short and long term solutions, aligned to the resilience principles in order to increase overall network resilience as well as develop our approach to identifying and addressing long-term resilience risks. This approach and the solutions we develop will deliver benefits for customers in the form of ever reducing risks of long-term supply interruptions and water quality incidents by improving the overall operability and interconnectivity of our water networks over the coming years.

Our 2020 to 2025 water resilience plan has been developed by use of consequence and tendency to fail analysis, asset condition assessments, risk assessments, technical reports and extensive scenario testing including hydraulic modelling. Solution optioneering and cost benefit analysis has been used to develop our plan and support the achievement of our long-term objectives in line with both governmental, regulatory and customers' expectations.

Several investment schemes have been identified that deliver overall improvements to system resilience and risk reduction across our water networks. A 'system thinking' approach has been adopted for long term system operation and investment, developing long term strategic network plans (25 year horizon). The first strategic network plan for the Teesside network, completed in 2017, has proven the value that this approach provides when developing a future long-term resilience planning approach. Further details are provided on p15, Forward looking analysis and options appraisal. The strategic network plans align to NWL's 25 year Water Resource Management Plan and Water Quality strategy. In preparation for AMP8 we are proposing to complete our integrated network plans for all our remaining areas. The findings and recommendations from this analysis will inform our future water investment and resilience strategies.

NWL's 2020 – 2025 plans are the enabler of the creation of a fully integrated potable water grid system across the North East of England by 2045 which will fully complement the current resource resilience on the Kielder Raw Water Transfer system. This plan will enable better management of future uncertainty and risk, address the legacy of overcapacity within parts of our networks as industrial and customer demand for water continues to decline, and effectively manage the risks from an ageing asset portfolio. We are also proposing to strengthen our respond and recover capability for large loss of supply events in the future by increasing our tankering and alternative water capacity. As we improve this capability our requirements to invest in resilience schemes to mitigate risks and consequences of service failure, often at great cost reduces. Making sure we maintain a balance between capital solutions and operational response capability means our customers continue to see improvements in overall service resilience balanced against affordability. This ensures customers do not overpay for improvements to service resilience going forward.

NWL's plan has also considered the resilience obligations and the expectations from its regulators as set out in many recent consultation and guidance documents as summarised below:

- Guidance Note: Long term planning for the quality of drinking water supplies (DWI)[6];
- WISER - Water Industry Strategic Environmental Requirements (EA)[7];

[6] https://www.ofwat.gov.uk/wp-content/uploads/2017/12/Appendix-4-Resilience-FM.pdf
[7] https://www.customer-panel.co.uk/media/1017/water-industry-strategic-environmental-requirements-wiser.pdf

- Water Resources Management Plan (England) Direction 2017 (Defra)[8];
- Water Resources Planning Guideline (the WRPG) (EA)[9];
- Resilience in the Round (Ofwat)[10].

Customer and Stakeholder Expectations

The development of our enhanced resilience plans have also been informed by our customers' priorities and levels of acceptability in regards to risk and consequence from events that could impact the services we provide them. We have engaged with our household and non-household customers on what resilience means to them and their understanding of and appetite to risks to service during five specific phases of customer engagement plus a Water Forum Enhancement Sub Group review as summarised below:

Workshop	Date	Number of Customers engaged	
		NW	ESW
Resilience	May / June 2016	63	62
Resilience, Asset Health and long term affordability	Nov 2017	57	57
Discretionary Enhancements	March 2018	50	28
Water Forum Enhancement Sub Group	April 2018		
Discretionary Enhancements	May 2018	82	33
Acceptability of overall plan	June 2018	1090	1060
		1342	**1240**

Several groups of customers have been engaged as we have developed our resilience plans:

- Customers affected by flooding or other resilience scale events;
- Customers at risk from flooding;
- Young people (future customers);
- Vulnerable customers and those on the NWL risk register;
- Customers with recent contact with NWL.

Our research has provided a comprehensive understanding of customer views and expectations in relation to resilience and how these should influence NWL's future resilience strategy.
Our customers have told us they:

- Expect NWL to be prepared for unexpected events and responsive when they occur;
- Expect NWL to be planning for the future and implement preventative measures when needed;
- Expect an adequate level of investment is made in infrastructure and use new technologies to try to stop issues arising in the first place;
- Expect NWL to have alternative sources of water that can be easily utilised in the event of a problem at a treatment plant;
- Expect us to help educating customers on water efficiency and saving water. Customers had little appreciation of how much water they used and what they are using it for day to day;
- Expect NWL to be working in partnership with customers and stakeholders as a key part of developing their resilience strategy going forward;

[8] https://www.gov.uk/government/publications/water-resources-planning-managing-supply-and-demand/water-resources-planning-how-water-companies-ensure-a-secure-supply-of-water-for-homes-and-businesses
[9] https://naturalresources.wales/media/681612/interim-wrpg-update-final-april-2017.pdf
[10] https://www.ofwat.gov.uk/wp-content/uploads/2017/09/Resilience-in-the-Round-report.pdf

- Expect NWL to publish its plans to provide reassurance to members of the public that they are managing these risks to service adequately.

To understand what was most important for both customers and stakeholders in terms of water service resilience we conducted a sorting activity where customers placed potential failures on an acceptability scale. From this we concluded that customer and stakeholders resilience priorities are:

- The provision of clean, clear drinking water that tastes good;
- The provision of a reliable and sufficient supply of water;
- The provision of a sewerage service that deals effectively with sewage and heavy rainfall [NW only].

In March and April 2018, we conducted two phases of deliberative qualitative research with customers to explore their acceptability for a range of discretionary resilience enhancement schemes. The schemes were presented in the context that in 2020 customers' bills would be reduced by 10% and that the schemes could be funded by making the 10% reduction smaller.

When reviewing the results of the engagement, we considered customers' acceptability to be anything over 70%. This was based on CCWater's Threshold of Acceptability research that was carried out for PR14.

The second phase of research was conducted because in the first phase a number of customers stated that they did not know if they accepted the schemes. We discussed this with the Water Forums and agreed that we should carry out additional engagement to understand why this was, and what information we would need to provide to customers to allow them to answer the acceptability question.

The results from the acceptability engagement were discussed with the Water Forums, who welcomed the generally very high levels of customer support for the schemes. Members did not agree on a definitive threshold for support in percentage terms, however some views shared were that anything over about 60% would be acceptable.

All our resilience enhancements were included in our overall acceptability research, where our plan was supported by 91% of customers who participated in the acceptability research sessions.

Ofwat

Ofwat accepts that water companies are already doing lots of work to maintain resilient services to our customers as part of business as usual. However for PR19 water companies have been required to identifying opportunities to deliver improved levels of service resilience that meets the priorities and expectations of their customers, including overall affordability. Ofwat expect us to have:

- Understood both the risks and the consequences to our ability to deliver our service to customers;
- Undertaken optioneering of solutions and developed plans to manage these risks;
- Explored how we can deliver more resilient services by greater use of partnership, technology and market opportunities;
- Engaged and shared these plans and options with our customers;
- Understood customers' priorities and willingness to support and fund enhanced resilience activity;
- Built this into our PR19 submission to commence delivery in AMP7.

For PR19 Ofwat has allowed companies the opportunity to claim 'enhanced' funding for those resilience schemes that we can demonstrate meet the key tests listed above. In addition Ofwat has also issued guidance for PR19 to aid companies in determining whether a proposed resilience scheme meets the criteria of delivering 'enhanced' resilience – that is it delivers a step change in the base level of resilience customer already have.

We have made sure our approach has remained compliant with the guidance from Ofwat when determining whether a proposed resilience scheme meets the criteria of delivering an 'enhanced' level of resilience. Our enhanced schemes will deliver a 'step change' in the base level of service to our customers and are not a replacement for capital maintenance funded within the current bill. We have incorporated this new guidance within our own methodology for enhanced resilience scheme verification.

We are confident that the approach we have taken, including our engagement with our customers meets all of the expectations from Ofwat including assurance that our customers have indicated a willingness to invest in these schemes during the next AMP.

Forward Looking Analysis and Options Appraisal

For our 2020 to 2025 plan we have used a number of sources of data and undertaken a significant amount analysis to identify the need for additional resilience in our systems using a combination of consequence, tendency to fail and modelling analysis whilst considering Ofwats own guidance on 'enhancement' investment to identify where we carry the highest risks to service across our networks. We have used this analysis to support the optioneering and cost benefit analysis of a range of solutions that form the basis of our resilience plan.

Whilst such risks are unlikely to materialse but if they do the consequence to our customers in terms of the high numbers likely to lose their water supply for an extended period of time and the likely impact on drinking water quality make these undesirable both to NW and our customers.

The following section details the methods we have used to develop and inform those schemes we have included within our 2020 to 2025 water resilience plan. They provide assurance that we have undertaken appropriate and relevant risk analysis, option appraisals and solution development as part of the plan development. Further details of how our analysis and options appraisals were applied to the specific schemes is covered in detail within the relevant Annex attached.

Consequence of Failure analysis

We have completed a review of all our critical above and below assets across NW and ESW whose failure would result in a large scale (greater than 10,000 population loss of supply event post any mitigation available to us). The assets assessed included water treatment works, strategic raw and potable mains, strategic crossings, pumping stations and service reservoirs. The locations assessed were considered to present the highest consequence impact where there is currently no or insufficient mitigation actions available to us. An extract of this analysis is shown in Figure 1

This example shows a number of strategic mains crossings for the Derwent North strategic transfer main. The analysis and report indicate that post mitigation up to 50,000 population is directly at risk of a loss of supply within 8 hours of a catastrophic failure of this main at these locations. This increases to 70.000 after 1 day and 150,000 after 3 days. An event on this scale would exceed our capability to respond with alternative water supplies and would be classed as a major loss of supply event.

Figure 1: Consequence of failure analysis for strategic mains crossings. Resilience Project report, NWL, 2010.

ASSET CONS OF FAILURE	ASSET REF	ASSET TYPE	Normal pop Supplied	Pop at risk post Mitigation after					Mitigation Comments	Area	Supply	Additional Comments	CP0 ID
				8 HRS	1 DAY	3 DAY	TIME TO SUPPLY LOSS	POP SUPPLY LOSS					
W5 - Crossing of A1 Smithy Lane		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North		I00000020420
W5 - Crossing of A167 Durham Rd		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North		I00000020421
W5 - Crossing of A182		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North		I00000020422
W5 - Crossing of A194 Washington		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North		I00000020423
W5 - Crossing of A68 Mosswood		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North		I00000020424
W5 - Crossing of A692 Sunniside/Streetgate		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North		I00000020425
W5 - Crossing of A694 Ebchester		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North		I00000020426
W5 - Crossing of Ebchester Burn		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North		I00000020590
W5 - Crossing of ECML Lamesly		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North		I00000020591
W5 - Crossing of Letch Burn		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North		I00000020592
W5 - Crossing of Minor road Lamesly		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North		I00000020593
W5 - Crossing of River Derwent Ebchester		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North		I00000020594
W5 - Crossing of River Team Lamesley		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North		I00000020595

An initial options appraisal (Figure 2) was also undertaken at this time to identify possible solutions that would reduce or remove the consequence, in this case loss of supply. These options were primarily based on local knowledge with key technical stakeholders representing their respective areas. In most cases options were heavily influenced by the hydraulic capability and capacity of the existing and/or supporting water system.

To aid the review of options, a matrix for each supply area was created linking the critical assets to the identified options. The impact of the option at mitigating against critical asset failure was then identified terms of whether the *Risk Remained*, the *Risk Reduced* or the *Risk Removed*.

In the example above a number of options to reduce or remove the consequence of a failure of the Derwent North strategic mains crossings asset are considered and their benefit assessed. It can be seen that for some options they deliver no reduction in risk, a reduced risk or the risk is removed. Springwell SR was identified as a single option that would remove the risk for a number of sites. It should be noted that the Springwell SR option addressed the risks from a number of other critical assets on this network which we are proposing to address as part of our PR19 resilience plan.

Figure 2 – Options appraisals for strategic mains crossings. Resilience Project report, NWL, 2010.

Derwent North Area Resilience Matrix

	Options	W5-Derwent North (Down-stream Carr Hill Link)	W5-Crossing of A68 Moss-wood	W5-Crossing of Letch Burn	W5-Crossing of Shotley-field Burn	W5-Crossing of River Derwent Ebchester	W5-Crossing of A694 Ebchester	W5-Crossing of Ebchester Burn	W5-Crossing Cut-Throat Lane	W5-Crossing of A692 Sunniside /Streetgate	W5-Crossing of River Team Lamesley	W5-Crossing of Minor road Lamesley	W5-Crossing of ECML Lamesley	W5-Crossing of A1 Smithy Lane	W5-Crossing of A167 Durham Rd	W5-Crossing of A182	W5-Crossing of A194 Washington
Option 1	Springwell Reservoir with appropriate connections into South Tyneside and back into W5 - increased storage in the area; Increase 15" Low Service at Heworth into South Tyneside with connections at DixiLands/Whitemere Pool; Plus Carhill Pumping station.	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed
Option 2	Valves and rider points at crossing	Risk Remains	Risk Remains	Risk Reduced	Risk Reduced	Risk Remains	Risk Remains	Risk Reduced	Risk Reduced	Risk Reduced	Risk Reduced	Risk Reduced	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains
Option 3	Dual Crossings (A68)	Risk Remains	Risk Removed	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains
Option 4	Dual Crossings (R. Derwent and A694)	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Removed	Risk Removed	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains
Option 5	Dual Crossings (River Team and Minor road Lamesley)	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Removed	Risk Removed	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains
Option 6	Dual Crossings (A182 and A194)	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Removed	Risk Removed
Option 7	Duplicate Main using alternative route - Cross A1 at Lamesely - Chowdene Bank - Hertford - A167	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Removed					Risk Remains	Risk Remains

Durham Area Resilience Matrix

This analysis did not consider cause or likelihood of the failure; this would be addressed as part of the development of our tendency to fail analysis.

Tendency to fail analysis / ALFA

Since 2009 Tendency Trees have been embedded within NWL for identifying future issues and prioritising delivery for asset groups which fail very rarely in practice and which have insufficient historical failures to build performance relationships. These

The tendency trees incorporate the physical or operational factors which have a bearing on the likelihood of the failure for an asset. These factors are different for each asset type and failure mode, but may include such parameters as age, material, soil conditions and operating conditions.. The tendency trees have been developed further to incorporate additional data sets and are reviewed with relevant business stakeholders. These reviews determine the appropriate factors and scoring for each failure mode backed up with any new data where available, for example pipe condition assessments.

ALFA (Assessment of Low Failure Assets) is a tool that allows us to incorporate tendency trees and consequence of failure data to provide a risk score. The tendency to fail score provides an indication of the likelihood that an asset will fail in the future based on physical and operational factors. The factors scores and weightings were calibrated using condition data. The tendency to fail score is combined with the consequence of the failure to determine the theoretical risk score, primarily based on the number of properties affected.

Figure 3 shows an extract from the ALFA database highlighting the River Team Lamesley crossing as shown previously with a TTF score of 7.2. TTF scores for the 1772 strategic mains crossings assessed across NW range from 8.56 to 0. River Team Lamesley strategic crossing is ranked in the top 10% of our highest risk crossings based on TTF analysis.

Figure 3 – Extract from the ALFA database for River Teams strategic mains crossing

Crossing.Id	Name	MainId	Length	Materia	Material.Band	TTF.2017	syszone	corr_fe	shrswel	Location	NET_FUNC
ANW-XNG700329	RIVER TEAM LAMESLEY	WTE-MN568130	2477.23	ST	Steel	7.2	SZ10	Moderately Aggressive	high	RIVER	TRUNK
ANW-XNG701452	HIGH TEAM BRIDGE	WTE-MN1347307	29.44	CIPU	Cast Iron	6.31	SZ06	Non-aggressive	low	RAIL	TRUNK
ANW-XNG701326	A184 TEAMS	WTE-MN1343645	116.17	SICL	Spun Iron	5.21	SZ06	Non-aggressive	low	ROAD	TRUNK
ANW-XNG700614	RIVER TEAM	WTE-MN1343641	17.25	CICL	Cast Iron	4.39	SZ06	Non-aggressive	low	OTHER	TRUNK
ANW-XNG700356	EASTERN AVENUE TEAM VALLEY	WTE-MN572537	56	ST	Steel	4.32	SZ06	Moderately Aggressive	high	RAIL	TRUNK

TTF supports our ongoing annual asset maintenance and inspection schedules with any new data identified during asset inspections feeding back into the ALFA analysis tool.

Technical reports and zonal studies

We have also considered a number of recommendations from technical reports and studies we have undertaken over recent years. We have used three technical reports to help inform our PR19 resilience plans, Tees Strategic Network Study (2017), North Suffolk Zonal Study (2012) and Wearside Strategic Storage Study (2016). These technical reports, supported by extensive hydraulic modelling analysis have helped to inform our understanding of system risks, intervention options and the expected benefits from the implementation of the recommendations.

Tees Strategic Network Study

The objective of the Tees Strategic Network Study, completed in 2017 was to understand the long term strategic operation of the network. This will enable us to plan the investment required to deliver industry leading strategic customer service. The investigation and analysis focused upon the strategic mains, water pumping stations, service reservoirs and all their ancillary assets that convey water from our water treatment works to the boundaries of our district metered areas. The Tees Strategic Network Study also covered the raw water assets which transfer to the inlets of our treatment works.

We created a calibrated strategic mains model that encompassed System Zones 14, 15, and 16 and all subsequent analysis was based on ‘average daily’ and ‘peak day’ demand scenarios. We also undertook:

- Supply/demand review using forecasted household and non-household growth within the system up to 2035. This indicated that water demand across the 3 zones is expected to fall by 6.6Mld by 2035 compared to 2017 (Figure 4);
- Deployable output review, linked to the current NW Water Resource Management Plan to determine the ability to meet our future supply demand balance from a raw water perspective;
- Raw water transfer and water treatment capacity review, including identification of any known asset issues at our raw water abstraction and water treatment works that could impact our ability to meet our future supply demand balance;
- Strategic network asset review for all assets in the network including condition assessments where data was available. This review, undertaken alongside asset owners and operators often highlighted significant risks (Figure 5) within the zones that would need to be considered during optioneering.

Figure 4 - Net water demand changes per system zone. Teesside Strategic Network Study, 2017

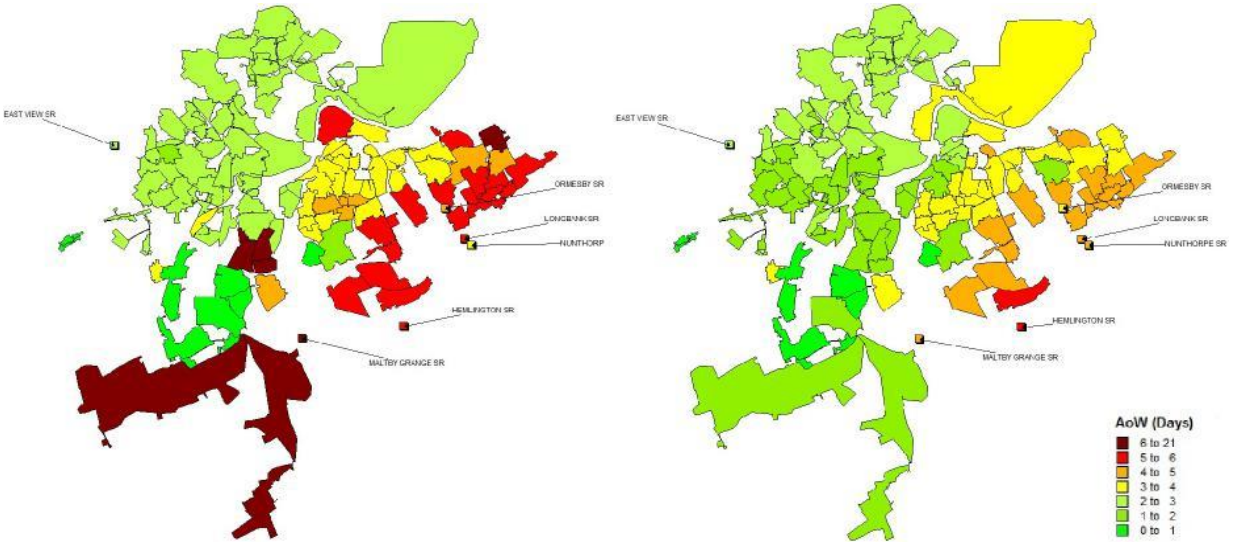
System Zone	Growth (DMAs)	Growth (Ml/d)	Decline (DMAs)	Decline (Ml/d)	Net demand (Ml/d)
SZ14	9	0.07	75	-1.05	-0.98
SZ15	32	0.41	143	-4.01	-3.6
SZ16	1	0.0021	78	-2.06	-2.06
				Total	**-6.64**

Once all the data and information had been collected and analysed we then undertook a significant period of modelling and scenario testing for the Tees network. From the basis of a 'blank canvas' we started to reconstruct the Tees network with key strategic assets and modelled the predicted network performance. We assessed each scenario against performance measures that covered both quantity and quality. These included water age, system pressure and mains velocities that would increase the ability of the network to be self-cleansing wherever practicable.

We also took the opportunity to explore options to rationalise existing assets in the network due to significant overcapacity caused by a decline in heavy industry as well as day to day demand for water. Our approach has identified a number of large network assets that present significant risk to both day to day performance and overall system resilience. We were then able to show the expected performance benefits for each scenario we tested and demonstrate the improvement in the resilience of the reconfigured strategic network. The outputs from this analysis have been used to inform our proposals for the Tees strategic network as detailed in Annex F.

Figure 5 – Evidence of asset condition deterioration of Conduit 3 main. Teesside Strategic Network Study, 2017

Figure 6 – current and future water age profiles for SZ15 showing overall water quality improvement under the proposed network configuration. Teesside Strategic Network Study, 2017



Significant Deterioration	Marginal Deterioration	Unchanged	Marginal Improvement	Significant Improvement

To further test our findings we undertook additional asset failure scenario testing as if the failure occurred across consecutive peak days. This analysis showed that network performance (quality and quantity) was resilient against such events and customer's levels of service were maintained. The failure scenarios we tested included:

- The output at Broken Scar WTW or Lartington WTW being lost;
- A large (above 100Ml capacity) service reservoir operating at 50% capacity due to service reservoir cleaning being underway;
- Reconfigured strategic network was evaluated for its ability to support neighbouring Hartlepool Water and Yorkshire Water through possible new and existing intercompany transfers.

North Suffolk Zonal Study 2012

North Suffolk Zonal Study was completed in 2012 using a similar approach and the recommendations and outputs from that study have led to a number schemes deemed as carrying too high a risk of customer disruption to be completed during AMP6. For our PR19 submission we have identified a number of remaining options as detailed in Annex C from this study which were deemed suitable, that is they met our customers priorities identified during our resilience research and were offered up to customers as part of enhanced resilience investment.

As part of our future long term water quality strategy development we have committed to complete zonal studies for all remaining parts of our water networks, including North Suffolk using the new approach developed for Tees. These studies will help inform our investment decisions both within AMP and as part of future periodic reviews and business plan development.

APPENDIX 3.2
WATER RESILIENCE

Wearside Strategic Storage Study 2011

The high level aim of the study was to achieve the security of supply as required in the NWL Draft E-Spec for Service Reservoir Design in the Wearside supply area (SZ10 and SZ12). The storage requirements were assessed by considering the normal diurnal variation of 6 hours and the capability of the downstream network and alternative supplies to provide a minimum of 24 hours supply to Customers. This may be achieved by a number of options such as replacement of current storage capacity on an existing or new site, new additional storage capacity on a new site/s on an existing or new site or identification of a suitable network solution.

Other project aims were:

- To remove some of NWLs ageing reservoir assets in Wearside if feasible;
- Ensure compliance with Water Supply (Water Quality) Regulations and NWL internal water quality targets;
- Incorporate any impacts of the Sunderland GWS study and any potential overlaps or opportunities for rationalisation;
- Demonstrate an improvement in resilience in the network under emergency conditions.

Recommended outputs from this study (Table 2) identified the need for 77.7Ml of new storage capacity at Springwell would be required in the future (2026 onwards) with an additional 10Ml required at High Moorsley SR.

Table 2 – Program of recommendations, Wearside Strategic Storage Study, Entec, 2011.

Year	Recommendation	Location	NPV Cost
1	Install FPA liner in Downhill 1	Downhill	£305,000
	Install FPA liner in Downhill 2		£260,000
	Install FPA liner in Ryhope	Ryhope	£320,000
	Install FPA liner in Mill Hill	Mill Hill	£500,000
5	Construct 38.5 Ml storage at Springwell to reduce the current deficit.	Springwell	£6,950,000
	Construct new inlet main from Rainton to High Moorsley and outlet mains from High Moorsley to Stoneygate via Rainton to utilise any storage for system zone 12.	High Moorsley	£9,650,000
	Construct 10Ml storage at High Moorsley to reduce the current deficit.		£2,500,000
10	Begin construction of 5Ml storage on the Ryhope site (to maintain storage at Ryhope for local properties). Construction to complete when FPA liner has reached end of useable life (15 yr).	Ryhope	£1,400,000
	Begin construction of 11.55Ml storage at Springwell to replace the majority of storage at Ryhope. Construction to complete when FPA liner has reached end of useable life (15 yrs)	Springwell	£1,860,000
	Begin construction of 14Ml storage at Springwell to replace Downhill 1. Construction to complete when FPA liner has reached end of useable life (15 yrs)		£3,240,000
15	Once construction of 14Ml of storage at Springwell has been commissioned Downhill 1 can be abandoned	Downhill	£120,000
	Replace FPA liner in Downhill 2		£150,000
	Ryhope SR can be abandoned after construction of replacement storage is complete.	Springwell	£155,000
	Decomission Mill Hill 1&2	Mill Hill	£250,000
25	Begin construction of 13.68Ml storage at Springwell to replace Downhill 2. Construction to complete when 2nd FPA liner has reached end of useable life (15 yr)	Springwell	£1,350,000
30	Once construction of 13.68Ml of storage at Springwell has been commissioned Downhill 2 can be abandoned.	Downhill	£61,000
		Total	£29,100,000

The option for High Moorsley was discounted from a cost and hydraulic perspective as it would require a new network pumping station to be built to transfer the water into the Wearside network. This now meant that the best cost option was to construct a new reservoir of at least 87Ml volume at Springwell, Gateshead to address both current storage shortfalls and ensure we maintained system resilience as older reservoir assets came to the end of their working lives which was estimated to be around 2025-2030. Alongside our consequence and TTF analysis the recommendations from this study have supported our resilience plans as detailed in Annex D.

System Planning – managing emerging risk

The Asset Planning and Investment teams ensure a proactive, integrated, consistent and informed approach to decision-making regarding investment into the company's assets. A key role of the Asset Planners and the Investment Planners is to manage the investment planning for all of our company systems. System Planning can be simply broken down in to three stages (Figure 7). They work with operational teams within the business to make sure their issues are understood, prioritised and solutions delivered in a timely manner. This is achieved through use of the AMPS Corporate System and the System Planning process. Issues are also identified and anticipated through the use of computer models maintained by the modelling team. This feeds into investment planning decision making.

A key element of system planning process is regular liaison with other departments. Asset Planners hold local liaison and strategic system planning meetings with operational teams on a regular basis to discuss local issues and understand changes in investment priorities. New issues may be identified or discussed; known issues are reviewed; and queries on risk can be raised. It is during these forums that most new or emerging issues are identified and capture in the AMPS system. A number of our proposed resilience schemes have been identified through this business planning route and are covered in Annex A and Annex E.

Figure 7 – 3 stages of system planning at NW

Issues are also identified and anticipated through the use of computer models maintained by the modelling team. This feeds into investment planning decision making process.

Issue Review

The AMPS (Asset Management Process System) process starts with the identification of an issue from asset owners. The issue is recorded on a CP0 form. Asset Planners review these forms to determine the appropriate investment source (if any). An issue in the context of the asset management process can be defined as a problem that has or will cause the Company:

- to fail to meet target levels of service on a sustained basis;
- to fail to meet target levels of performance on a sustained basis;
- to address an unacceptable level of risk, or;
- an opportunity that will allow the Company to improve performance, effectiveness or efficiency on a sustained basis.

If an issue is relatively simple and non –complex to resolve and fits a pre-defined scope, it can be allocated to an appropriate delivery programme of work. If an issue cannot be resolved through the programmes due to its cost or complexity it is sent to system review. At this stage, asset planners will hold further meetings with stakeholders to better understand the issue and potential solutions. One aspect of this further understanding is the risk-based prioritisation of issues.

APPENDIX 3.2
WATER RESILIENCE

Risk Based Approach

Risk scoring is carried out using a model on the corporate AMPS system. The model calculates a score by looking at consequences of asset failure, the frequency of failure and the probability of failure causing the consequence(s) identified.

There is a set list of consequences to choose from on the model all with detailed background calculations which generate a value. The consequence values are reviewed periodically. They capture ways in which asset failure may directly impact on our customers. Risk scores represent the financial risk to the business for a particular issue. If solutions are known, the risk reduction achieved by implementing this solution can also be determined.

- An assessment of the risk “post intervention” is required for each option
- The difference between this and the “do nothing” risk is the risk reduction that option offers
- When combined with cost estimate data a risk reduction per pound can be calculated
- This is the most cost effective way of reducing risk for an issue.

Risk scores are reviewed periodically to ensure that all risk scores accurately capture the latest situation as likelihood scores will generally increase over time until an appropriate control measure is put in place.

Any scheme identified from our analysis or a technical study that we expect will require capital investment is required to go through our system planning approach and included all the PR19 enhanced resilience schemes. This risk based prioritisation approach allows us to develop and manage our medium term base capital plan ensuring capital investment is prioritised and allocated to the plan based on the best risk return per £ spent. Schemes that are not included in the short term plan are always visible in the AMPS system and are periodically reviewed at system planning liaison meetings as risk factors may change over time. However the business accepts the risk they present to service impact but will manage this through our risk registers and appropriate risk mitigation controls.

The majority of the PR19 resilience schemes are deemed high consequence low probability with substantial intervention costs. These scheme would not normally warrant delivery as part of our base medium term capital plan based on risk reduction benefit per £ spent. However these schemes met our customers’ criteria for additional resilience intervention so were included in our plan.

PR19 system review

To supplement the system planning process a number of strategic workshops were held in preparation for the PR19 plan. These meetings were held company-wide and were facilitated by the Asset Investment teams. Attendees at these meetings were representatives from Operational Teams, Water Quality, Health & Safety, Asset Investment, Strategic Network and Network Control.

These sessions allowed a review of;

- An operational peer review of investment planned for the following two years as part of the medium term capital plan;
- Prioritisation of new or emerging issues that were likely to impact the current medium term plan;

- Likely performance commitment targets between 2020 and 2025;
- Enhanced resilience schemes being considered for AMP7;
- Sites we had deemed as 'too critical to fail' based on the consequence analysis and where additional risk mitigation measures were or should be considered;
- Any areas of overlap or duplication of investment schemes;
- Any other area of concern they may wish to highlight.

Suffolk and Tyne PR19 System Planning meetings, 2017.

Following each session we were able to confirm a list of prioritised investment schemes for inclusion in the AMP7 medium term plan and the ranked order for delivery. The risk from these schemes was considered as medium to high likelihood / medium to high consequence and warranted inclusion onto the medium term plan. It was agreed that other schemes could be offered to customers as an enhancement option or to be held in AMPS and be reviewed on a regular basis to determine if the risk score / risk mitigation measures had significantly changed.

By utilising all the information and technical expertise NWL has been able to identify a number of low likelihood high consequence scenarios that, whilst unlikely could lead to a significant loss of supply event of extended duration and/or significantly impact the quality of the water received by our customers.

Customers have clearly stated that such events, whilst accepting they are unlikely to happen could lead to a significant impact in their water service. This was deemed unacceptable to customers and they expected NWL to address these when it was cost beneficial to do so and within the context of an affordable bill. Customers accepted that if they declined to support such schemes investment from the base capital plan was highly unlikely and the company would continue to manage the risk of service failure as best as possible.

We identified 17 schemes that we felt met this criterion and would be presented as options to our customers for delivery between 2020 and 2025.

Our 2020 to 2025 Plan

Each of our regions faces unique and bespoke risks and challenges but we have been able to identify the highest areas of risk with the largest potential consequence to both the business and our customers. Such events, should the risk materialise will far exceed both our current and future respond and recover capabilities (alternative supply capacity and people resources). The risks we identified from our analysis are primarily based on consequence of failure of an asset (number of customers impacted), asset reliability (tendency to fail), asset and network capacity, asset and network connectivity and an inability to produce sufficient water treated to the required water quality standards. Our ability to respond and recover from such events is likely to take several days before service would be restored. Previous experience from failures of strategic assets indicates a period of 2 to 3 days to restore services to customers from either a repair or temporary fix. Our customers

have clearly stated that events impacting large numbers of customers and over an extended duration of 3 days are undesirable and our customers expect us to be planning to manage such risks accordingly.

Essex Region

- Risk due to emerging changes in catchment quality (turbidity and algae) at Abberton IR impacting our ability to maintain both water quality regulatory compliance and deployable output from Layer WTW which supplies over 420,000 customers;
- Reliance on a third party (EA) to provide emergency raw water transfer capability between the Blackwater catchment and Hanningfield IR. The current configuration means we are unable to fully utilise the resilient raw water resources we now have from an enlarged Abberton to support Hanningfield in the event of resource restrictions or asset failures within the Blackwater catchment;
- Risk to 110,000 customers from a large loss of supply event lasting between two and three days due to the failure of a single strategic main at Herongate SR and we currently do not have a respond and recover capability sufficient enough to respond to such an event.

Our resilience plans to address the risks identified in Essex are covered in more detail in Annex A and Annex B. Herongate proposal, 30m of 900mm duplicate main has been accepted in full by Ofwat on the basis of materiality. No additional information has been provided on this scheme
Our long term plans for the Essex system will be further refined during AMP7 when the 25 year strategic network plans are completed.

North Suffolk Region

- Risk of a large loss of supply event lasting more than three days impacting over 62,000 customers in Great Yarmouth caused by a failure at Ormesby WTW. This is currently the only supply source for these customers and we currently do not have a respond and recover capability sufficient enough to respond to such an event;
- Lack of strategic network transfer capability reducing our ability to fully utilise available treated water capacity in the event of a treatment works outage at Ormesby WTW.
- Risk of a large loss of supply event lasting more than three days impacting over 27,000 customers (some within 20 minutes) caused by a failure at Barsham WTW and we currently do not have a respond and recover capability sufficient enough to respond to such an event;

Our resilience plans to address the risks identified in Suffolk are covered in more detail in Annex C.
Our long term plans for the Suffolk system will be further refined during AMP7 when the 25 year strategic network plans are completed.

Central Region

- Emerging changes in catchment water quality have led to an increase in cryptosporidium risk from Derwent Impounding Reservoir. We now need to achieve 3log removal treatment for Derwent raw water rather than the 2log removal previously. This also reduces our ability to use more raw water from the Kielder system (3log removal required) as we previously able to blend this with Derwent to manage cryptosporidium risk. We are currently managing this risk by reducing the treatment works distribution input. Analysis indicates that the current raw water yield from Derwent IR is such that an increased reliance on Kielder water will be required in order to maintain the works deployable output from Mosswood WTW. This water quality restriction is impacting our ability to maintain both water quality regulatory compliance and deployable output from Mosswood WTW, a single source of supply to over 170,000 customers;
- Risk of a large loss of supply event lasting more than three days to over 170,000 customers currently supplied from Mosswood WTW due to limited strategic transfer capability between neighbouring system zones (Tyne and Tees);

- Risk of a large loss of supply event lasting between two and three days as a result of a failure on the Derwent South main: this strategic main is the single source of water for over 70,000 customers with no alternative supply source other than current reservoir storage capacity [24-36 hours maximum]. We currently do not have a respond and recover capability sufficient enough to respond to such an event;
- Risks of a large loss of supply event lasting between two and three days as a result of a failure of the Derwent North main, this strategic main is the single source of water for 99,000 customers with no direct reservoir storage and very limited alternative supply capacity. This main also has a number of strategic crossings [A1M, A194M, River Teams and East Coast main railway line] and we currently do not have a respond and recover capability sufficient enough to respond to such an event;
- A number of strategic storage reservoirs are approaching the end of their asset life (next 15 – 20 years estimated) so the enhanced resilience plan will need to provide flexibility of operation to manage future uncertainty and risk.

Our resilience plans to address the risks identified in Central are covered in more detail in Annex D, Annex E and Annex F.
Our long term plans for the Central system will be further refined during AMP7 when the 25 year strategic network plans are completed.

Tees

- Poor strategic transfer capability due to asset condition and capacity between Lartington WTW and Teesside presents an unacceptable failure and loss of supply risk lasting between two and three days. 18,000 customers are directly fed off this part of the network and it presents a wider water quality risk to over 255,000 customers on Teesside in the event of an asset failure. The operational constraints in place to manage this risk are restricting our ability to deliver long term resilience and risk reduction in the wider Tees system;
- Limited transfer capacity to utilise the abundant raw water and treatment capacity from our Tees system to support the Central system, specifically the single Derwent South main from Mosswood WTW. This treatment works and the Derwent South strategic main are the single source of water for 70,000 customers with no alternative means of supply other than strategic storage (24-36 hours);
- Poor transfer capability and interconnectivity within the system which is restricting our ability to fully support the entire Tees network from existing treatment sources;
- Risks of a large loss of supply event lasting between two and three days for 27,000 customers in Darlington which are currently supplied by a single strategic main with no alternative suitable supply;
- Overcapacity of existing mains and service reservoirs due to reduced water demand presenting opportunities for long term rationalisation of the network and therefore removal of future capital investment and operational costs.

These areas of risk have been identified as part of the Tees Strategic Network Plan, our approach to developing 25 year long term investment and operational strategies for each of our areas. Each element of our Tees plan is either an enabler to or supportive of other elements of the wider PR19 resilience plan for the north, especially our proposals for Central and the creation of a potable transfer grid by 2045.

Our resilience plans to address the risks identified in Tees are covered in more detail in Annex F.

Tyne

- Risks of a large loss of supply event lasting between two and three days for 43,000 properties currently supplied from a single outlet main at Chirton SR, North Shields and we currently do not have a respond and recover capability sufficient enough to respond to such an event.

Significant investment has already been made in the Tyneside system over the last ten years and there are limited requirements for enhanced resilience schemes at this time. Our long term plans for the Tyne and Northumberland systems will be further refined during AMP7 when the 25 year strategic network plans are completed.

Chirton proposal, 315m of 700mm duplicate main has been accepted in full by Ofwat on the basis of materiality. No additional information has been provided on this scheme.

Too critical to fail sites

- We currently have 63 operational water sites that are deemed 'too critical to fail' and currently directly supply over 942,000 customers with no alternative suitable supply and if any one of these sites failed they would exceed our current respond and recover capability;
- Limited understanding of risk and current resilience against a range of natural and manmade hazards that have the potential to impact the operation of our sites;
- We have a requirement as part of our commitments to Defra to understand our current resilience at these sites and develop a cost beneficial plan to reduce the risk and consequence in the future.

Our approach, including our proposals to manage or mitigate the impact from these hazards is covered in more detail in Annex G.

Option appraisal

In 2017 75% of our customers indicated a level of trust in NWL to just deal with the issues and risks that impact our ability to deliver water services that meet the needs of current and future generations in a changing world. We have therefore made sure that schemes we have proposed meet the priorities and expectations of both our regulators and our customers and can be demonstrated to be cost beneficial in regards to the whole life cost of the scheme and the resilience benefit delivered. The option of 'do nothing' for these specific schemes were therefore not considered appropriate.

Schemes have been shortlisted for inclusion in enhanced resilience plans based on our technical appraisal, technical studies and reports as well as our understanding of current asset, site and system risk and base resilience. This has included the use of pipeline condition assessments, failure history, in house technical knowledge as well as potential population size impacted to determine our highest resilience risk schemes.

Some schemes did allow for optioneering and we used a whole life cost Totex approach to determine the optimal solution for both the business and our customers. Full details of all the options considered as part of developing our resilience plan are shown in Annex A to G. Examples included:

- New transfer capability between Tees and Central; options included a choice of 600mm, 800mm and 1400mm gravity mains and/or a water pumping station. Cost estimates ranged from £180m (full gravity transfer) to £67m (mix of gravity and network pumping). Using estimated annual opex costs it was determined that the option of including additional network pumping capacity offered the best value for customers even though it would increase energy consumption and therefore have a larger carbon footprint over the next 25 years;
- Abberton raw water transfer main; an option was to formally adopt and operate the Ely / Ouse Essex Transfer Scheme (EOETS), including the existing river transfer stations at Kennet and Wixoe. This scheme and associated assets are currently owned and operated by the Environment Agency. This option was discussed by our Board but discounted as the EOETS would not prevent the imbalance in Hanningfield and Abberton Reservoir storage in dry years

whereas the proposed pipeline will by transferring raw water from Abberton to Hanningfield WTW where we have spare treatment capacity. An alternative to the Abberton pipeline was increasing the capacity of Layer WTW to 165Mld; however, this would be significantly more expensive compared to the preferred pipeline / utilisation of existing treatment capacity option. Appropriate environmental assessments will be undertaken including Water Framework Directive 'No Deterioration' assessments which will cover, among other aspects, the risk of transferring Invasive Non-native Species (INNS) and a Habitats Regulation Assessment (HRA).

We have incorporated the PR19 Ofwat enhanced resilience guidance within our own methodologies for scheme verification to ensure resilience enhancement funding is additional to base totex. Where we are proposing the replacement of an existing asset we will calculate the current base level of service this asset provides to customers and only seek enhanced funding for the additional benefit above this base position if this can be readily determined. In addition we must ensure we make consideration for any additional benefit to current and future PCs so that customers only fund the improvement to system resilience through enhanced funding or through an ODI incentive.

For natural and manmade hazard risks, sites were selected that should they no longer be available to support the network the number of customers who would lose supply would exceed NWL's current respond and recover capabilities. Risks were prioritised at these sites following the methodology developed by Arcadis and United Utilities and recognised by Ofwat as an example of good practice. Arcadis have supported NWL in developing the approach to carry out site risk assessments and develop a base and future resilience metric to measure improvements in resilience at sites for specific hazards. From these assessments a prioritised program of optioneering based on risk and likelihood has been developed and ensures we deliver the best resilience benefit per £ spent. In addition, we made sure the identification and appropriate allocation of funding of enhanced resilience schemes aligned to the definition received from Ofwat's Principal Costs and Charging Analytics. This ensured the correct apportioning of costs between base and enhanced capital funding has been applied.

Costing of Options

To estimate the Totex enhancement cost associated with the PR19 business plan submission we have taken four primary approaches to scheme costing, including the allocation of a RAG assessment score as described below:

1. Full iMod cost estimate using business as usual processes

    a) Green - Cost Estimate has been produced using iMod, utilising Engineering Scoping Engine and Costing Database
    b) Amber - Cost Estimate has been largely produced using iMod, utilising Engineering Scoping Engine and Costing Database, with partial costs from other sources
    c) Red - Not Applicable - Approval processes built into iMod would ensure that no RED estimates could be produced

2. PR19 Costing Tool created from iMod base estimates

    a) Green - Cost Estimate has been produced using PR19 Costing Tool and has been correctly applied
    b) Amber - Cost Estimate has been largely produced using PR19 Costing Tool, with partial costs from other sources, and has been correctly applied
    c) Red - PR19 Costing Tool has been used, but not correctly applied

3. Traditional unit rate build up estimates

a) Green - Unit rates are valid historical NWG costs or current Framework Rates and the rates build up is sufficient and appropriate to the scope
b) Amber - Unit rates are largely valid historical NWG costs, current Framework Rates or Industry available rates and the rates build up is sufficient and appropriate to the scope
c) Red - No cost evidence available for rate source and/or rates build up is insufficient or does not appropriately reflex anticipated scope

4. Assessment and forecasting of historical spend

a) Green - Historical spend in relevant area has been assessed and appropriately applied in forecast calculation
b) Amber - Historical spend in similar area has been assessed and appropriately applied in forecast calculation
c) Red - No cost evidence available and/or inappropriately applied in forecast calculation

Whilst the Cost Assurance team will use the most appropriate costing method for each scheme the default position is always to use a full iMod estimate or iMod based tool where possible as this best reflects NWG's business as usual cost estimating process.

iMod

iMod is a Client focused Engineering Scoping and Cost Estimating software system, developed for Northumbrian Water, bringing project scope definition, whole life costing and tender evaluation together in one integrated system. iMod comprises a suite of 50 engineering scoping models and a cost database, which with a minimum of input criteria that is readily known at project inception, can provide a detailed CAPEX, OPEX and whole life costing for a range of business issues. Supplier tender submissions can be entered directly into the system to allow tenders to be automatically checked against the iMod asset based cost database, enabling tender evaluation to be carried out with a limited resource requirement as well as providing an enhanced confidence in a project's affordability. On completion outturn costs are captured in the system as part of the agreed project closeout procedure.

The purpose of iMod is to form the cornerstone of our Capital Delivery Model allowing us to embed a 'should-cost' culture as the entry point to working collaboratively with our delivery partners. It also supports Northumbrian Water's strategic outcome to ensure that our finances are sound, stable and achieve a fair balance between customers and investors.

iMod CAPEX Cost Estimating

The iMod system uses a Process and Component costing hierarchy. The relevant processes are selected for each estimate, with the engineering scoping model run for each process. This produces a quantified Work Breakdown Structure (WBS), with detailed attribute tags, with costs applied via the iMod cost database. The process models are then supplemented with individual components and/or unit rates to complete the estimate as appropriate.

Contract overheads are then applied from a selection of 19 sub-categories that are chosen based on site specifics or work type specific considerations. Each sub-category consists of historical data cost curve and is generated using the value of the measured works. Project overheads are then applied to the combined value of the measured works and the contract overheads, based on a selection of 21 sub-categories.

All cost estimated have been produced using APG specific cost curves for Process, Component, Contract and Project Overheads.

PR19 costing tools

PR19 Totex costing tools have been created specifically for the Water Treatment and Waste Water Treatment enhancement schemes. The costing tools consist of tables where the user can input individual site data, giving site specific yardsticks (i.e. PE or M/ld) and can then select which processes will be required to fulfill the enhancement output needed. The tool will then calculate the Totex costs for the specific site. The costs are generated from a series of PR19 specifically generated cost curves, which are based on estimated points. These estimated points have been produced using the iMod system previously described, using NWG's business as usual estimating processes.

Unit costs build up

Traditional unit cost build up have been carried out for enhancement areas where either iMod system does not have coverage or is not appropriate. In this approach traditional bills of quantities have been produced and costed using unit cost rates. Unit cost rates have been sourced from the following:

- Actual historical costs
- Framework rates
- Industry Data (SPONS etc)
- Quotes

The above list order represents the order of preference that has been applied to the selection of rates used for costing. Contract and Project Overheads have been applied using the same methodology as previously described.

OPEX costs have not been calculated for the enhancement areas where unit costs have been used as it has been assumed that there would be no significant increase in OPEX costs in the areas applied.

Historical spend

For issues not covered by the previous costing methodologies, a historical spend approach has been used. Assessments of historical spending for programmes of work or unit costs have been completed, benchmarked and applied to forecasts of the activities proposed in PR19.

PR19 Scheme costs

All PR19 water resilience schemes have been costed following the costing approach described previously. We have applied a RAG score for each scheme depending on the costing approach selected as the most effective summarised in Figure 8 below. This assessment has indicated that the majority of our scheme costs are 'Green' status and the unit rates we have used are cost efficient. Where costs are classed as Amber then we have less certainty on the unit costs and these carry a degree of risk in terms of both the deliverability of the schemes for the costs requested and the efficiency of the unit cost. However these schemes, totaling £11.2m of the total resilience plan of over £163m represent around 7% of the total programme costs. Any actual cost variance to deliver these schemes is unlikely to be material to the delivery of the overall 2020 to 2025 resilience and raw water deterioration plan and our proposed incentive mechanism protects customers in the event of late or non-delivery.

Figure 8 – Water resilience schemes - Cost assessment summary

Title	AMP7 Totex [£m]	Cost Assurance Methodology	Cost Assurance RAG
Undertake a hazard risk assessment at 63 'too critical to fail' (TCTF) sites [natural and man-made hazards]	£8,340,000	2. PR19 Costing Tool created from iMod base estimates	Amber
Teesside System Resilience Project - Replace 37.5km of 600mm with single 800mm St main	£14,080,000	1. Full iMod cost estimate using business as usual processes	Green
Teesside System Resilience Project – Lay 16km of 800mm main from Whorley to Shildon	£19,200,000	1. Full iMod cost estimate using business as usual processes	Green
Teesside System Resilience Project - New inlet/outlet arrangement at Maltby SR	£5,400,000	1. Full iMod cost estimate using business as usual processes	Green
Teesside System Resilience Project - Abandon Uplands WBS	£60,000	1. Full iMod cost estimate using business as usual processes	Green
Teesside System Resilience Project - Abandon Long Newton SR	£240,000	1. Full iMod cost estimate using business as usual processes	Green
Teesside System Resilience Project - Abandon South Lackenby SR	£240,000	1. Full iMod cost estimate using business as usual processes	Green
Teesside System Resilience Project - Mods to Ormesby WPS	£160,000	1. Full iMod cost estimate using business as usual processes	Green
Teesside System Resilience Project - Cross connections into C60/60a for Darlington	£210,000	1. Full iMod cost estimate using business as usual processes	Green
Central System Resilience Project - Springwell SR -62Ml capacity	£16,200,000	1. Full iMod cost estimate using business as usual processes	Green
Central System Resilience Project - 1.5km of 600mm main Carr Hill Link to Springwell SR	£3,000,000	1. Full iMod cost estimate using business as usual processes	Green
Central System Resilience Project - 7km of 1000 mm main from Springwell to Pikes Hole	£14,860,000	1. Full iMod cost estimate using business as usual processes	Green
Central System Resilience Project - 2 x 600mm EOV @ Pikes Hole and Wash West	Inc in above	1. Full iMod cost estimate using business as usual processes	Green
Central System Resilience Project - 2 X 400mm EOV @ Heworth	Inc in above	1. Full iMod cost estimate using business as usual processes	Green
Central System Resilience Project - 4km of 1000mm main between Heworth and Pikes Hole	£8,520,000	1. Full iMod cost estimate using business as usual processes	Green
Central System Resilience Project - Install new UV treatment at Mosswood WTW to manage Kielder crypto risk	£7,900,000	3. Traditional unit rate build up estimates	Green
Central System Resilience Project - New 55Ml WPS at Shildon SR [Option 2 - Tees Resilience]	£3,160,000	4. Assessment and forecasting of historical spend	Amber
Tyne System Resilience Project - 315m of 700mm main to duplicate	£400,000	1. Full iMod cost estimate using business as usual	Green

Chirton SR outlet main		processes	
Suffolk North System Resilience Project - Enabling mains schemes at North Cove and S Lowestoft	£4,100,000	1. Full iMod cost estimate using business as usual processes	Green
Suffolk North System Resilience Project - New treated water storage and WPS. Need to move existing pumping station to tie into new service reservoir	£10,440,000	1. Full iMod cost estimate using business as usual processes	Green
Essex System Resilience Project - Abberton to Hanningfield RW transfer main at 50 Mld capacity	£20,356,853	1. Full iMod cost estimate using business as usual processes	Green
Essex System Resilience Project - DAF treatment at Layer WTW [assume its to 145Ml DO]	£26,870,000	1. Full iMod cost estimate using business as usual processes	Green
Essex System Resilience Project - 30m of 900mm main @Herongate SR	£230,000	1. Full iMod cost estimate using business as usual processes	Green
	£163,966,853		

As stated in the Business Plan (p236) we are also proposing an additional 1% pa efficiency target for our enhancements.

Third party assurance

In January 2018, Northumbrian Water Group (NWG) commissioned Mott MacDonald Ltd (MML) to carry out technical and cost assurance assessments across its resilience and Water Industry National Environmental Programme (WINEP) investment areas in readiness for the PR19 Business Plan submission to Ofwat in September 2018. The purpose of the assurance work was to provide confidence that NWG has developed the programmes for these enhancement areas in line with the requirements set out in Ofwat's PR19 methodology released in December 2017.

NWG requested that an additional criterion be added to the assessment associated with whether expenditure was enhancement and not base, and where there is overlap with base (e.g. where the enhancement provides a capital maintenance benefit) that expenditure is appropriately allocated.

MM has reviewed NWG's approach to internal cost assurance *(*PR19 Enhancement Programme Business Case Assurance Summary Report, Mott Macdonald September 2018*)* and found it to be consistent with good industry practice. They have concluded that:

"NWG have developed enhancement business cases to address Ofwat's criteria2 around the need for investment, justifying that it is the best option for customers, demonstrating robustness of costs and ensuring protection of customers. Our review of NWG's cost estimating approach found that it was in line with the industry and our review of NWG's internal cost assurance found that cost estimates are mostly robustly justified, with the internal cost assurance identifying that less robust estimates are confined to only 6% of costs".

Specifically for the water resilience plan MML rated the robustness and efficiency of our scheme costs as 'Green' based on their scoring criteria with supporting commentary to support the conclusion as shown in Figure 9.

Figure 9 – Extract from Mott Macdonald PR19 Enhancement Programme Business Case Assurance Summary Report, 2018 showing assessment of resilience enhancement costs

	2.5 - Has the impact on natural capital and the environment been considered?		It is unclear how environmental impacts have been considered within optioneering. In section 7 (Consistency with the rest of the BP) it states *"both customers and the local environment benefit in the long term as we manage the use of our natural capitals to manage future water demand whilst accommodating economic growth within our region"*. But this is only applied to Essex. You could improve this plan by addressing Ofwat's principle: - A naturally resilient water sector - by giving more clarity to how natural resilence approaches are included in the planning apporach, both in water resource management and in flood resilience. In addition, there is no mention of collaboration with other stakeholders or partners (e.g. EA, FCRM, RFCCs) in planning to address environmental impacts or flood risk management.
3. Robustness and efficiency of costs	3.1 - Is there persuasive evidence that the cost estimates are robust and efficient?		Business case briefly summarises the costing methodology and Indicates that the costs were assured by the cost assurance team. NWG cost assurance team assessed costs as predominantly green, with 7% of costs assessed as amber. Evidence needs to be reflected in the business case.
	3.2 - Is there high quality third party assurance for the robustness of the cost estimates?		Third party assurance of approach and selected unit cost models has been conducted by MM. NWG internal assurance on costings has been conducted and this has been subject to third party review by MM. NWG cost assurance team assessed costs as predominantly green, with 7% of costs assessed as amber. There is reference made to third party assurance in this business case.
	3.3 - Is evidence provided that expenditure is enhancement, not base, and where there is overlap with base (e.g. where the enhancement provides a capital maintenance benefit) then expenditure is appropriately allocated		The business case explains that the objective is to achieve enhanced water service resilience. The business case states that where an existing asset is being replaced then the enhancement funding sought only relates to the enhancement over the base service provision. This is explained in Section 7.
4. Customer protection	4.1 - Are customers protected if the investment is cancelled, delayed or reduced in scope?		Table 8 summarises how customers will be protected in the event of a delayed or cancelled investment for each of the proposed schemes. NWG is proposing a scheme specific performance commitment that will protect customers against late or non-delivery of the enhancement schemes. If delivery is late, or does not occur at all, a penalty will be calculated based on the NPV of the difference in cash flows compared to on time delivery.

Benefits assessment

Having a more resilient water network reduces the risk of a long-term supply interruption, which has benefits to both households and businesses, including the ability to continue operating business as usual, not paying for additional bottled water and no inconvenience. It also reduces the risk of water quality incidents and increases our capacity to respond to events to a greater extent than under business as usual investments needed to meet our performance commitments.

Therefore the benefits from the resilience programme comprise not just the benefit of avoiding the losses associated with severe risks but also the benefit of reduction in risk for household and businesses, including the greater customer confidence that this generates. This is consistent with the World Bank research into resilience (2015)[11] that identified i) avoiding losses and ii) unlocking economic potential through addressing risk concerns as two of the three main areas of benefits from improved resilience.

However, estimating the benefits presents a challenge. The benefits depend partially on how much customers would pay to avoid an event and this is difficult for customers to accurately define. It is also necessary to estimate the losses that will occur if an event happens, and these depend on several sensitive variables such as average earnings and the cost of time spent as a consequence of an interruption (i.e. travelling to obtain bottled water or to a friend or relative for bathing).

The biggest hurdle for estimating how much customers value a lower risk of severe events is that these events occur very infrequently, but when they do the impact is very high. It is well understood that customers find it difficult to engage with the concept of risk, in terms of engaging with probabilities and percentages. Behavioral economics has shown that customers struggle to move from a small probability to an even smaller one and that people tend to overestimate the scale of small probabilities and give them too much weight in making decisions[12]. Customers without direct experience of an event such as a long-term supply interruption are unlikely to have a good understanding of what the impact will be on them, or what the response from the company should be.

Behavioral research has shown that people systematically underestimate the impact on them from a hypothetical situation, and that prior experience can determine responses[13]. The long-term nature of resilience also acts as a barrier as we cannot communicate with all customers who may benefit from the enhancement, as we can only engage with current customers. Current customers are therefore being asked to value improvements that they know will affect not just them but future generations of customers too. These issues mean that the results of traditional, stated-preference surveys in relation to resilience improvements should be used carefully. Ofwat acknowledges the potential issues with WTP surveys in this regard but also that they remain an important and valid source of evidence.

Given our approach has been to consider the widest possible range of evidence we have considered evidence from previous WTP surveys, our PR19 customer engagement on resilience improvements and evidence from previous incidents.

Scale of potential impacts

Our approach to estimating resilience benefits considers:

- The consequences of severe events lasting three days or more;
- Evidence on customers valuation of risk reduction and overall resilience improvements;
- The value of risk reduction, customer support for the proposed solutions and evidence from WTP surveys from PR14.

[11] World Bank (2015), The Triple Dividend of Resilience https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/10103.pdf. As cited in Ofwat's Resilience in the round (2017) https://www.ofwat.gov.uk/wp-content/uploads/2017/09/Resilience-in-the-Round-report.pdf

[12] For example, see Burns, Chiu and Wu, 2010, Overweighting of Small Probabilities

[13] Cameron and Englin, 1997, Respondent experience and contingent valuation of environmental goods

Consideration of the scale of consequences is useful given the evidence that customers find it difficult to engage around probabilities. There are data issues in estimating consequences, for instance in terms of loss of earnings, but it is possible to estimate indicative figures for this as we outline in the following section.

The only large scale supply interruption in the UK in the last 15 years occurred at Mythe, Gloucestershire in 2007, when 130,000 homes and businesses were without mains water for six days. In its report on the 2007 summer floods the EA stated that the impact of customers from the water shortages was in the order of £25 million (around £31 million in today's prices). This is equivalent to £40 per property per day of interruption. Such an event would likely result in the closure of schools and many businesses with a consequent loss of earnings as individual's place of employment are closed or they have to take time-off to care for children. Furthermore, customer's face additional disruption in terms of collecting bottled or alternative water supplies, travelling to friends or relatives for bathing and general inconvenience.

Table 3 below illustrates the potential scale of impact for a six day interruption affecting 100,000 properties. This illustration gives a range of £31 to £51 per property per day. Although we make a number of assumptions the figures are consistent with those stated in the EA report for Mythe and in our view provide a reasonable, if not conservative estimate for the impact on customers. For example, although we have included loss of earnings we have not allowed for the additional loss of turnover and profits for businesses that are affected or wider socio-economic and environmental costs due to localised disruption to strategic transport corridors and longer commuter journeys.

Although not a supply interruption incident, the cryptosporidium incident in United Utilities' area in 2015 also illustrates the material consequences of a severe risk incident. The contamination of the water supply at Franklaw resulted in a boil water notice affecting 300,000 properties for up to 30 days. This resulted in United Utilities having to pay compensation to customers of £20 million.

This evidence shows that the scale of impact of a severe event can be very large and run into the tens of millions of pounds.

Table 3: Illustration of potential financial impact on households from long-term interruptions to supply

Impact	Low	High	Notes
Earning days lost per working household	2 days	3 days	Assumption for 6 day interruption
Average daily earnings	£110	£110	ASHE data for north and south areas of NWL
% working households	76%	76%	Labour force statistics
Loss of earnings	£12.3 million	£18.5 million	
Additional inconvenience per property per day	£10	£20	Assumption. For example the GSS payment for interruption is £20 per day for households and £50 per day for businesses.
Total impact	£18.3 million	£30.5 million	Loss of earnings and inconvenience
Impact per property per day	£31	£51	

Customer valuation of risk reduction

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There has been limited customer research specifically asking customers to value a reduction in risk of a long-term interruption, perhaps due to the difficulties in framing the research outlined above. Using the Accent report of the comparison of PR14 customer research[14], it shows that one company asked its customers to value reducing the number of properties at risk of an unexpected interruption of between one day and seven days. The resulting valuation was £29 per property per year where the risk was removed. This would translate to £31 in today's prices using CPI inflation.

In equivalent expenditure terms this implies that customers would support an expenditure level of £800 per property to reduce the risk of long-term supply interruption. This assumes an average asset life of 60 years and a rate of return of 3.4%. This figure is substantially higher than the cost per customer benefitted shown in Table 10 indicating that customer benefits from our proposed resilience schemes are greater than costs.

This antidotal evidence indicates that customers place a high value on resilience services and avoiding risks of severe events, even when the probability of these events is very low. This ties in with behavioral insights that customers are generally risk averse and is consistent with the other evidence presented here.

Customer support for resilience investment – PR14

At PR14 NWL conducted WTP research that included questions about investment to improve water resilience. Customers were presented with the following information (this example for the northern area).

"Many communities in the region can be supplied with water by more than one route. If there is a failure on their normal supply route, a burst water main for instance, Northumbrian Water can usually either:

- *Supply them by a second route*
- *Repair the damage without causing any interruption to supply or only a short interruption lasting a few hours.*

However, an extreme event such as exceptional flooding, a train derailment or terrorist destruction could destroy part of the system. This would leave communities with only one supply route without a mains water supply for a number of days. Most customers would need to walk/drive to a distribution station to get water, although Northumbrian Water would deliver water to the housebound and those with special needs. Only one event of this type has happened in the UK in the last 10 years, at Mythe in Gloucestershire, when 130,000 homes and businesses were without mains water for six days.

Respondents were asked to indicate their willingness-to-pay to reduce the number of communities exposed to this level of risk. Across the two areas customers were prepared to pay £16.4 million (£17.6 million in today's prices) to reduce the number of communities exposed to this risk from nine to zero. Using the same assumptions on asset life and discount rate as above this would imply a NPV of benefits of £448 million over 60 years. Assuming an average of 50,000 properties per community protected this implies a benefit per property of just under £1,000.

At PR14 five other companies used WTP surveys to estimate the value of reducing an unexpected long-term supply interruption. The values per property interrupted ranged from £404 to £16,391 with a median value of £1,116 (in today's prices), close to the value obtained by the NWL research. Again these figures are much higher than the cost per property for the proposed schemes as shown in Table 10.

Customer support for resilience investment – PR19

[14] Accent, Comparative Review of Willingness to Pay Results, Final Report, October 2013.

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We have undertaken extensive customer engagement as we have developed our proposed resilience schemes as part of the PR19. Having established that resilience was a strong customer priority we developed our enhancement plans based on these priorities and expectations and presented the specific discretionary resilience enhancement schemes to customers. Discretionary investment is considered where customers have a choice as to whether they pay for additional levels of service, in this case resilience or not.

The information presented includes scheme details, customer benefits, cost to deliver and overall impact on their 2020-2025 bills, summarised in Table 4 and Table 5.

Table 4: Northumbrian Water discretionary resilience enhancement proposals

Northumbrian Water proposal [Water]	Scheme cost	£ on each customers' bill	% on the average customers' bill
Our plans for Tyne area	£500,000	£0.03	0.01%
Our plans for Tees area	£29,000,000	£1.59	0.41%
Our plans for Central area	£47,000,000	£2.57	0.66%
Our plans for sites too critical to fail	£5,000,000	£0.27	0.07%
Water total	**£81,500,000**	**£4.46**	**1.15%**

Table 5: Essex and Suffolk Water discretionary resilience enhancement proposals

Essex & Suffolk Water proposal	Scheme cost	£ on each customers' bill	% on the average customers' bill
Our plans for Essex area	£40,000,000	£3.63	1.48%
Our plans for Suffolk area	£13,600,000	£1.24	0.50%
Our plans for sites too critical to fail	£5,000,000	£0.45	0.19%
Water total	**£58,600,000**	**£5.32**	**2.17%**

This information was presented alongside other discretionary investment options such as wastewater resilience (NW only), smart meters and cyber security. This enabled customers to understand the impact on their bill from all discretionary schemes being offered so they were able to make an informed decision when voting. The results of the customer votes on our proposed resilience schemes are summarised in Table 6 and Table 7.

Table 6: Results for each individual water scheme from Northumbrian Water

Northumbrian Water proposal [Water]	Yes	No	Unsure
Our plans for Tyne area	84%	6%	10%
Our plans for Tees area	90%	6%	4%
Our plans for Central area	92%	2%	6%
Our plans for sites too critical to fail	90%	0%	10%
All water schemes as a package	94%	0%	6%

Table 7: Results for each individual water scheme from Essex and Suffolk Water

Essex & Suffolk Water proposal	Yes	No	Unsure
Our plans for Essex area	89%	7%	4%
Our plans for Suffolk area	100%	0%	0%
Our plans for sites too critical to fail	100%	0%	0%
All water schemes as a package	96%	0%	4%

To express these results in terms of cost and benefit terms we have translated the research results in to benefit-cost ratios. To do this we assume that the 'demand curve' is linear and we consider price elasticities ranging from 0.5 (inelastic) to 2.0 (elastic). These results are shown in Table 8 and Table 9.

Table 8: Benefit-Cost Ratios for each individual water scheme from Northumbrian Water

Northumbrian Water proposal [Water]	Low	High
Our plans for Tyne area	1.23	1.93
Our plans for Tees area	1.23	1.93
Our plans for Central area	1.24	1.98
Our plans for sites too critical to fail	>1.25	>2.00
All water schemes as a package	>1.25	>2.00

Table 9: Benefit-Cost Ratios for each individual water scheme from Essex and Suffolk Water

Essex & Suffolk Water proposal	Low	High
Our plans for Essex area	1.23	1.92
Our plans for Suffolk area	>1.25	>2.00
Our plans for sites too critical to fail	>1.25	>2.00
All water schemes as a package	>1.25	>2.00

The tables show that all of the proposed elements of the programme have very strong support from customers and implied benefit cost ratios of materially over 1.0. In most cases the higher benefit-cost ratio is equal to 2.0 which is the maximum possible given the assumed elasticities.

Summary of benefits evidence

We have considered a wide range of benefit evidence that supports the proposed programme of enhanced resilience investment.

- Evidence on the consequences of a severe incident. The limited evidence from previous major incidents in the UK and illustrative assessment of the impact in NWL shows that the financial consequences of a severe water supply incident that affects a large community could easily run into the tens of millions of pounds. This does adjust for the low probability of such events but, given the challenge of incorporating low probabilities into the research, it is valid to highlight the scale of the potential impacts.
- Evidence of WTP surveys. Looking at the evidence of previous WTP studies, updated to today's prices, indicates a benefit valuation in the order of £800 to £1,100 per property protected from the risk of a severe incident. This is substantially higher than the cost per property of our proposed programme. We acknowledge the potential limitations of survey evidence in this area, but the scale of the results suggest that customers place a high value on reducing the risk, even when the probabilities are low. Even the lowest value from any of these studies, at £404 per property would indicate support for the schemes proposed.
- Finally, there is overwhelming customer support for these schemes in the customer research undertaken for PR19. This research has been undertaken on small sample groups but with detailed information about the costs and benefits of the programme. The level of support has been consistent and compelling across the different regions.

Taking account of all of the evidence there is a clear conclusion that the proposed schemes are cost-beneficial as shown in Table 10. We are therefore assured that our discretionary enhanced resilience plans meet our customers' expectations and priorities, are fully supported and cost beneficial for our customers.

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Consistency with rest of the Business Plan

We have identified one scheme where a combination of base and enhanced funding is required, the replacement of 75 km of trunk mains in Teesside. We have made an allowance to differentiate between current base performance of the assets (mains have a current carrying capacity equal to a 600mm main) against the enhanced resilience and performance of the new replacement asset (an 800mm main). Customers only pay for the additional enhanced benefit (+200mm) and not for base. In the case of the pipeline this means around £31m of cost will be funded from our base 2020 -2025 capital plan and £14m as enhancement funding.

We have applied this approach across all the investments proposed to ensure customers only pay for the benefit once and this is the only scheme where we consider this base/enhancement cost split applies.

While we recognise that these solutions will have a positive impact on future service performance, particularly in relation to supply interruptions and water quality incidents we are confident that no double counting has occurred since the risks that these investments address have not occurred in the recent past and are therefore not reflected in current or proposed performance levels – in other words the investments will not result in expected rewards for NWL between 2020 and 2025 since the PCs are based on historic performance and industry leading comparisons. Indeed if these risks did materialise before we had completed the schemes then the company would likely face adverse financial impacts in the form of our proposed AMP7 ODI penalties and other financial compensation.

We have also allowed and accounted for the impact of short and long term growth within our networks when developing our plans. Where we have identified that a scheme addresses both growth and enhanced resilience we have ensured costs are captured and assigned correctly. This situation exists in our plans for improving strategic network transfer capacity for North Cove in Suffolk where the total resilience scheme will also eventually support future development in this area. The full scheme cost of £3.6m has been allocated to enhanced resilience as the primary purpose of the investment is improving network resilience that will benefit existing customers. £1m of potential mains reinforcement, paid for by the developer has been removed from our growth scheme list and developers will therefore only contribute towards site connection charges rather than for significant mains reinforcement

Solutions for longer term growth have also been considered in our proposals for improving raw water transfer capability in Essex ensures we are able to fully utilise existing treatment capacity to meet future forecasted growth in North Essex for the next 25 years without the need for additional resource or treatment capacity. This makes sure that both customers and the local environment benefit in the long term as we deliver a naturally resilient water sector across Essex that manages the impact of future water demand from accommodating economic growth with no detrimental impact on the natural environment.

Incentivising Delivery and Protecting Customers

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed. To protect our customers we will apply a penalty rate for underperformance against this enhancement. As this enhancement targets a specific output by a date in the future, we have based our penalty on a per day late of delivery basis. This uses the same principle as our Performance Commitment for R-F1 Delivering a consolidated customer information and billing system, penalty rate 2 at PR14.

Any penalty will be calculated as a net present value neutral adjustment as part of the PR24 true up process of the relevant 2019 Final Determination cash flows should the outcome be delivered late, partially or not at all. The discount rate used will be 3.3% real, the CPIH stripped cost of capital.

Additionally a number of the resilience schemes have full DWI support and the raw water deterioration schemes have support in principle pending further assessment by DWI. All DWI supported schemes will be transferred into legally binding programmes of work. Milestones will be agreed with DWI in due course and annual reports will be provided documenting progress.

Further details of our enhancements delivery incentive mechanisms are included in Chapter 4: Measuring and Incentivising Success of our final business plan.

A number of the schemes are significant civil engineering projects and early planning and design are essential in order to complete them by 2025. None of our schemes meet the NCIP criteria and will therefore need to follow standard planning rules. We have started early involvement of our delivery framework partners in discussions on planning, including land requisition / access and overall project delivery.

This early engagement is required to ensure we not only deliver this significant amount of additional investment by 2025 as planned but also are able to deliver our 2020-2025 base capital investment plans as well.

Cost benefit profiles

A summary of the discretionary PR19 resilience programme costs, risk reduction, resilience benefit and number of customers benefiting is shown in Table 10. Scheme cost per customer benefiting ranges from £2.09 per customer to £426.56 per customer. The median cost per customer benefitting is £48.15.

The range of costs is due to the schemes we have proposed, from significant capital schemes to smaller, more targeted interventions. All our schemes will reduce or remove the risks we have identified, reduce the likelihood of a three day plus loss of supply event impacting over 2.2m of our customers and improve overall system resilience and security of service to our customers.

Overall we believe our plans provide our customers with the right balance of risk reduction and customer affordability. Costs per customer benefitting are also well within the levels of investment customers had previously indicated they were prepared to pay for such a benefit.

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Table 10 - Summary of all scheme costs, customers benefiting and £ per customer

Resilience Project	Risk reduction benefit	Customers benefiting (Nr)	Totex (£m)	£ per customer benefited	Risk Score- Before	Risk Score - After	Risk Reduction delivered
Undertake a hazard risk assessment and implement resilience measures at 63 'too critical to fail' sites	Increased resilience measures reduce consequence of hazard on sites. Quantified by increase in resilience metric from 2018 base position to 2030 future position in 5 years	942,000	£8.34	£8.85	n/a	n/a	n/a
Teesside System Resilience Project							
Replace 37.5km of 600mm with single 800mm St main	Reduce risk of pipe failure, improve operability	255,871	£14.08	£55.02	551.00	91.83	459.16
Cross connections into C60/60a for Darlington	30K benefit from second supply point	27,758	£0.21	£89.38	83.77	16.75	67.01
New inlet/outlet arrangement at Maltby SR	Remove cause of risk		£5.40		34.41	6.88	27.53
16km of 800mm main from Whorley to Shildon [links to Central resilience plan]	Reduce no of props impacted		£19.20		88.70	14.78	73.92
Mods to Ormesby WPS	Remove source of risk	38,374	£0.16	£18.24	77.83	2.08	75.75
Abandon Uplands WBS	Remove future base totex costs		£0.06		50.00	0.00	50.00
Abandon Long Newton SR	Remove source of risk		£0.24		50.00	0.00	50.00
Abandon South Lackenby SR	Remove source of risk		£0.24		90.00	0.01	89.99
Central System Resilience Project							
Springwell SR -62Ml capacity	Provide strategic storage for up to 3 days	99,821	£16.20	£426.56	213.47	2.14	211.34
1.5km of 600mm main Carr Hill Link to Springwell SR	Provide additional strategic transfer capability		£3.00		170.78	4.27	166.51
7km of 1000 mm main from Springwell to Pikes Hole plus EOV	Provide additional strategic transfer capability		£14.86		170.78	11.39	159.39

control							
4km of 1000mm main between Heworth and Pikes Hole plus EOV control	Provide additional strategic transfer capability						
Install new UV treatment at Mosswood WTW to manage Kielder crypto risk	Ability to manage crypto risk from all raw water	170,225	£7.90	£46.40	301.11	5.71	295.40
New 55Ml WPS at Shildon SR [Links to Tees resilience plan]	Provide additional strategic transfer capability	70,404	£3.16	£44.88	88.70	14.78	73.92
Tyne System Resilience Project							
315m of 700mm main to duplicate Chirton SR outlet main	Provide additional strategic transfer capability	43,116	£0.40	£9.27	69.32	3.45	65.87
North Suffolk Resilience Project							
Enabling mains schemes at North Cove and S Lowestoft	Provide additional strategic transfer capability	62,128	£4.10	£49.89	509.22	50.92	458.30
New treated water storage and WPS. Need to move existing pumping station to tie into new service reservoir	Provide strategic storage for up to 3 days	27,245	£10.44	£383.18	116.51	0.02	116.49
Essex System Resilience Project							
Abberton to Hanningfield RW transfer main at 50 Mld capacity	Provide in house strategic transfer capability and treatment capability at treatment plants	421,860	£20.35	£48.23	86.12	8.61	77.51
DAF treatment at Layer WTW [assume its to 145Ml DO]	Provide suitable treatment capability to manage changing water quality from Abberton IR and achieve 145Ml/d		£26.87	£63.69	124.13	12.46	111.67
30m of 900mm main @Herongate SR	Provide additional strategic transfer capability	110,000	£0.23	£2.09	158.33	4.75	153.58
		2,268,802	£163.97		3204.9	262.2	2942.7

Alignment with Stakeholder Needs

Our final resilience plans have been shared with and are supported by the DWI and customers.

In regards to provide a reliable and resilient supply of good quality drinking water we have received explicit support from the DWI in regards to our plans for the Tees and Central networks as well as addressing the raw water deterioration at Abberton (Essex) and Derwent (Central) IRs. This is in the form of Regulation 28 Notices or letters of support. DWI recognise the resilience enhancement benefits these schemes deliver our customers in regards to mitigating residual risks to the supply of wholesome water to consumers including compliance with the manganese and iron drinking water quality standards.

We have also engaged with and consulted with the Environment Agency in regards to our long term plans to improve overall resilience across our water networks via the NW and ESW Water Resource Management Plans.

The primary environmental risks from our resilience plans are within our Essex area and our approach to fully utilise existing raw water resource and treatment capacity ensures we are delivering a naturally resilient water service that manages the impact of future water demand and economic growth with no detrimental impact on the natural environment for the foreseeable future. Our resilience plans for our Suffolk and Northumbrian regions aims to utilise existing raw water resources and improve the overall interconnectivity of the potable network. We therefore do not anticipate our plans to have any detrimental impact on the local environment from increased abstraction over current licensed levels.

Customers have also shown a willingness to invest more of their future bill to deliver a more reliable and resilient service for them while protecting and enhancing the environment we operate within. We have received significant levels of support from customers, over 90% which is an exceptionally high level of acceptance.

We are therefore assured we are meeting the principles of a naturally resilient water sector[15] across all our regions and meeting our customers' expectations

[15] Delivering Water 2020: Our final methodology for the 2019 price review, p79, Ofwat, December 2017.

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Annex A - Abberton to Hanningfield Raw Water Transfer

Name of claim	Abberton to Hanningfield raw water transfer main
Name and identifier of related claim submitted in May 2018	n/a
Business plan table lines where the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line 14
Total value of enhancement for AMP7	£20.35m
Total opex of enhancement for AMP7	£0m
Total capex of enhancement for AMP7	£20.35m
Depreciation on capex in AMP7 (retail controls only)	n/a
Remaining capex required after AMP7 to complete construction	Expected to complete schemes by 2025
Whole life totex of claim	n/a
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	1.69%
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	No
Need for investment/expenditure	Raw water transfer capacity resilience
Need for the adjustment (if relevant)	Customer protection from loss or reduction of service risk
Outside management control (if relevant)	n/a
Best option for customers (if relevant)	Refer to main text of business case
Robustness and efficiency of claim's costs	Refer to main text of business case
Customer protection (if relevant)	Refer to main text of business case
Affordability (if relevant)	Refer to main text of business case
Board Assurance (if relevant)	Refer to main text of business case

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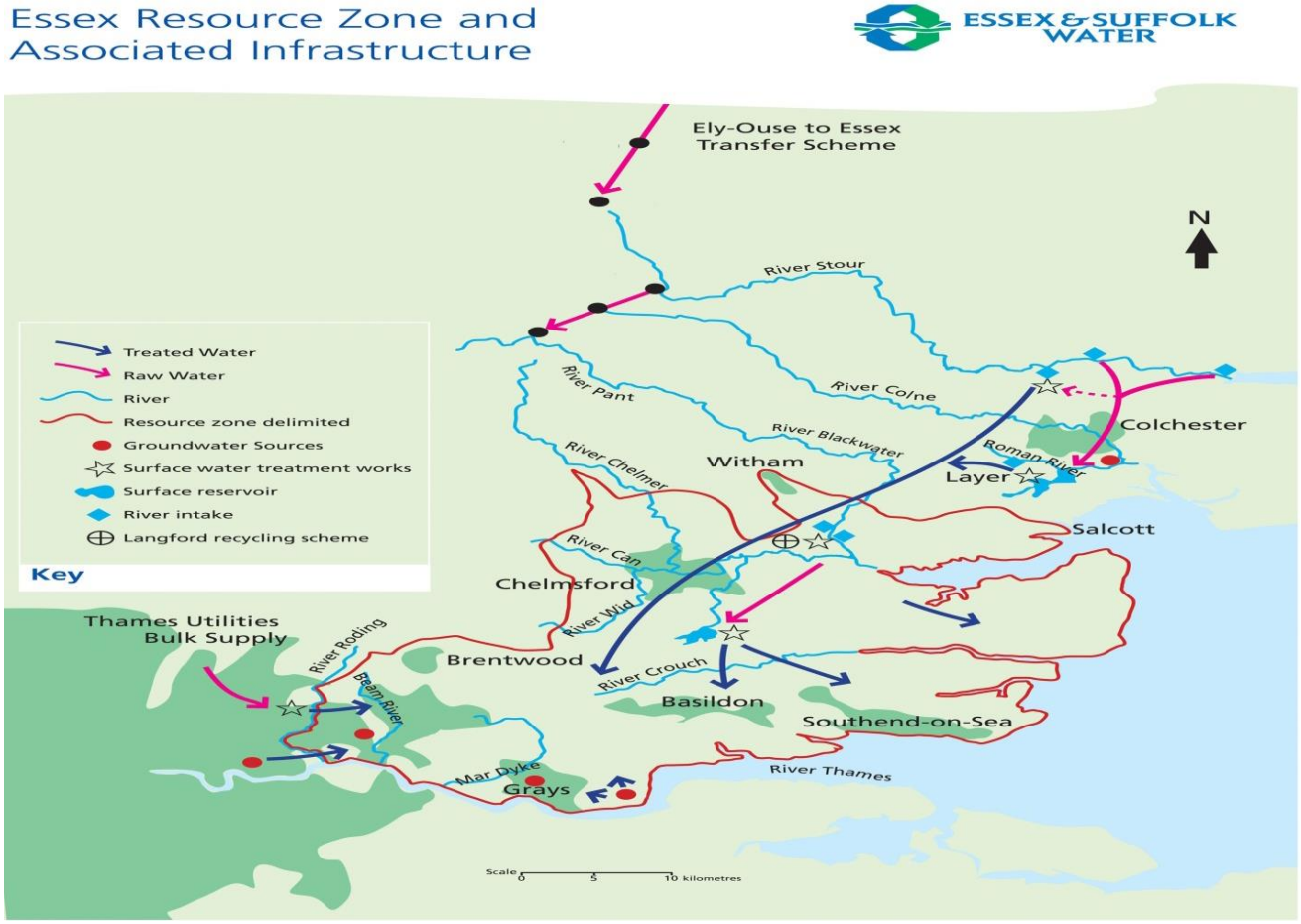
Background Information

The Essex Water Resource Zone (WRZ) serves a population of nearly 1.66m people in the East and South of Essex and three of the London Boroughs. This population is forecast to increase to 1.98m by 2045 (as indicated in the Company's Water Resources Management Plan), an increase of almost 20%. The main bulk of the population resides within the London Boroughs with the greater Southend-on-Sea area being the next most populous.

The Essex WRZ (Figure 10) is highly integrated with the water from each of the five water treatment works able to compensate for lower distribution input from another WTW. This level of integration stems from the 1971 merger of the Southend Waterworks Company with the South Essex Waterworks Company.

Figure 10 – Essex resource zone schematic



The Southend Waterworks Company, from its water treatment plant at Langford fed water east into Southend. The South Essex Company, from its Langham (R Stour) and Layer (Abberton Reservoir) WTWs supplied water from northern Essex to its customers in the south of the county and the London Boroughs. In the mid 1950s both companies jointly developed Hanningfield reservoir and WTW to feed the growing demand in both areas. This effectively integrated both company systems prior to the companies merging in 1971. In 1963, the South Essex Company built Chigwell WTW, taking water from the Lea Valley reservoirs (now belonging to Thames Water) to meet the growing demand of the London Boroughs. The final major development was completion of the enlargement of Abberton reservoir in 2014 which increased its capacity from 25,500Ml to 41,500Ml.

Vulnerability of the Essex WRZ in 2016 and 2018/19

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The Essex WRZ has five Water Treatment Works (WTW) producing over 98% of the potable supplies. Two small well sources make up the remainder. The WTW have two distinct methods of treating water. Layer, Langham and Chigwell are Slow Sand Filter (SSF) works where water is primarily filtered and then slowly passes through large beds of fine grade sand where bacteriological processes established on the sand bed aid purification of the water. The other two WTWs are Langford and Hanningfield which use physico/chemical treatment, including pre-ozonation, coagulation, primary filtration, ozonation and Granular Activated Carbon filtration. These physico/chemical works handle algal blooms in their source water far more effectively than the current SSF works. This can be seen by the recorded outage at each works in Figure 11.

The outage tabulated in Figure 11 is calculated as per the Water Resources Management Planning (WRMP) guidance methodology using actual WTW data from 2012 to 2016. The full contribution from the 2016 exceptional algal events therefore only contributes 20% to the WRMP Layer outage figure.

Figure 11 - Summary of Essex Outage data 2018

Table 3.15: Summary of Essex outage data

Water Resource Zone		Raw Water Source	Planned	Unplanned - Algae	Unplanned - Nitrates	Unplanned - Pollution of Source	Unplanned - Power Failure	Unplanned - System Failure	Unplanned - Turbidity	Grand Total
Total Ml										
Essex	Chigwell	Reservoir	552	4,775				1,516		6,843
	Langford	River	3,862	1,232	1,215	1,357	57	330	1,912	9,965
	Langham	River	5,145	4,303	92	1,855		2,030	502	13,927
	Layer	Reservoir	3,996	17,351				219	13,442	35,007
	Total		**13,555**	**27,661**	**1,308**	**3,212**	**57**	**4,096**	**15,856**	**65,743**
Total Days										
Essex	Chigwell	Reservoir	14	229				64		307
	Langford	River	112	68	95	167	2	35	71	550
	Langham	River	282	219	12	115		109	36	773
	Layer	Reservoir	104	456				9	240	809
	Total		**512**	**972**	**107**	**282**	**2**	**217**	**347**	**2,439**
(Average Ml/d)										
Essex	Chigwell	Reservoir	0.30	2.62	-	-	-	0.83	-	3.75
	Langford	River	2.12	0.68	0.67	0.74	0.03	0.18	1.05	5.46
	Langham	River	2.82	2.36	0.05	1.02	-	1.11	0.28	7.63
	Layer	Reservoir	2.19	9.51	-	-	-	0.12	7.37	19.18
	Total		**7**	**15**	**1**	**2**	**0**	**2**	**9**	**36**
(Average Days / Year)										
Essex	Chigwell	Reservoir	2.80	45.80	-	-	-	12.80	-	61.40
	Langford	River	22.40	13.60	19.00	33.40	0.40	7.00	14.20	110.00
	Langham	River	56.40	43.80	2.40	23.00	-	21.80	7.20	154.60
	Layer	Reservoir	20.80	91.20	-	-	-	1.80	48.00	161.80
	Total		**102**	**194**	**21**	**56**	**0**	**43**	**69**	**488**

The highest outages in the Essex supply area are experienced at Layer WTW, driven by algal blooms and turbidity changes.

Whilst Layer's maximum works output is 145Ml/d for 7 consecutive days the annual average reliable Distribution Input is around 120 to 130Ml/d, as demonstrated by NWL's water treatment works output records. In years such as 2016, during periods when there are severe algal blooms, the output is considerably less at around 70 Ml/d. Although a treatment solution could address the water quality issue, this would not address the issue of balancing storage in the two pumped storage reservoirs at Abberton and Hanningfield, which has also be impacted by other factors such as availability of the Environment Agency's Ely Ouse to Essex Transfer Scheme (EOETS).

Following the raising of Abberton reservoir, completed in 2014, Essex has a significant surplus of raw water supplies against current and future demand. This has allowed us to trade raw water back

to Thames Water and to be in discussion with both Anglian Water and Affinity Water about trading water with them for resilience of their jointly owned Ardleigh WTW.

With the raising of Abberton its capacity at 41,500Ml is now much greater than that of Hanningfield at 25,500Ml whereas previously they were of equal capacity. To maximise the deployable output of the system both reservoirs need to be drawn down at equal percentages, meaning the flows from Abberton should, on average, be 50% greater than those from Hanningfield.

However, raw water algal events in 2016 and the extreme dry, hot summer of 2018 have shown that constraints to our treatment capability at Layer and Chigwell WTWs increases the need for Hanningfield WTW to produce consistently high volumes of water. This has resulted in Hanningfield reservoir (25,500Ml) being drawn down below historic minimum levels, whilst at the same time Abberton reservoir, with much higher capacity (41,500Ml) has remained at plentiful levels, often above its pre-raised full level.

Events of 2016

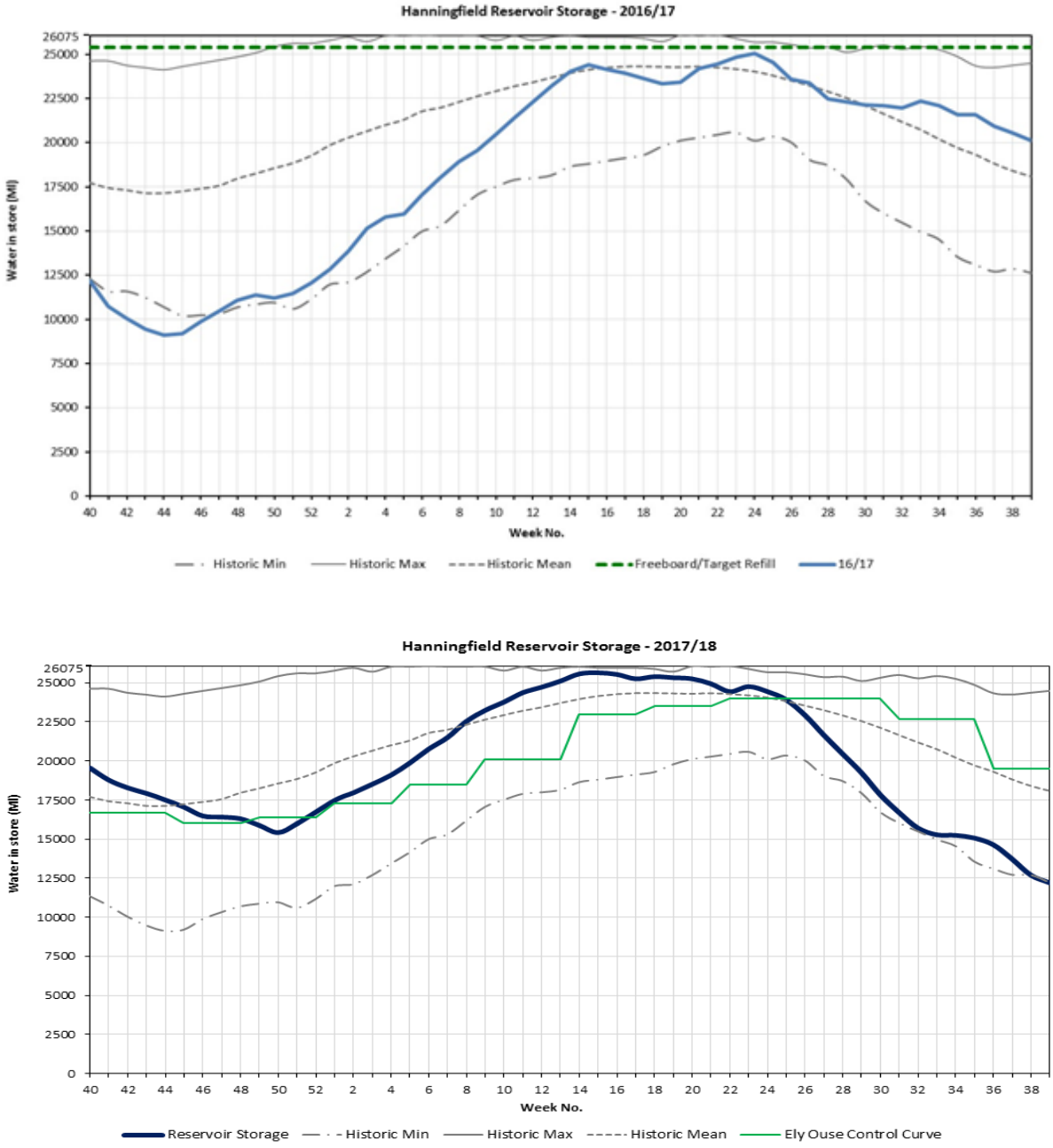
In the summer of 2016, from August almost through to Christmas, all of our reservoir sources suffered severe algal blooms as evidenced by NWL water quality records. Whilst in eutrophic lowland waters algal blooms are common and expected, having all three sources so affected and, for such duration, is uncommon. Other companies with similar waters also reported similar problems (as evidenced in DWI annual reports). Abberton was worst affected both in type of algae, total biomass and duration of severe blooms. Chigwell experiencing blooms at this time of year is unusual as normally this water source suffers more in early spring from diatom blooms.

Hanningfield had severe blooms but the ability to disrupt the water in the reservoir using the installed air curtains reduced the duration and better treatment allowed higher outputs to be produced. Abberton's algal blooms, predominated by diatoms that require silica salts to exist, were undoubtedly exacerbated by the reservoir raising. The newly flooded virgin soils would have been a new and abundant source of silica.

The autumn remained dry through to mid December reducing the volumes able to be pumped to Hanningfield reservoir. This combined with Hanningfield WTW having to run at a constant high load to compensate for the other WTWs saw the reservoir declining by 4% per week, as evidenced by NWL reservoir level records. The Environment Agency's EOETS which, should water be available in the Ely Ouse, transfers water into the Essex rivers to aid in refilling Abberton and Hanningfield reservoirs was unavailable during 2016. This was due to serious problems with the power supplies and pumps following a major refurbishment.

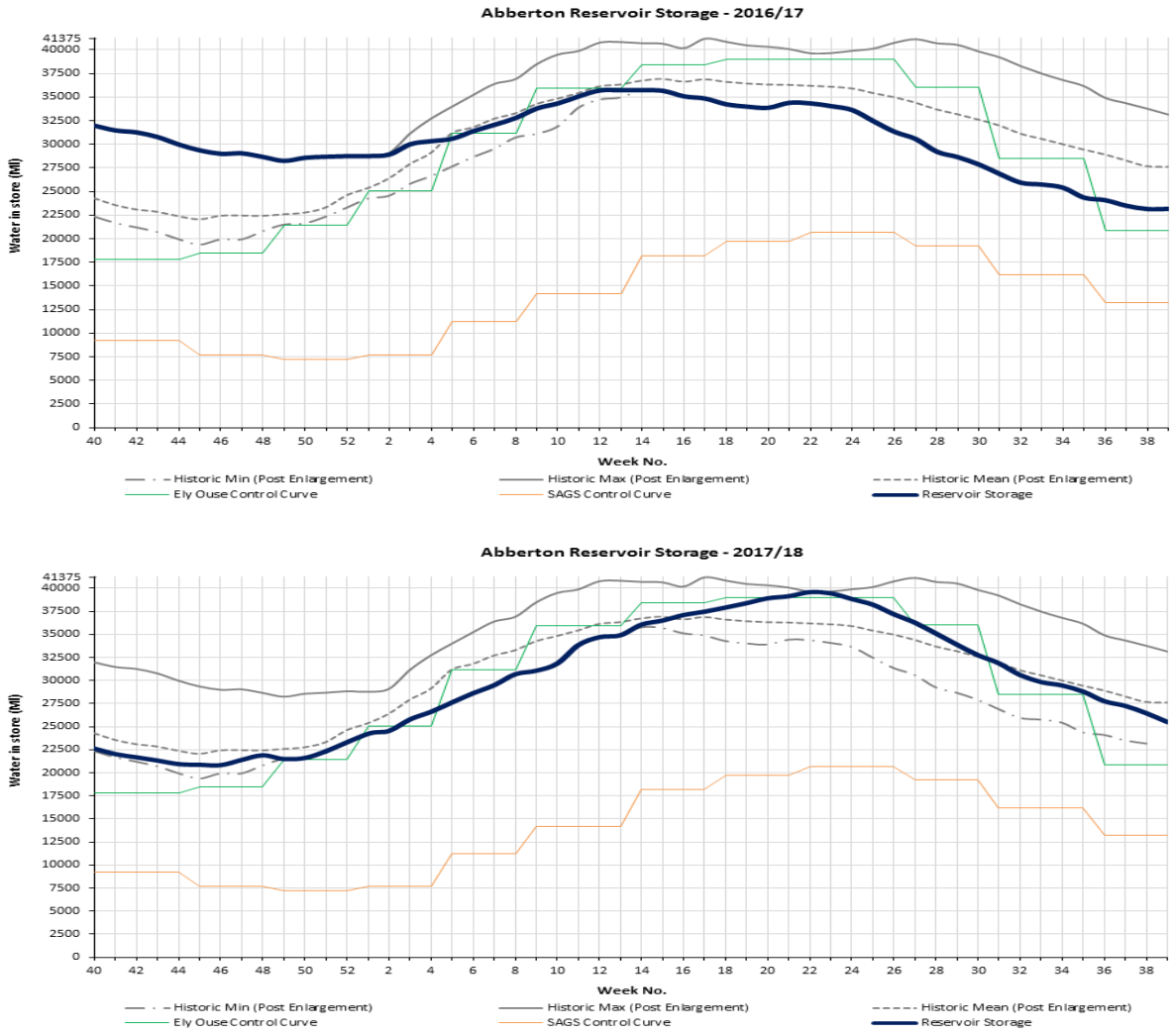
The combined consequences of these events on the drawdown of Hanningfield reservoir between 2016 and 2018 can be seen in with the reservoir being below its historic minimum for six weeks (Figure 12)). At the same time, Abberton reservoir (Note week 40 = 1st October for each year. This was a historic low level for Hanningfield IR as shown in Figure 13). A wet December, marked improvement in algal content at Abberton allowing a higher output from Layer WTW and some transfer from the EOETS allowed recovery of Hanningfield reservoir.

Figure 12 – Hanningfield IR storage levels 2016/17 to 2017/18 (from NWL records)



Note week 40 = 1st October for each year. This was a historic low level for Hanningfield IR

Figure 13 – Abberton IR storage levels 2016/17 to 2017/18 (from NWL records)

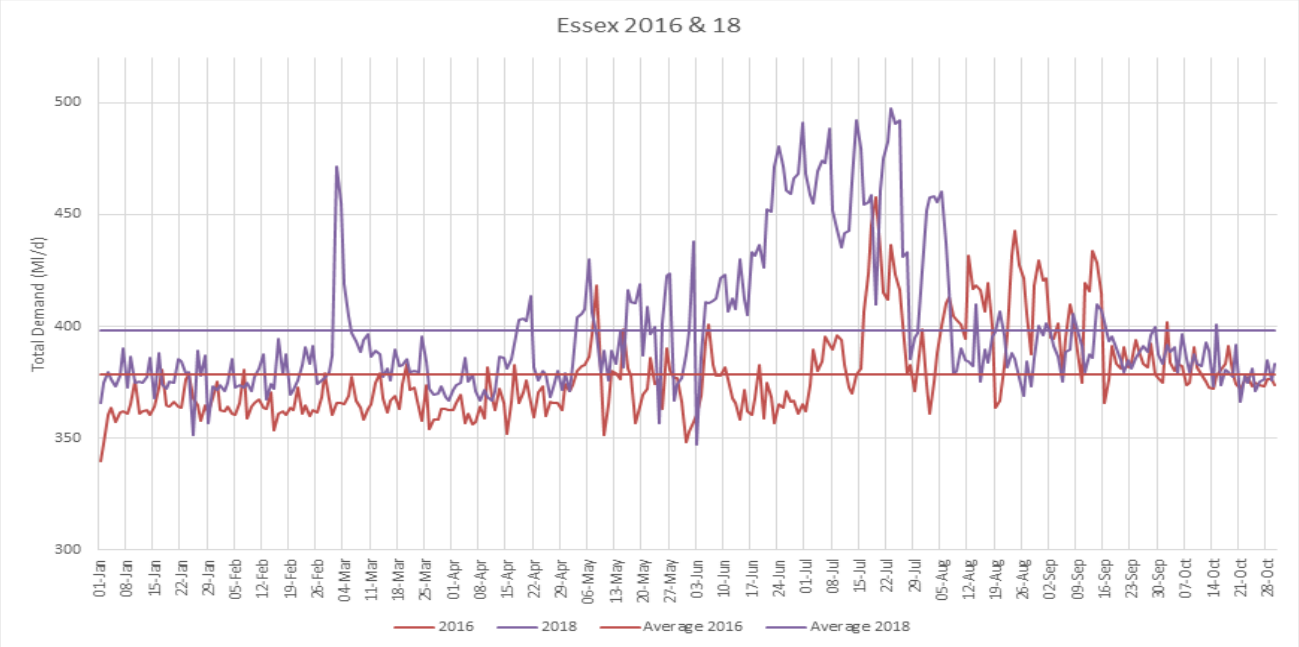


Note week 40 = 1st October for each year

Events of 2018/19

The autumn of 2017 and the first 2 months of 2018 had been significantly dry. Beast from the East, depositing useful amounts of snow, was followed by above average wet conditions through to the end of May. This allowed full refill of both reservoirs by the end of May. From June onwards our Essex area along with most of England then entered one of the driest and hottest summers on record. Figure 14 below demonstrates the increase to demand over this period, peaking at 30% above normal and averaging 20% above normal between January and October.

Figure 14 – Historic water demand (Essex) from 2016 to 2018 (from NWL Records)

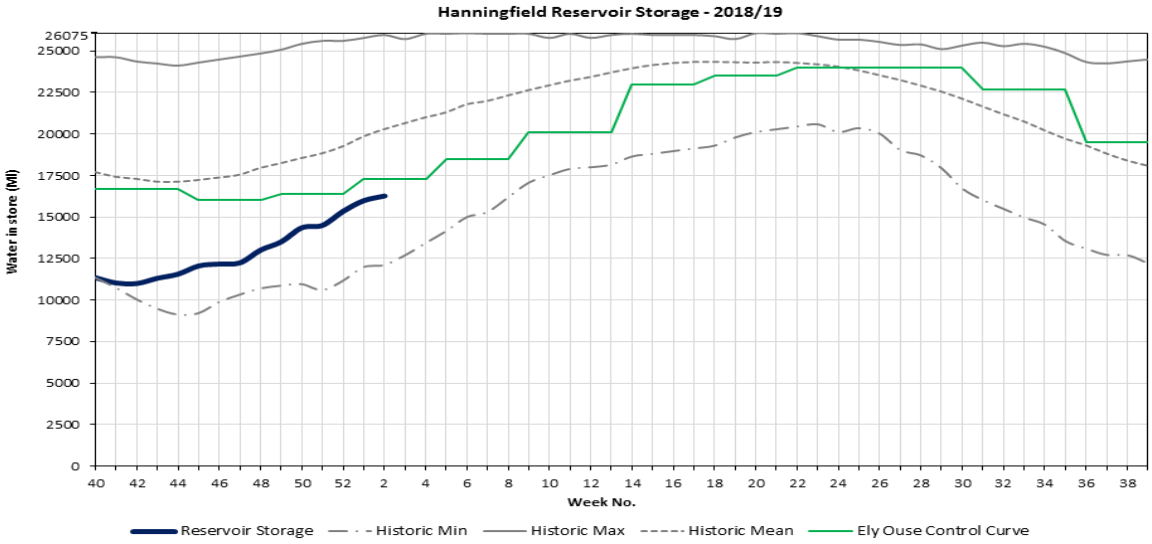


Layer WTW performed well over this period producing its expected 130Ml/d on average. Hanningfield was required to produce more water than in a normal year to meet the increased demand, as Hanningfield WTW is where the headroom in our deployable output resides. This resulted in Hanningfield reservoir beginning to draw down rapidly from July (Figure 12). Although the weather broke from its high temperatures in August the period from August 2018 to end of January 2019 saw rainfall, and hence river flows, significantly below the long term average for this period.

Layer WTW performing as required up until September, then entered a period of low output continuing through to end February 2019. These low outputs were due to a combination of one-off emergency repairs, and long term operational needs required of Slow Sand Filters (SSFs).

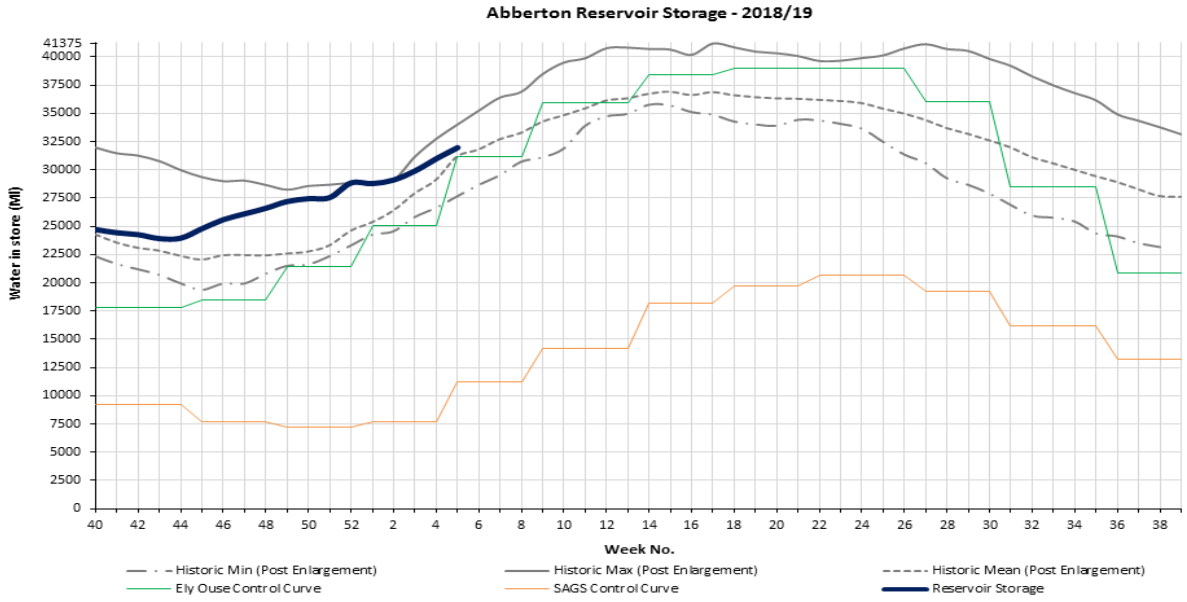
When a SSF has run for approximately 20 weeks, it must be drained down, an approximate 10cm of sand skimmed off the bed and then “ripened” by running the bed to waste until the bacteriological fauna has built up sufficiently to reduce colifom and E.Coli within the filtered water to a predetermined level. In warm water conditions this can take three weeks or more. Only two beds can be ripened simultaneously. Additionally after five or so skims the whole bed then requires reinstatement. Having fulfilled its role through the summer we would expect lower output from Layer WTW during the late summer/autumn. However the number of beds requiring skimming at similar times, due to the high summer demand, allied to the contact tanks repairs meant the works output was much lower in this period than historically. Hanningfield was required to make up this shortfall in Layer output on top of meeting the continuing higher than normal water demand due to the dry conditions. Figure shows the rapid decline of the reservoir through to the end of September 2018, with Figure 15 below demonstrating the slow rate of refill, compared to long term average due to high output and low river flows. Transfers from the EOETS through to the beginning of February have aided refill. Currently, full refill for summer 2019 is expected by the end of May 2019, but could be sooner if rainfall and river flows allow.

Figure 15 - Hanningfield IR storage levels Oct 2018 to present (From NWL Records)



Abberton IR remains at healthy levels and continues to fill as usual (Figure 16)

Figure 16 - Abberton IR storage levels Oct 2018 to present (From NWL Records)



System Risk –

This scheme aims to address a number of specific risks identified from;

- Reservoir level, outage data, and water quality data from events in 2016 to 2018.
- Data on operational restrictions on the Environment Agency's EOETS
- Recent emerging issues experienced in 2016 and 2018.

Primary Risk

The primary risk is the impact from the lack of resilience associated with unprecedented outage events exacerbated by more extreme weather conditions in the Essex area, which have impacted on storage levels at Hanningfield reservoir. The data presented in this report in the 'Background

Information' section demonstrates that the frequency of such events has increased since 2016. Additionally data from our Water Resources Management Plan suggests that more extremes of weather from climate change is likely to occur in the future.

The consequence of Hanningfield reservoir being too low to provide water for treatment at Hanningfield WTW could impact on supplies to 480,000 people under average summer conditions, raising to almost 750,000 when the Essex System comes under stress during peak demand periods.

Secondary Risks

Although not resource constrained, the impacts of a severe drought at a depth or duration not previously encountered would further exacerbate supply issues in the area, as would failure of assets in the Environment Agency's Ely Ouse to Essex Transfer Scheme.

Optioneering and scheme development –

Options considered were as follows:

Option 1: Do nothing
Option 2: Increase the reliable maximum output from Layer WTW and Triplicate Mains
Option 3: Increase raw water transfer capability from Abberton reservoir into the Hanningfield system.

Option 1: **Not viable**

Doing nothing is not considered a viable option. The risk of doing nothing is that a longer repeat event of the outages experienced in 2016 and 2018 could result in impact to the supply to at least 480,000 customers.

Option 2: **Discounted as not cost effective**

This option is to increase the reliable maximum output of Layer WTW and triplicate associated water transfer mains.

Layer WTW is currently designed to treat a seven day peak output of 145Ml/d and an average annual output of 120-130Ml/d. Changes to reservoir water quality as a result of the raising has increased the occurrences of works outage significantly, primarily due to algal blooms. This is meaning that we are often unable to meet the target outputs from the works. Our resilience scheme proposing the installation of a Dissolved Air Floatation (DAF) front end treatment stream that addresses these risks has been submitted as part of the enhancements due to raw water deterioration within our PR19 Business Plan.

The enlarged Abberton reservoir, and the associated infrastructure and licenses, can support a deployable output of 210Ml/d. Feasibility and Conceptual Designs for increasing Layer's output were produced at the time of the Abberton enlargement scheme by our engineering consultancy MWH. (07/4/2006 – MWH-ESW Layer 145-Feasibility and Conceptual Design Report V3).

This report defined the work needed to increase the Layer treated water output to first 165Ml/d and the further work to reach the maximum output of 210Ml/d. Each stage of capacity increase timed for when population growth would require higher works outputs. The treatment increase to 165Ml/d and 210Ml/d was scheduled to follow the increase in peak demands due to growth. The new treatment solution is in addition to the existing Slow Sand Filter (SSF) treatment which will remain and capable of producing up to 145Ml/d of total demand.

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The new treatment stream will be physico/ chemical and will be a side stream to the existing WTW. Land for its construction was acquired as part of Abberton Scheme. The first additional 20Ml/d WTW (Layer to 165) had a 2006 Capex cost of £32m for the WTW and an additional £10.8m for sludge handling, £42.8m in total for new treatment.

In addition to the new treatment stream it will also be necessary to further triplicate the strategic mains that take the flows from Layer and Langham into the north Essex zone to meet the forecasted demand. The current strategic mains from Layer and Langham are limited to a total capacity of 180Ml/d meaning if Layer is on full flow of 145Ml/d then the maximum Langham WTW can produce is 35Ml/d compared to its DO of 55Ml/d.

Increasing Layer to 165Ml/d requires triplication of the following mains:

- Layer Marney to Tiptree - 6 km
- Tiptree to Oxley Green – 1 km
- Woodham Walter PS to Butts Green - 7.1km

At 2006 costs this was estimated to be around £14 to £16m.

So the total cost (2006 prices) to increase Layer WTW to 165Ml/d output capacity was estimated to be £59m (£42.8m for treatment plus £16m for the mains).

Option 3: **Preferred Option**

This resilience proposal is to “link” the two Essex reservoirs, Abberton and Hanningfield via a raw water pipeline capable of transferring up to 50 Ml/d.

To understand why this is the favoured option to build resilience into the Essex WRZ by overcoming future multiple outage events, it is necessary to understand the Langford/Hanningfield system.

The rivers Chelmer and Blackwater come together at Langford. Langford has a stand-alone WTW with a DO of 56Ml/d and is a physico/chemical works very able to treat water of poorer quality, including algal blooms. The main outages associated with this WTW are nitrate and pesticide levels in the river water, especially in the autumn/early winter flows. Water is abstracted from the rivers to firstly supply Langford WTW with excess flows pumped 14km to Hanningfield reservoir. When river flows allow, up to 240Ml/d can be pumped to Hanningfield reservoir.

The concept of the Abberton reservoir to Hanningfield reservoir link is not that water from Abberton is piped directly to Hanningfield reservoir but rather it supports the system by substitution. Abberton reservoir water will be transferred directly onto Langford WTW, via its bank-side storage reservoir. This removes all concerns, and any additional treatment associated with the risk from transfer of Invasive Non Native Species. This risk would arise if Abberton raw water was discharged directly into the River Blackwater to then be abstracted at Langford RWPS and pumped onto Hanningfield reservoir.

By supplying between 30Ml/d - 50Ml/d of Abberton water on to Langford WTW, the equivalent volume is then available in the two rivers for pumping onwards to Hanningfield reservoir. This allows Hanningfield WTW to increase its average output by the equivalent 30 to 50Ml/d without increasing its normal drawdown of the raw water storage on site.

A further benefit of water going directly on to Langford WTW from Abberton is the improvement to water quality compared to that in the River Chelmer and Blackwater, especially so in the autumn and winter months. Both reservoirs are predominantly filled in the autumn and winter months where, following dry summers, rainfall usually washes out nitrates from agricultural land in to the rivers. These nitrates reduce significantly in the impounding reservoirs during summer leaving low nitrate

water. By using Abberton water at Langford WTW, all of the outage due to nitrate and most pesticide outages are significantly reduced or removed.

The cost of the link pipeline is estimated to be £20.4m totex at 2017/18 prices. By fully utilising existing treatment capacity and capability to address current raw water quality and sufficiency risks we will ensure further expansion of Layer WTW beyond 145Mld is likely not required till at least 2045 if not later.

Benefits of Option 3

- This builds resilience to manage outage events and changes to weather and rainfall as a result of changes to the climate as seen in 2016 and 2018/19;
- Hanningfield WTW will be able to meet increased water demand when other treatment works have extended outages without risk of drawing down the raw water reservoir to unacceptable and risky levels;
- If we increased the treatment and potable water transfer capacity at Layer to balance an equal percentage drawdown of the reservoirs we effectively mothball a significant percentage of Hanningfield WTW's existing treatment capacity. Option 3 removes this risk and allows the full treatment capacity at Hanningfield to be utilised;
- It is the most cost effective solution to address the current resilience risks.
- Further resilience and efficiency is derived from our ability to transfer water from Abberton to Hanningfield without restriction and at the most effective and efficient times of the year;
- Having the ability to treat Abberton reservoir water at Langford WTW reduces the outage risk at Langford due to nitrates and pesticides from the rivers;
- Building the link defers upgrade to Layer WTW outside of the 25 year demand forecasts currently calculated in NWL's WRMP.

Option 3 has been taken forward as the preferred option due to the advantages highlighted.

Proposed Option

The proposed scheme is to build a new raw water pipeline effectively linking the raw water sources of the two reservoirs at Abberton and Hanningfield, and thereby building resilience into the raw water transfer capability of the Essex WRZ. This option will balance reservoir levels in Hanningfield reservoir thereby reducing the likelihood of supply problems to 480,000 customers. The option is not about increasing raw water availability and therefore does not increase headroom in the Essex supply demand balance.

This and other schemes in Essex have been assessed by NWL's Asset Planning team and risk scored. This ensures we are able to assess this investment against all other schemes in a consistent and fair manner. The scheme has been scored as follows:

Resilience Project	Risk reduction benefit	Customers benefiting (Nr)	Capex (£m)	Opex (£m)	£ per cust benefit	Risk Score- Before	Risk Score - After	Risk Reduction delivered
Abberton to Hanningfield RW transfer main at 50 Mld capacity	Provide in house strategic transfer capability and treatment capability at treatment plants	421,860	£20.35	£0.00	£48.24	86.12	8.61	77.51

Using this assessment indicates that the risk to customers will reduce by 90% as a result of implementing the scheme.

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

All costs for the Abberton to Hanningfield Raw Water Transfer were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[16]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed costs for the Abberton to Hanningfield Raw Water Transfer are £20.35m totex

These costs were benchmarked and assured using a full iMod cost estimate using business as usual processes.

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance as previously described earlier.

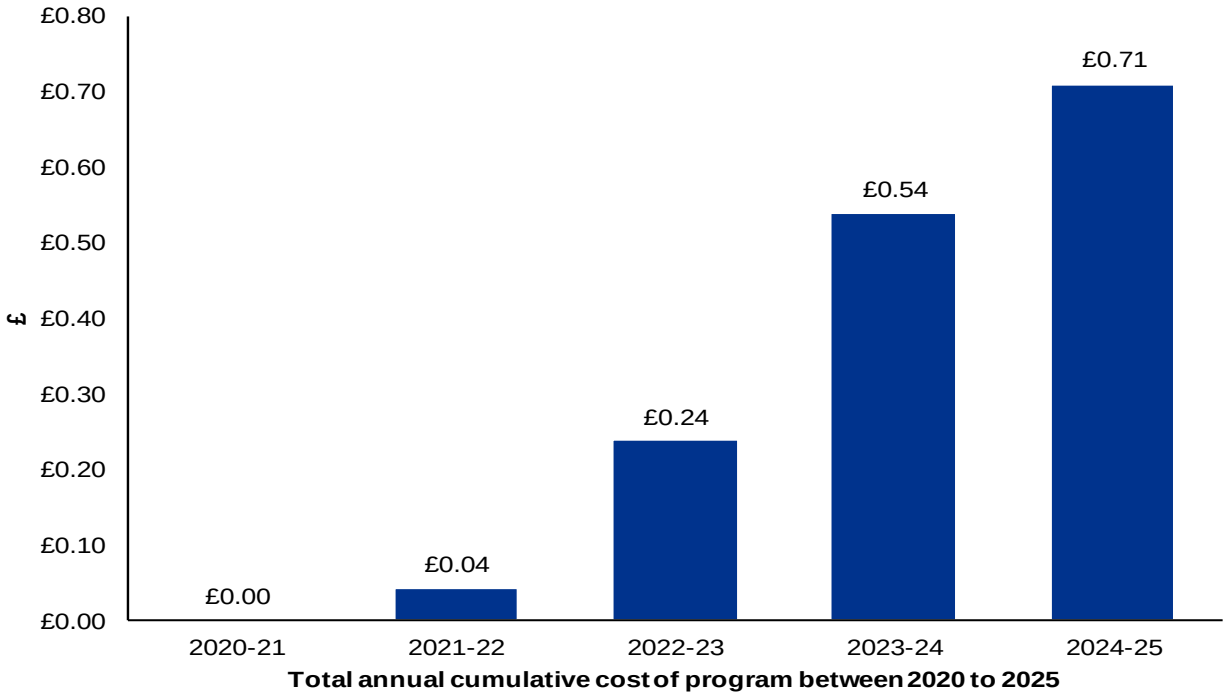
Affordability

The impact of these enhancement investments on customer bills are shown below with this scheme costing customers a one off cost of £0.71 on their bill between 2020 and 2025[17].

[16] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology

[17] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.

APPENDIX 3.2
WATER RESILIENCE



This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[18] driving significant improvements to average customer affordability.

We shared details of our plans including the Abberton to Hanningfield scheme with customers in the Essex area in a series of workshops held across the region. Customers from all areas were allowed to comment and indicate their support on all our resilience proposals even if they did not directly benefit from the improved resilience to service themselves.

Overall customer support for our plans to improve the resilience in our Essex area was supported by **89%** of our ESW customers.

When all schemes were considered as a package **96%** of ESW customers supported our proposals. Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remain a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 2030[19] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

Overall customer support can be summarised as follows:

Essex & Suffolk Water proposal	Yes	No	Unsure
Our plans for Essex area	89%	7%	4%
Our plans for Suffolk area	100%	0%	0%

[18] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

[19] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

Our plans for sites too critical to fail	100%	0%	0%
All water schemes as a package	96%	0%	4%

Customer Protection

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers. Details are included in the main body of this document and in Chapter 4: Measuring and Incentivising Success of our business plan.

Stakeholder Support

The scheme is consistent with Water Resources Management Planning guidance and also with the guiding principles regarding the need for resilience set out by Defra.

Defra have also requested that the proposal for this pipeline link between the two reservoirs is added to our draft Final Water Resource Management Plan prior to them issuing permission to publish.

Board assurance

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers"

Annex B - DAF Treatment at Layer WTW

Name of claim	DAF treatment at Layer WTW
Name and identifier of related claim submitted in May 2018	n/a
Business plan table lines where the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line 13
Total value of claim for AMP7	£26,870,000
Total opex of claim for AMP7	£0
Total capex of claim for AMP7	£26,870,000
Depreciation on capex in AMP7 (retail controls only)	n/a
Remaining capex required after AMP7 to complete construction	Expected to complete schemes by 2025
Whole life totex of claim	n/a
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	2.2%
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	No
Need for investment/expenditure	Raw water deterioration
Need for the adjustment (if relevant)	Customer protection from loss or reduction of service risk
Outside management control (if relevant)	n/a
Best option for customers (if relevant)	Refer to main text of business case
Robustness and efficiency of claim's costs	Refer to main text of business case
Customer protection (if relevant)	Refer to main text of business case
Affordability (if relevant)	Refer to main text of business case
Board Assurance (if relevant)	Refer to main text of business case

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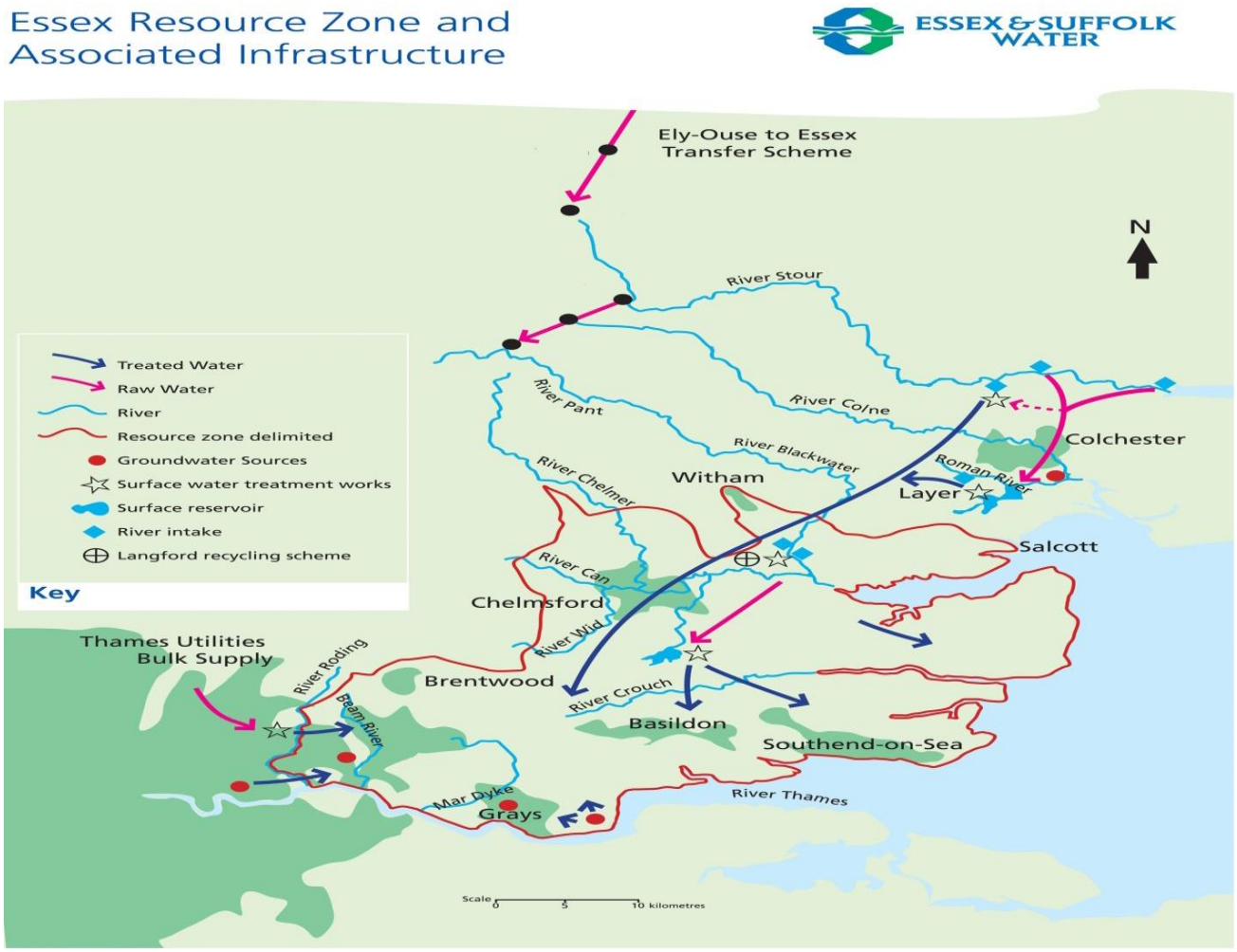
Background Information

The Essex Water Resource Zone (WRZ) serves a population of nearly 1.66m people in the East and South of Essex and three of the London Boroughs. This population is forecast to increase to 1.98m by 2045 (as indicated in the Company's Water Resources Management Plan), an increase of almost 20%. The main bulk of the population resides within the London Boroughs with the greater Southend-on-Sea area being the next most populous. The Essex WRZ (Figure 17) is highly integrated with the water from each of the five water treatment works able to compensate for lower distribution input from another WTW. This level of integration stems from the 1971 merger of the Southend Waterworks Company with the South Essex Waterworks Company.

Figure 17 – Essex resource zone schematic



The Southend Waterworks Company, from its water treatment plant at Langford fed water east into Southend. The South Essex Company, from its Langham (R Stour) and Layer (Abberton Reservoir) WTWs supplied water from northern Essex to its customers in the south of the county and the London Boroughs. In the mid 1950s both companies jointly developed Hanningfield reservoir and WTW to feed the growing demand in both areas. This effectively integrated both company systems prior to the companies merging in 1971. In 1963, the South Essex Company built Chigwell WTW, taking water from the Lea Valley reservoirs (now belonging to Thames Water) to meet the growing demand of the London Boroughs.

The final major development was completion of the raising of Abberton reservoir in 2014 which increased its capacity from 25,500Ml to 41,500Ml.

Changes in water quality in catchments and Abberton Reservoir since 2010

The Essex WRZ has five water treatment works producing over 98% of the potable supplies. Two small groundwater sources make up the remainder. The WTWs have two distinct methods of treating water, using older slow sand filtration or chemical treatment and rapid gravity filtration. Layer, Langham and Chigwell WTWs are Slow Sand Filter (SSF) works where water is primarily filtered and then slowly passes through large beds of fine grade sand where bacteriological processes established on the sand bed aid purification of the water.

Enlargement of Abberton reservoir took place between 2010 and 2014. Clear evidence has emerged that changes in catchments and climate have led to unpredicted changes in the raw water quality from Abberton. Since the expansion of the reservoir in 2010 this deterioration appears to be accelerating. An internal review of water quality data shows that since the start of the enlargement of Abberton in 2010, there has been a significant deterioration in reservoir turbidity

Figure 18 illustrates annual average turbidity (blue bar) for each of the years between 1998 and 2017 and an increasing trend line. The 1998 to 2010 mean turbidity (red bar) was 2.22 NTU but increases to 4.68 NTU post 2010 (green bar).

Figure 18 – Abberton Annual Mean turbidity 1998 to 2017.

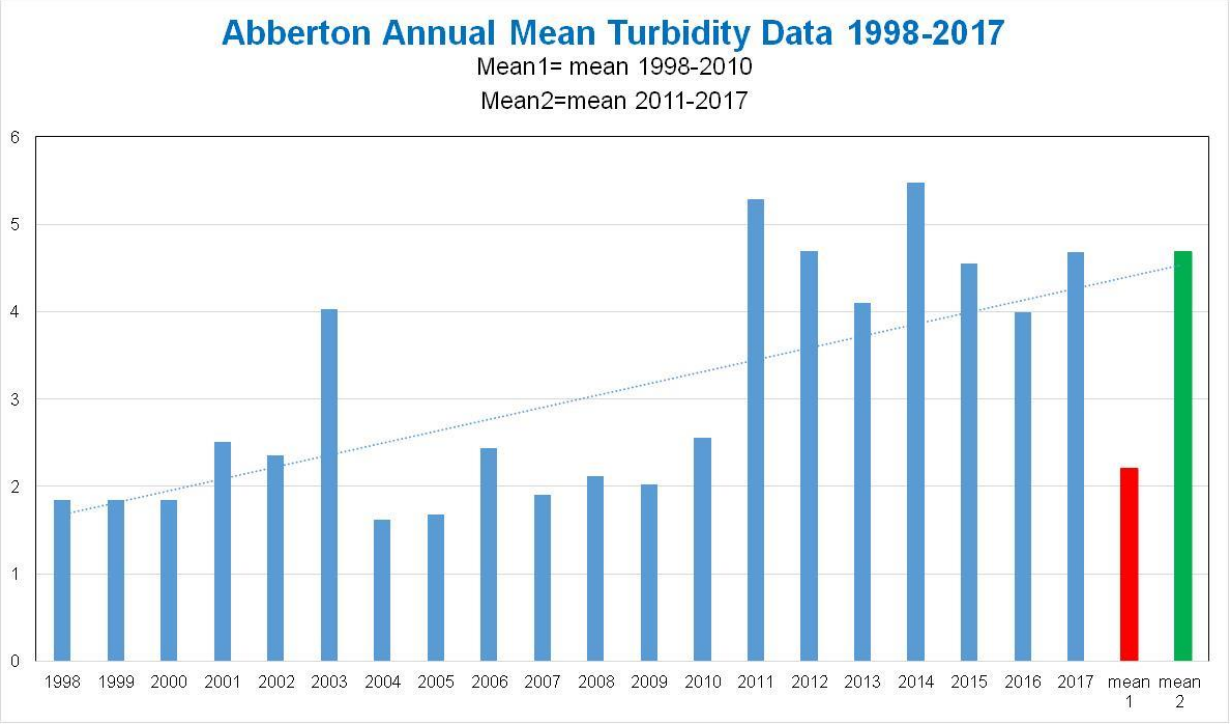


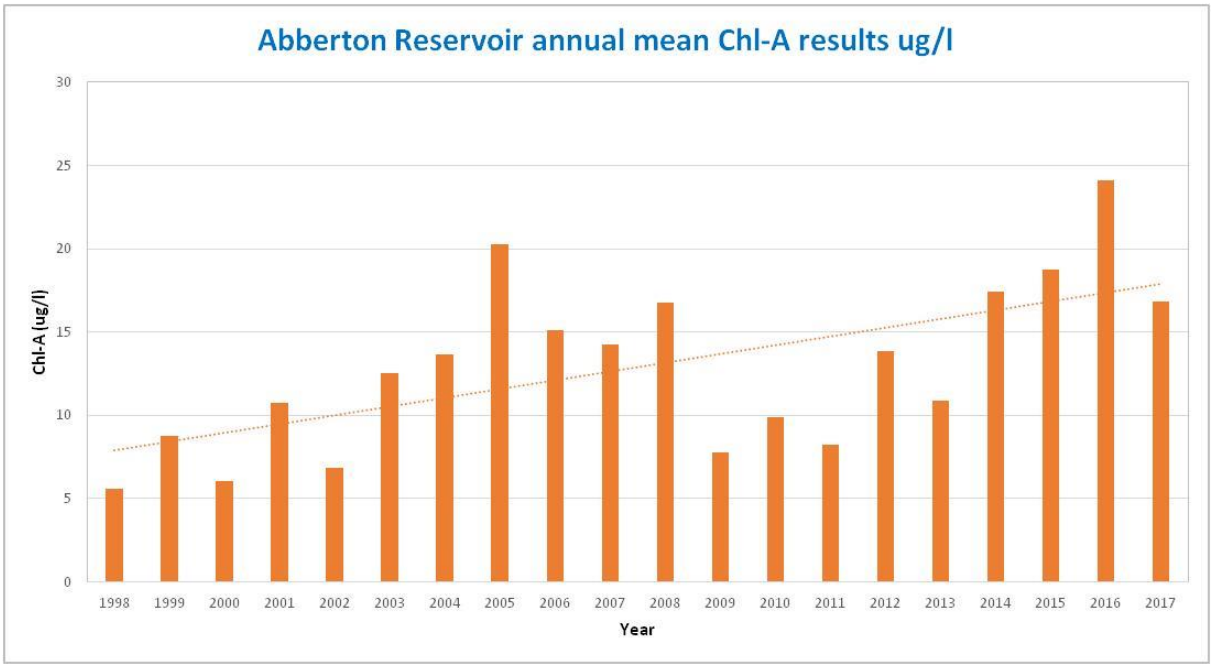
Figure 19 illustrates annual average Chlorophyll A concentrations for Abberton and can be used as an indicator of how much algae was present in the water column. This shows that a peak concentration of just under 25 µg/l was observed in 2016, the highest value since before 1998. It also shows that the previous four years had concentrations that were on the whole higher than the previous 12 years with the exception of 2005 and 2008.

The raw water quality deterioration as a result of exceptional outage events due to the dry periods since 2016 (including the long hot summer of 2018) have therefore elevated the risk of severe restrictions on water use in the Essex Water Resource Zone.

APPENDIX 3.2
WATER RESILIENCE

The water quality deterioration experienced at Abberton is impacting upon the effectiveness of our treatment works at Layer WTW and at times leads to a reduction in works outputs.

Figure 19 – Abberton Annual Mean Chl-A 1998 to 2017



The highest outages in the Essex supply area are experienced at Layer WTW, driven by algal blooms and turbidity changes. This is evidenced by Figure 20 which compares outage figures for four of the Essex WTWs. Raising the reservoir has produced additional deployable output for the Essex resource zone. This has also altered the quality of the water within the reservoir, making it more difficult to treat by the existing WTW. Increased turbidity could be a consequence of the reservoir enlargement which caused new ground to be flooded but also removed previous concrete skirting that had circled the original reservoir. Increased algal blooms, due to either more exposed soils in contact with the water or the new surface area or depth or all three, has accounted for most of the works outage.

The objective of the proposal is therefore to address the impact of raw water deterioration at Abberton on the treatability of water at Layer WTW.

Figure 20 – Summary of Essex Outage data 2018

Water Resource Zone		Raw Water Source	Planned	Unplanned - Algae	Unplanned - Nitrates	Unplanned - Pollution of Source	Unplanned - Power Failure	Unplanned - System Failure	Unplanned - Turbidity	Grand Total
Total Ml										
Essex	Chigwell	Reservoir	552	4,775				1,516		6,843
	Langford	River	3,862	1,232	1,215	1,357	57	330	1,912	9,965
	Langham	River	5,145	4,303	92	1,855		2,030	502	13,927
	Layer	Reservoir	3,996	17,351				219	13,442	35,007
	Total		**13,555**	**27,661**	**1,308**	**3,212**	**57**	**4,096**	**15,856**	**65,743**
Total Days										
Essex	Chigwell	Reservoir	14	229				64		307
	Langford	River	112	68	95	167	2	35	71	550
	Langham	River	282	219	12	115		109	36	773
	Layer	Reservoir	104	456				9	240	809
	Total		**512**	**972**	**107**	**282**	**2**	**217**	**347**	**2,439**
(Average Ml/d)										
Essex	Chigwell	Reservoir	0.30	2.62	-	-	-	0.83	-	3.75
	Langford	River	2.12	0.68	0.67	0.74	0.03	0.18	1.05	5.46
	Langham	River	2.82	2.36	0.05	1.02	-	1.11	0.28	7.63
	Layer	Reservoir	2.19	9.51	-	-	-	0.12	7.37	19.18
	Total		**7**	**15**	**1**	**2**	**0**	**2**	**9**	**36**
(Average Days / Year)										
Essex	Chigwell	Reservoir	2.80	45.80	-	-	-	12.80	-	61.40
	Langford	River	22.40	13.60	19.00	33.40	0.40	7.00	14.20	110.00
	Langham	River	56.40	43.80	2.40	23.00	-	21.80	7.20	154.60
	Layer	Reservoir	20.80	91.20	-	-	-	1.80	48.00	161.80
	Total		**102**	**194**	**21**	**56**	**0**	**43**	**69**	**488**

The expansion of Abberton has secured our raw water resources up to 2065 so there is no longer a supply/demand deficit in our Essex resource zone. Improving our ability to treat the changing raw water quality from Abberton at Layer WTW will, when combined with improvements to the resilience of our raw water transfer capability provided by the new Abberton to Langford transfer main ensures we can meet all future water demand from the projected population growth in the North Essex area up to at least 2045 without the need to construct additional treatment capacity.

Need for the investment / expenditure

This scheme aims to address a number of specific risks identified from;

- Consequence of Failure analysis;
- Water quality and outage data for Abberton and Layer WTW.
- Recent emerging issues.

Primary Risk

The primary risk is the impact due to emerging changes in catchment quality (turbidity and algae) at Abberton impacting on the ability to maintain both water quality regulatory compliance and deployable output from Layer WTW which supplies over 300,000 properties. The likelihood of this occurring, whilst not definitive, can be partially evidenced by the water quality trends in turbidity and Chlorophyll A as shown in Figures 2 and 3. The trend for the latter suggests similar conditions to recent elevated levels of Chlorophyll A occurring in 2005 suggesting a return period of peak concentration of around 1 in 10 years. The consequence of not being able to treat the current elevated concentrations could therefore significantly impact on customers at these properties.

Secondary Risks

Although not resource constrained, the impacts of further raw water quality (as recent deterioration has been at levels not previously encountered) could further exacerbate supply issues in the area.

Optioneering and Scheme Development

As already indicated the consequence of Layer WTW not being able to fully treat water from Abberton with unprecedented levels of algae and turbidity would be unacceptable as the works typically supplies 300,000 properties.

The likelihood of algae and turbidity parameters increasing in concentration in Abberton raw water appears to be increasing, as evidenced from water quality data and by default increases in treatment works outage noted since the Abberton enlargement project commenced. The likelihood of further or increasing issues related to raw water deterioration is considered to be a **medium likelihood and high consequence.** As previously indicated likelihood can only be partially evidenced from the turbidity and Chlorophyll A trend data previously presented.

Options considered were as follows:

Option 0: Do nothing
Options 1 to 5: Install new treatment capability at Layer WTW

Option 0 - **Discounted**

Doing nothing is considered an unviable option. The risk of doing nothing is that increasing concentrations of algae and turbidity in the raw water at Abberton could occur, causing treatment problems potentially impacting 300,000 properties.

Treatment-Based Options

Layer WTW is currently designed to treat a seven day peak output of 145 Ml/d and an average annual output of 120 to 130 Ml/d. Changes to reservoir water quality as a result of the raising of Abberton has increased treatment works outage (due to algal blooms and turbidity) such that both output figures are not being met with output often considerably lower.

In a report on Layer Treatment Works Upgrade, produced by MWH, five options were considered in respect of increasing the output from Layer WTW and addressing similar concerns around treatability of algae. All the options included variants around using a new Dissolved Air Floatation (DAF) process in order to address increasing algal concentrations and sedimentation issues causing turbidity outages in the Abberton source water. The options considered are summarised as follows:

Option 1 - **Discounted**
Modify existing treatment plant and then build parallel treatment streams of the required capacity, comprising of dissolved air flotation (DAF), followed by rapid gravity filtration (RGF), and followed by granular activated carbon (GAC) contactors. As the study proceeded it became clear that the design of this option would mean that at times Layer would be unable to achieve output in excess of 110 Ml/d, so this option was quickly discounted.

Option 2 - **Discounted**
This option proposed that in order to reach flows of 145Ml/d the existing works would be abandoned, and a whole new treatment train would be constructed comprising DAF, RGFs and GAC contactors. This option was discounted on the basis of increased costs from having to construct an entirely new treatment works.

Option 3 - **Recommended**
This option was also designed to hit the required 145Ml/d WTW outputs, and with a DAF plant proposed upstream (and thereby more efficient) of the existing treatment processes.

Option 4 - **Discounted**
This option was identical to Option 3 but would potentially look to treat higher quantities of up to 165 Ml/d, potentially requiring interstage pumping and further treatment downstream. This option was

later discounted as this level of output is not currently required, so the increased costs to do this cannot be justified.

Option 5 - **Discounted**
This option also included an upstream DAF process stream but only on one rather than both of the current process streams. This option was later discounted due to concerns over whether this option would meet the required treatment works output.

A Pugh Matrix can be constructed to illustrate the option comparison as follows:

Evaluation Criteria	Importance	DO NOTHING Option 0		Option 1		Option 2		Option 3		Option 4		Option 5	
		rating	weighted	rating	weighted	rating	weighted	rating	weighted	rating	weighted	rating	weighted
Capex Cost	5	0	0	3	15	1	5	4	20	1	5	4	20
Opex Cost	3	0	0	3	9	4	12	2	6	2	6	2	6
Low Technical Complexity	2	0	0	2	4	3	6	3	6	2	4	2	4
Proven Technology	3	0	0	4	12	3	9	3	9	2	6	3	9
Guaranteed Output at 145 Ml/d	4	0	0	2	8	3	12	3	12	3	12	1	4
Total Score			0		48		44		53		33		43

Evaluation of the options identified Option 3, a DAF plant upstream of the current water treatment processes as the preferred option.

Preferred Option

The proposed scheme is to install a new front end DAF (dissolved air floatation) treatment process stream at Layer WTW to address the changes to catchment water quality at Abberton (principally turbidity and algae). This will ensure that the works can maintain its full deployable output all year and will remove the risks of supply restrictions to over 300,000 properties caused by emerging changes in raw water quality at Abberton.

An indicative process flow diagram for the recommended option is shown below. Blue process boxes indicate new structures, green modified structures, and orange indicating an abandoned structure:

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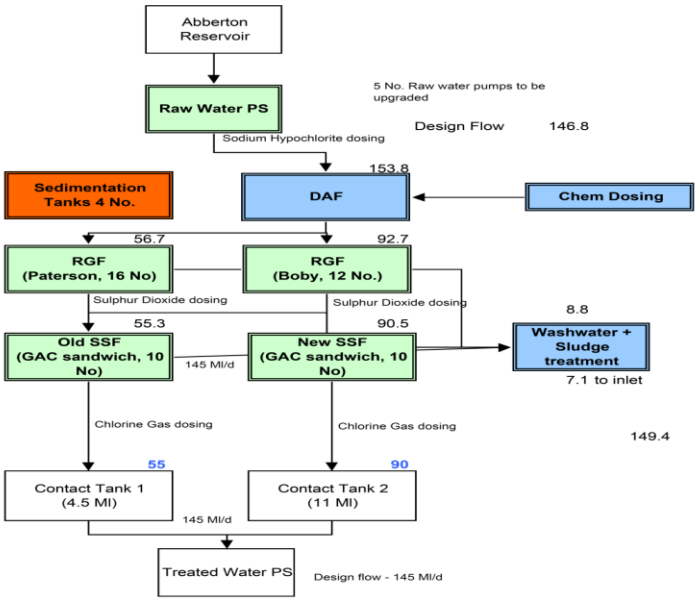


This and other schemes in Essex have been assessed by NWL's Asset Planning team and risk scored. This ensures we are able to assess this investment against all other schemes in a consistent and fair manner. The scheme has been scored as follows:

Resilience Project	Risk reduction benefit	Customers benefiting (Nr)	Capex (£m)	Opex (£m)	£ per customer benefited	Risk Score- Before	Risk Score - After	Risk Reduction delivered
Install new DAF treatment at Layer WTW at 145Ml	Provide suitable treatment capability to manage changing water quality from Abberton IR and achieve 145Ml/d	421,860	£26.87	£0	£63.69	124.13	12.46	111.67

Using this assessment indicates that the risk to customers will reduce by 90% as a result of implementing the scheme.

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

All costs for the DAF Treatment at Layer scheme were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[20]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;

[20] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology.

- Assessment and forecasting of historical spend; and
- Estimates from other data.

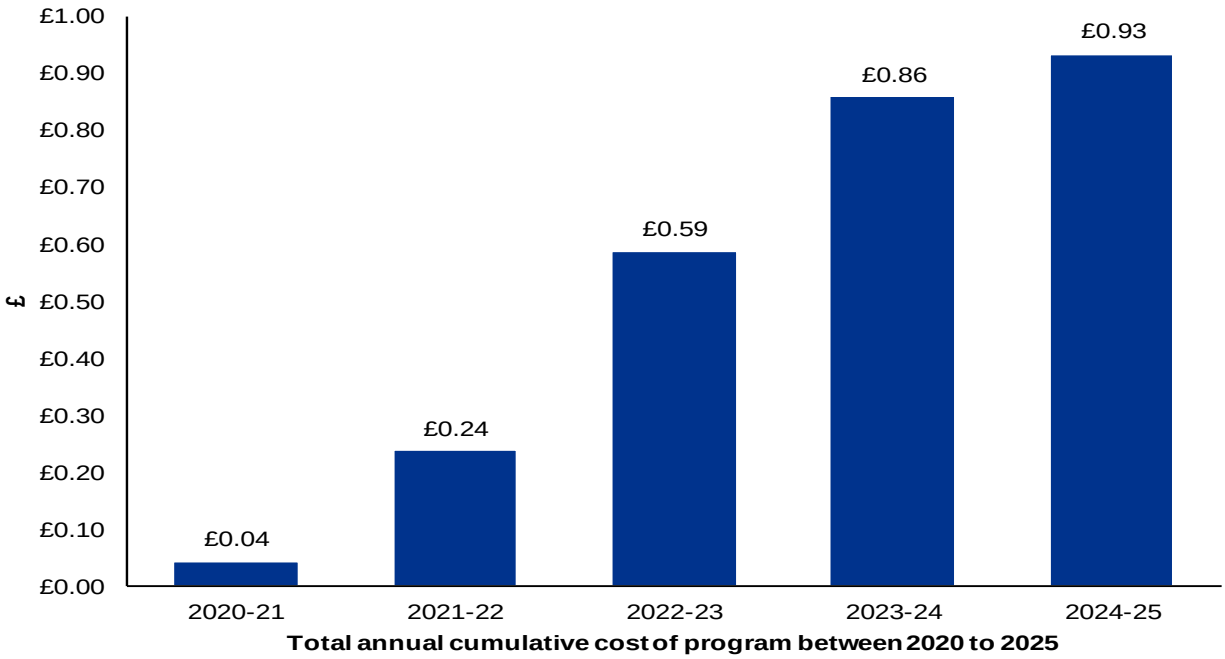
The assumed costs for the DAF Treatment at Layer scheme are £26.87m capex.

These costs were benchmarked and assured using a full iMod cost estimate using business as usual processes.

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance as previously described earlier.

Affordability

The impact of these enhancement investments on customer bills are shown below with this scheme costing customers a one off cost of £0.93 on their bill between 2020 and 2025[21].



This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[22] driving significant improvements to average customer affordability.

We shared details of our plans including the Layer DAF scheme with customers in the Essex Area in a series of workshops held across the region. Customers from all areas were allowed to comment and indicate their support on all our resilience proposals even if they did not directly benefit from the improved resilience to service themselves.

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[22] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

APPENDIX 3.2
WATER RESILIENCE

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Essex & Suffolk Water proposal	Yes	No	Unsure
Our plans for Essex area	89%	7%	4%
Our plans for Suffolk area	100%	0%	0%
Our plans for sites too critical to fail	100%	0%	0%
All water schemes as a package	96%	0%	4%

Customer protection

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers. Details are included in the main body of this document and in Chapter 4: Measuring and Incentivising Success of our business plan.

Stakeholder support

This scheme is subject to provisional support by DWI (minded to Support), further assessment is taking place and Final Descision Letters will be provided in due course. These will be circulated to Ofwat when received.

Board assurance

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers".

[23] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

Annex C - Barsham SR/WPS and North Suffolk strategic mains resilience

Name of claim	Barsham SR/WPS and North Suffolk strategic mains resilience
Name and identifier of related claim submitted in May 2018	n/a
Business plan table lines w here the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line 14
Total value of claim for AMP7	£14,540,000
Total opex of claim for AMP7	£0
Total capex of claim for AMP7	£14,540,000
Depreciation on capex in AMP7 (retail controls only)	n/a
Remaining capex required after AMP7 to complete construction	Expected to complete schemes by 2025
Whole life totex of claim	n/a
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	1.2%
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	No
Need for investment/expenditure	Enhanced resilience
Need for the adjustment (if relevant)	Customer protection from loss of service risk
Outside management control (if relevant)	n/a
Best option for customers (if relevant)	Refer to main text of business case
Robustness and efficiency of claim's costs	Refer to main text of business case
Customer protection (if relevant)	Refer to main text of business case
Affordability (if relevant)	Refer to main text of business case
Board Assurance (if relevant)	Refer to main text of business case

APPENDIX 3.2
WATER RESILIENCE

Background Information -

The Northern Central WRZ of the Suffolk supply area is bounded by the River Waveney and River Bure to the west and the Suffolk coastline from Southwold to Winterton-on-Sea in the east. The WRZ includes the towns of Lowestoft, Great Yarmouth, north Halesworth, Bungay, and Beccles. Demand in the WRZ is heavily influenced by the large population centers' of Lowestoft and Great Yarmouth. Approximately 70% of the water supplied in the Northern Central WRZ is sourced from surface water, and 30% sourced from groundwater in the south of the WRZ.

Surface water is provided via four sources, namely the River Waveney near Beccles, the River Bure near Wroxham, and groundwater fed lakes called Ormesby Broad, and the Lound Ponds and Fritton Lake. Water from the River Waveney is treated at Barsham River treatment works, water from the River Bure and Ormesby Broad is treated at Ormesby water treatment works (WTW) and water from Lound Ponds and Fritton Lake is treated at Lound treatment works.

A smaller component of raw water from groundwater can be sourced from remote Chalk groundwater sources near Wroxham in the north of the WRZ, which is treated at Ormesby WTW. Larger quantities of groundwater produced in the south of the WRZ are sourced from Chalk groundwater sources near Halesworth, Holton and Beccles and Crag and Gravel wells near Southwold and Broome respectively.

The Northern Central WRZ is named to reflect the fact that historically it effectively operated as two 'sub-zones' called the Northern WRZ and the Central WRZ, although it is no longer appropriate to consider these as separate resource zones. The Northern 'sub-zone' contains Ormesby treatment works and Lound WTW, whilst the Central 'sub-zone' contains Barsham treatment works and all the groundwater sources, except those near Wroxham.

Abstraction from the River Bure, Ormesby Broad, and groundwater chalk sources in the Bure valley is authorised by a group abstraction license which allows a total annual quantity of 10,000 Ml to be abstracted. An insignificant contribution is abstracted from the groundwater sources which tend to be only used as emergency sources when abstraction from the River Bure intake is not possible. This is generally due to elevated turbidity and / or nitrate concentrations following major rainfall events. The bulk of the abstraction comes from the River Bure and Ormesby Broad, with close to the total 10,000Ml limit being abstracted in most years. The quantity abstracted from each intake often depends on the source water quality and may result in more water being abstracted from Ormesby Broad one month and less in another. However, a review of the abstraction return data shows that on average, approximately 40% of Distribution Input (DI) is satisfied by the Broad and 60% by the Bure.

The North Suffolk Zone (Figure 21) comprises the Ormesby, Lound, Central Bores and Barsham and Broome system zones. Lowestoft Supply is fed jointly from Barsham and Lound Treatment Works as shown in Figure 22. Typical demand is 17.5 Ml/day under average conditions which rises to 23.5 Ml/day under peak conditions. The average supply condition sees Barsham supplying, typically, 11 Ml/day with Lound providing the remaining 6.5 Ml/day.

The largest proportion of the zone is classed as the Lowestoft low level zone and this is fed directly by both Barsham and Lound treatment works. Hollingsworth Road Reservoirs provide the controlling head (35.1m AOD / 9.9 Ml) within this area. The key connection between South and North Lowestoft and, hence the two treatment plants, are the two Lake Lothing Crossings at Lowestoft Harbour.

Figure 21 – North Suffolk Zone schematic

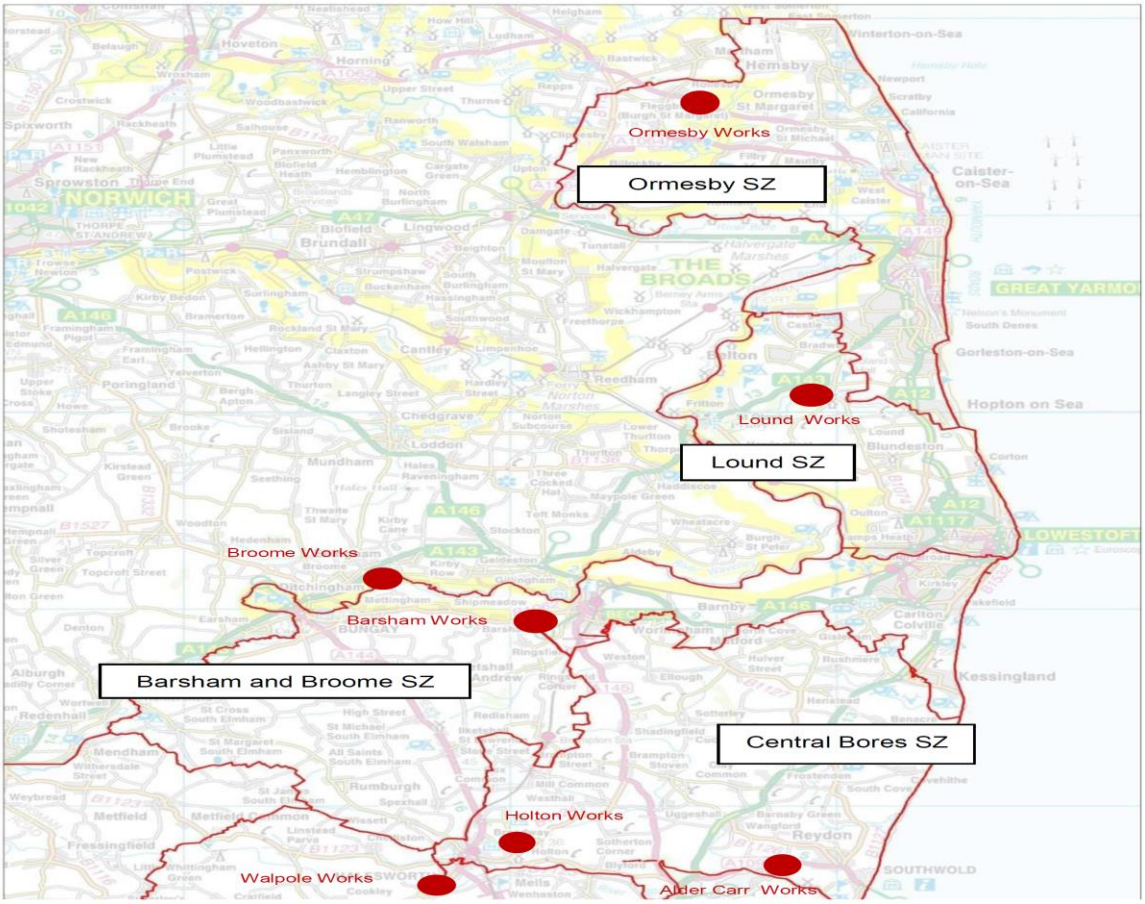
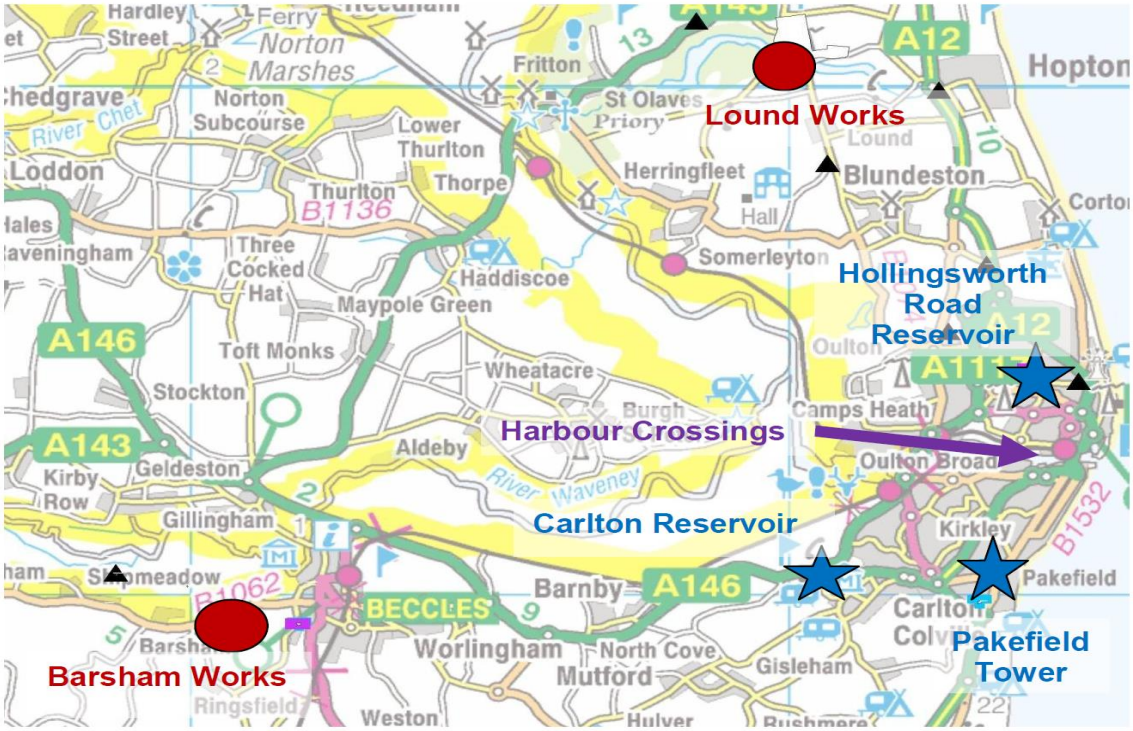


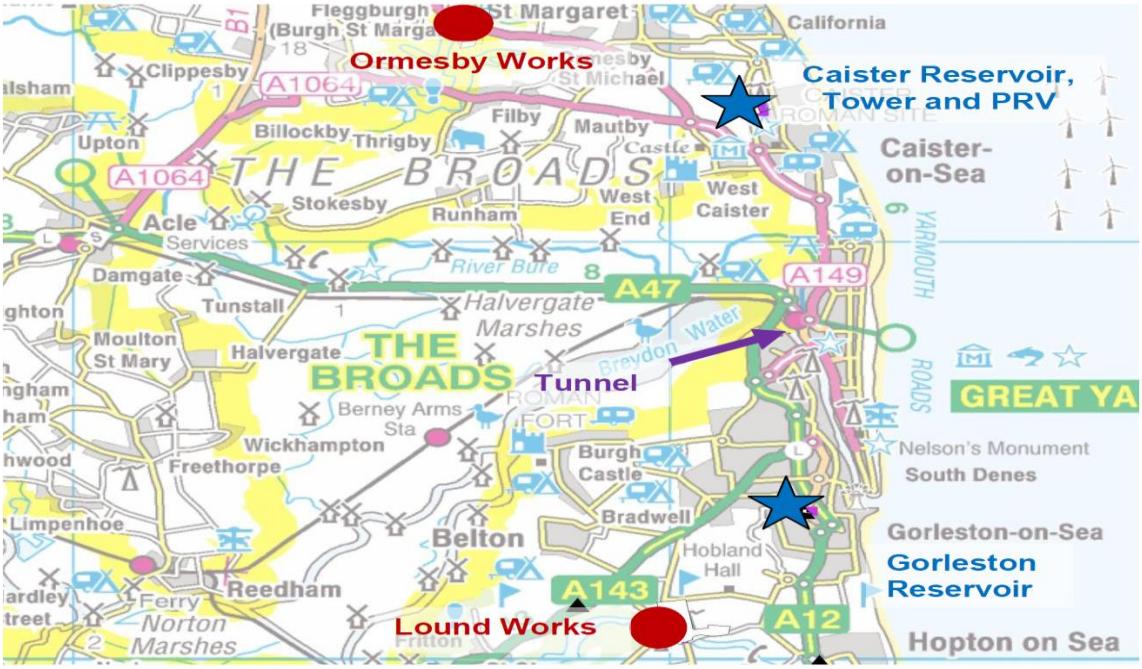
Figure 22 – Lowestoft Zone schematic



APPENDIX 3.2
WATER RESILIENCE

Great Yarmouth supply (Figure 23) is such that all of the water supplied to Great Yarmouth is currently produced at Ormesby Treatment Works. All this water passes through the Caister site comprising of a tower, two reservoirs and a pressure reducing valve complex. Within the southern half of the zone, all of the water for Gorleston passes through the Great Yarmouth Tunnel. There is no alternative method of supplying the Great Yarmouth and Gorleston zone currently. Typical demand values for the Great Yarmouth and Gorleston areas range between 20 and 27 Ml/day. Resilience will start to improve when an AMP6 project to link Lound to Gorleston is due to complete, however full flexibility and fully enhanced resilience will not be possible without further infrastructure enhancements.

Figure 23 – Great Yarmouth Zone schematic



The existing mid to long term asset strategy for the area (as outlined in the North Suffolk Zonal Study of 2012) is for Barsham to become a central 'hub' works for the area, with improved linkages between Lound and Ormesby in order to improve flexibility in moving water around the system and address critical points of failure from a resilience perspective.

The objective of the proposal is therefore to enhance resilience by providing strategic treated water storage capacity, and enabling better flexibility to move water around the North Suffolk network.

Need for the investment / expenditure –

These schemes aim to address a number of specific risks identified from;

- Consequence of Failure analysis;
- Recommendations made from the North Suffolk Zonal Study, 2012;
- Recent emerging issues.

Primary Risk

For the North Suffolk network the primary risk is the impact from the lack of flexibility in transferring water within the network between Barsham, Lound, and Ormesby WTWs in times of stress; either as a result of unplanned outages or unprecedented peak demand periods. Ormesby is currently the

only source for 60,000 customers, and currently there is no respond and recover capability sufficient enough to respond effectively should the source be off-line for any significant period.

For Barsham WTW the primary risk is the impact from a significant outage and/or failure of Barsham WTW. This could be due to asset failure and/or loss of abstraction from the River Waveney. The lack of strategic treated water storage at the site means that 27,000 customers are at risk of supply failure within 3 hours after Barsham WTW going off-line (with some properties at risk after only 20 minutes), and currently there is no respond and recover capability sufficient enough to respond effectively.

Secondary Risks

Although not resource constrained, the impacts of a severe drought at a depth or duration not previously encountered would exacerbate supply issues in the area. Enhanced strategic storage and network flexibility would alleviate this impact.

Best Options for Customers -

The proposed schemes are

(1) Construct a new 20Ml service reservoir and relocate an existing water pumping station at Barsham WTW. This will address the risk of a large loss of supply event lasting more than three days impacting over 27,000 customers (some within 20 minutes) caused by a failure at Barsham WTW, for which there is currently no respond and recover capability sufficient enough to respond effectively;

(2) Lay 4.3km of strategic main to improve the transfer capability between Barsham, Lound and Ormesby WTWs, thereby removing the risk of a loss of supply event impacting up to 50% of the customers currently supplied from Ormesby WTW. Ormesby is currently the only supply source for over 62,000 customers and there is not currently a respond and recover capability sufficient enough to respond to a loss of supply lasting more than 3 days;

Risk reduction benefit –

These schemes in Suffolk have been assessed by NWL's Asset Planning team and risk scored. This ensures we are able to assess this investment against all other schemes in a consistent and fair manner. The scheme has been scored as follows:

Resilience Project	Risk reduction benefit	Customers benefiting (Nr)	Capex (£m)	Opex (£m)	£ per customer benefited	Risk Score- Before	Risk Score - After	Risk Reduction delivered
Enabling mains schemes at North Cove and S Lowestoft	Provide additional strategic transfer capability	62,128	£4.10		£65.99	509.22	50.92	458.30
New treated water storage and WPS. Need to move existing pumping station to tie into new service reservoir	Provide strategic storage for up to 3 days	27,245	£10.14	£0.30	£383.18	116.51	0.02	116.49

Using this assessment indicates that the risk to customers will reduce by 92% as a result of implementing the scheme.

Optioneering and scheme development –

The North Suffolk Zonal Study is NWG's overarching strategy for delivering improvements in the North Suffolk area in response to identified issues in terms of both risks to supply and predicted future growth in the area. In formulating the strategy the study considered supply and demand forecasts and resilience and risk, before specifically considering appropriate solutions.

A number of the improvements identified have either been delivered or are in plan to be delivered. The next sequential improvement to secure supplies in the zone and specifically in Lowestoft is the Lound to Gorleston project, which is currently being planned for delivery. After delivery of this and a treatment works upgrade at Barsham, the final elements of the strategy are ensure a robust storage buffer in the zone, and also to enable greater flexibility in transferring water across the region, particularly to enable support to supply to Great Yarmouth should Ormesby experience a significant outage.

Enabling Mains Schemes at North Cove and Lowestoft

As part of Zonal Study resilience analysis was completed for each major asset in the supply system (pumping stations, storage 'cells' and water treatment works) to understand the number of properties that would be at risk of losing supply in the event of a complete asset failure and the time before supply would be lost to those properties.

In the case of relevant assets related Ormesby (which principally supports supply to Great Yarmouth) the results were as follows:

Asset	No properties losing supply	Population losing supply	Time before supply is lost
Ormesby Reservoir No.4	34,767	83,441	Immediate
Ormesby WTW Paterson Stream			22 hours

Given there is currently no other supply to Great Yarmouth then this analysis supports the view that in the absence of adequate transfer capacity between the other main treatment works at Barsham and Lound Ormesby WTW a critical single point of failure risk and any significant outage at the works will result in a large loss of supply water quality event lasting several days.

The zonal study then used the ALFA technique to assess the tendency to fail, financial consequence, and overall risk of strategic crossings, strategic mains and storage 'cells'. The relevant results relating to transfer capacity are as follows:

Storage	Name	Tendency to Fail	Consequence (£000's)	Overall Risk Score
WSK-MN530415	SK92A - Gorleston Reservoir to Lound Main	4.10	109,262	448
WSK-ST500028	Caister Tower Inner Tank	3.79	95,000	361

WSK-ST500029	Caister TW Reservoir No.1	3.24	95,000	309
WSK-ST500030	Caister TW Reservoir No.2	2.16	95,000	206

Tendency to fail is on a fail value scale of 1 to 10. On the basis of 'do nothing' this as a low to medium tendency to fail / high consequence event.

Barsham Treated Water Reservoir & Pumping Station

As part of North Suffolk Zonal Study resilience analysis was completed for each major asset in the supply system (pumping stations, storage 'cells' and water treatment works) to understand the number of properties that would be at risk of losing supply in the event of a complete asset failure and the time before supply would be lost to those properties. In the case of Barsham (which principally supports the supply into Lowestoft) the COF results were as follows:

Asset	No properties losing supply	Population losing supply	Time before supply is lost
Barsham No.1 Pumping Station	19,197	46,073	21 hours
Barsham No.2 Pumping Station	5,791	13,894	18 hours
Barsham Final Contact Tank Storage	31,544	75,706	Immediate

This analysis clearly indicates that lack of treated water storage in the Barsham area could provide a single point of failure to supply should the treatment works experience a total outage for any significant period of time.

The zonal study then used the ALFA technique to assess the tendency to fail, financial consequence, and overall risk of strategic crossings, strategic mains and storage 'cells'. The results for Barsham are as follows:

Storage	Name	Tendency to Fail	Consequence (£000's)	Overall Risk Score
WSK-ST700221	Barsham/Bores TW Contact Tank No.1	2.45	95,000	233

Tendency to fail is on a fail value scale of 1 to 10. On the basis of 'do nothing' this as a low tendency to fail / high consequence event.

Hence there is a requirement to increase storage in the area for the purposes of resilience. To address this risk, part of the zonal study focused specifically on solutions to address issues to supply in Lowestoft. One identified element of the supply strategy for Lowestoft was the requirement for improvements to Barsham Treated Water Storage and Pumping Plant.

Enabling Mains Schemes at North Cove and Lowestoft

The mains schemes to enable flexibility of water transfers within the area supplied by the current WTWs at Lound, Barsham and Ormesby have been identified as (1) North Cove to Carlton; and (2)

South Lowestoft. The required connections have been identified through robust network modelling and analysis, and can be summarised as follows:

(1) North Cove to Carlton: Lay 3800m of 600mm trunk main from North Cove to Carlton Colville Reservoir site to fully connect Barsham WTW to Lowestoft. Completion of this main will significantly increase the capacity to pump water from Barsham WTW to Lowestoft and will reduce the risk of a large loss of supply event should we experience a failure on the existing 15" strategic main;
(2) South Lowestoft Main: Lay 500m of 450mm trunk main from Love Lane to Recreation Ground, Walmer Road to increase the strategic transfer capability within the existing strategic 450mm mains. This will provide enhanced transfer capability between Barsham WTW and central and northern areas of Lowestoft thus providing a second source of supply in the event of an issue at either Lound WTW or within the existing strategic network.

Given the start and end points of the connections are constrained, then the only real options (other than do nothing) are related to any variants of the pipeline route and principally the longer North Cove to Carlton pipeline.

The options to address the remaining risks to supply at Great Yarmouth (manifested as outage at Ormesby WTW and lack of flexibility to support supplies from elsewhere in North Suffolk are as follows:

Option 1: Do Nothing
Option 2: Install the two mains schemes at North Cove and South Lowestoft using route 1
Option 3: Install the two mains schemes at North Cove and South Lowestoft using route 2

Option 1 – Do nothing deemed **Non-viable**

The risk of doing nothing is the risk posed to up to 60,000 properties in Great Yarmouth who would experience supply failures as a result of a significant outage at Ormesby WTW due to the lack of flexibility to transfer water from elsewhere in the North Suffolk network. The risk and consequence to customers is deemed unacceptable.

Options 2 and 3 – **Viable**

The mains schemes as outlined (North Cove to Carlton, and South Lowestoft) would improve resilience and alleviate the risk to supplies in the Great Yarmouth area in the event of a significant outage at Ormesby WTW.

Barsham Treated Water Reservoir & Pumping Station

At Barsham the wider strategy continues to be to develop the site as a central 'hub' works, with Lound and Ormesby effectively as satellite treatment works. Investment of c £15m is currently underway to upgrade Barsham WTW are planned for completion between 2019 and 2021 as part of our AMP6 capital maintenance programme. This investment, a new bores treatment stream will address the asset condition risks on the old plant and ensure we have a reliable output from the works in the future. In addition to this there is a requirement to address the quantified risk (highlighted above) due to the lack of storage capacity at Barsham. Currently there is a maximum of 2.5Ml of storage on site at Barsham although the reality is that only around 50% of this is available at any time.

As the supply strategy develops to enable Lound to supply Gorleston (this scheme is currently being delivered during AMP6) the flow from Barsham is likely to peak around 30-35 Ml/day. This means

that, should the process fail at any point, the supply will fail within around 30 minutes. This is recognised as significant high consequence risk.

Consideration on the required size for a new treated water storage facility took into account the balance between affordability and need. Given the previous analysis on the properties at risk, it was determined that 12-15 hours of storage (under average demand conditions) would be an appropriate requirements. This then equates to a storage volume of 20 Ml. In peak periods this would provide a buffer of 4 to 8 hours before supplies would be at risk.

The existing pumping plant has been installed progressively over the last 50 years and is now situated within two separate pumping stations. There are a number of issues associated with the pipework resulting in high station losses and losses of suction conditions. It is therefore proposed that a new pumping station should be constructed alongside the new treated water storage reservoir. This will ensure that the station losses are minimised and that the suction conditions are optimised.

Options to address the remaining risks of a large loss of supply event impacting Lowestoft are:

Option 1: Do Nothing
Option 2: Construction of New Treated Water Storage Reservoir with PS
Option 3: As per Option 2 but with different location/configuration
Option 4: As per Option 2 but with different location/configuration
Option 5: As per Option 2 but with different location/configuration
Option 6: As per Option 2 but with different location/configuration

Options 2 to 6 were evaluated as part of our analysis and planning for the construction of the new bores stream at Barsham WTW. The project, known as the *Barsham WTW Feasibility Study*, was produced by Grontmij in 2013. The configuration of the different options (in terms of key assets required) is summarised in Table 11.

Table 11 – Summary of options considered for Barsham WTW (Grontmij, 2013).

			Applicable				
Description – Bores WTW	**Plan Dims (m)**	**No.**	**OPTIONS**				
			1	**2**	**3**	**4**	**5**
River Works Contact Tank providing 690 m3 volume	21 x11 x3H	1					
Treated River Water Interstage Pumping Station	3 x 6	1					
Storage Tank providing 20 Ml	100x50x3H	1					
	125x40x4H	1					
High Lift Pumping Station housing Treated Water Pumps and MCC	9 x 18	1					
Surge Vessel for Lowestoft Treated water Pumps	As Existing	1					

Option 1: WTW offsite (north-east of current site), tank and PS on existing site (interstage PS)

Option 2: WTW offsite (south of exiting site), tank and PS on existing site
Option 3: WTW offsite (north-east of current site), tank and PS on existing site (no interstage PS)
Option 4: WTW located onsite, tank and PS located off-site
Option 5: WTW located onsite, demolition of old WTW allows space for tank and PS

Option 0: Do nothing **Non-Viable**

The risk of doing nothing is the risk posed to over 30,000 properties that would experience supply failures within a 3 hour outage at Barsham WTW due to the lack of treated water storage on the site. The risk and consequence to customers is deemed unacceptable.

Options 1 to 4: Treated Water Storage Tank and PS **Discounted**

All these options would improve resilience and remove the risk to supply from a 3 hour outage at the works. However all were all discounted due to a combination of both excessive cost of land purchase (tested through land agents for adjoining properties) and other issues including public rights of way, and location of archaeology (medieval road).

Option 5 - Treated Water Storage Tank and PS constructed within the current site **Recommended**

This option would also improve resilience and remove the risk to supply from a 3 hour outage at the works. The option was recommended by Grontmij because of land acquisition not being required and shorter connections required between existing structures.

Indicative costs were developed for all five options by Grontmij, with 40 year NPV costs for the storage tank and structures ranging from £11.08m to £13.28m

The decision was taken to accept the recommendation to construct a new service reservoir and pumping station at Barsham with additional mains reinforcement at North Cove and South Lowestoft to maximise the resilience benefit this investment would provide customers.

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

All costs for these schemes were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[24]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed cost for Barsham SR/WPS and North Cove/ S Lowestoft is £14.54m totex.

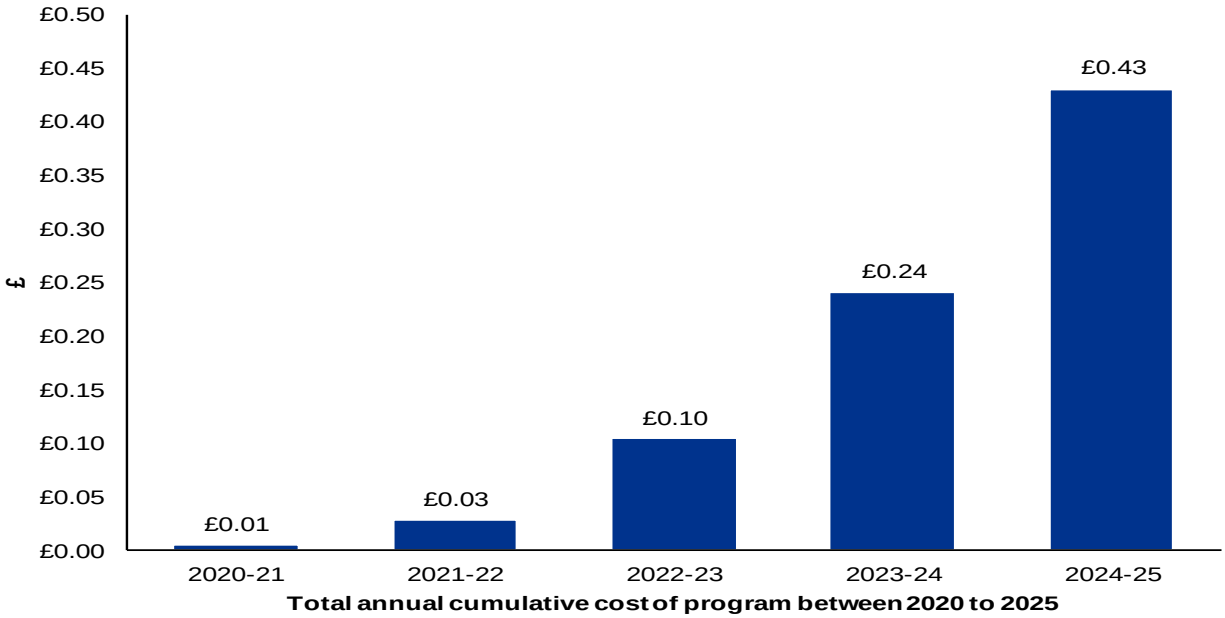
These costs were benchmarked and assured using a full iMod cost estimate using business as usual processes.

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance as previously described earlier.

[24] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology.

Affordability

The impact of these enhancement investments on customer bills are shown below with this scheme costing customers a one off cost of £0.43 on their bill between 2020 and 2025[25].



This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[26] driving significant improvements to average customer affordability.

We shared details of our plans for Barsham and North Cove / S Lowestoft with customers in the Essex and Suffolk area in a series of workshops held across the region. Customers from all areas were allowed to comment and indicate their support on all our resilience proposals even if they did not directly benefit from the improved resilience to service themselves.

Overall customer support for our plans to improve the resilience in our Suffolk area was supported by 100**%** of our ESW customers.

When all schemes were considered as a package **96%** of ESW customers supported our proposals.

Overall customer support can be summarised as follows:

Essex & Suffolk Water proposal	Yes	No	Unsure
Our plans for Essex area	89%	7%	4%
Our plans for Suffolk area	100%	0%	0%
Our plans for sites too critical to fail	100%	0%	0%
All water schemes as a package	96%	0%	4%

[25] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.

[26] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remain a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 2030[27] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

Customer protection

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers. Details are included in the main body of this document and in Chapter 4: Measuring and Incentivising Success of our business plan.

Board assurance

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers".

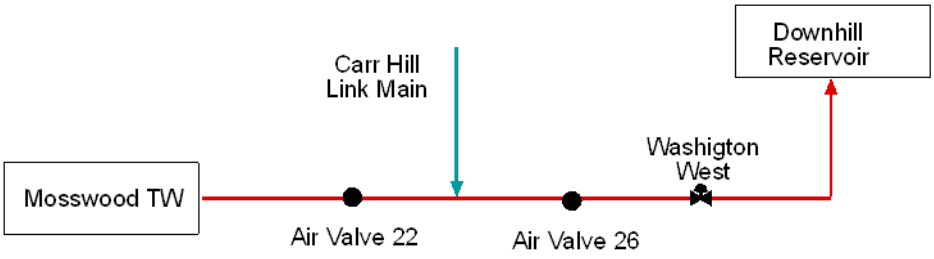
[27] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

Annex D - Springwell SR and South Tyneside strategic mains resilience

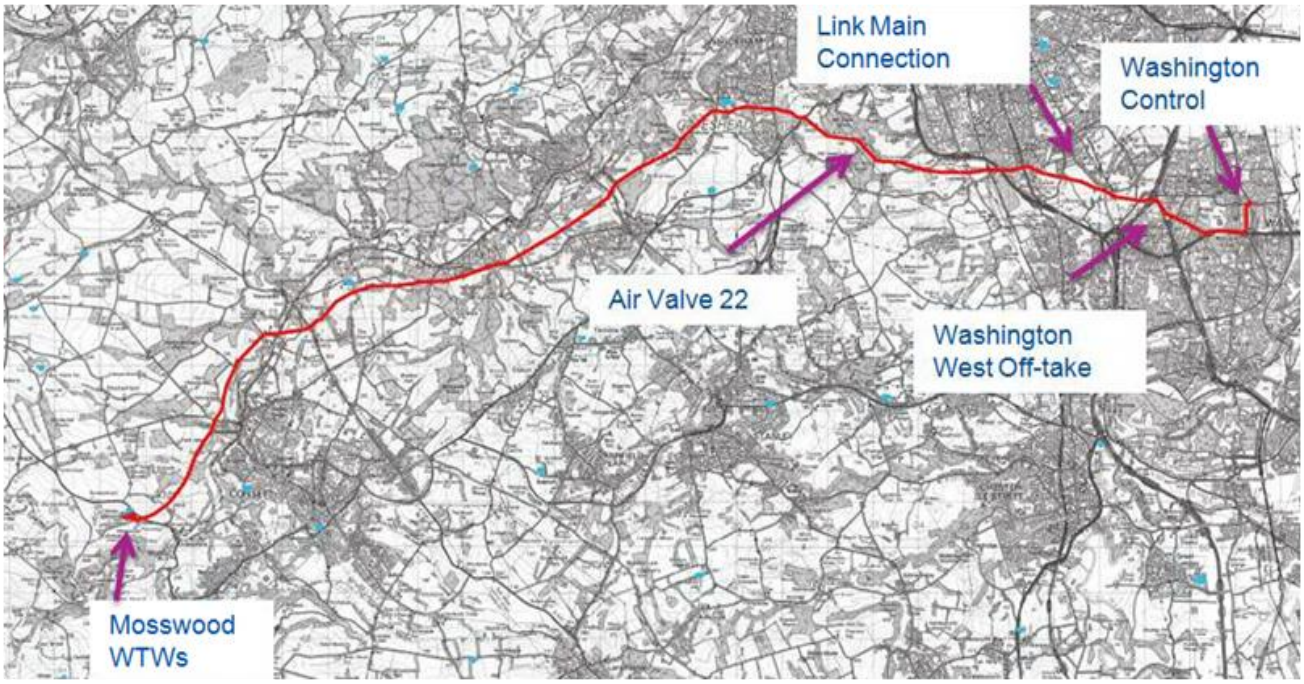
Name of claim	Springwell SR and South Tyneside strategic mains resilience
Name and identifier of related claim submitted in May 2018	n/a
Business plan table lines w here the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line 14
Total value of claim for AMP7	£42,580,000
Total opex of claim for AMP7	£0
Total capex of claim for AMP7	£42,580,000
Depreciation on capex in AMP7 (retail controls only)	n/a
Remaining capex required after AMP7 to complete construction	Expected to complete schemes between 2023 and 2025
Whole life totex of claim	n/a
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	3.5%
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	No
Need for investment/expenditure	Enhanced resilience
Need for the adjustment (if relevant)	Customer protection from loss of service risk
Outside management control (if relevant)	n/a
Best option for customers (if relevant)	Refer to main text of business case
Robustness and efficiency of claim's costs	Refer to main text of business case
Customer protection (if relevant)	Refer to main text of business case
Affordability (if relevant)	Refer to main text of business case
Board Assurance (if relevant)	Refer to main text of business case

Background Information -

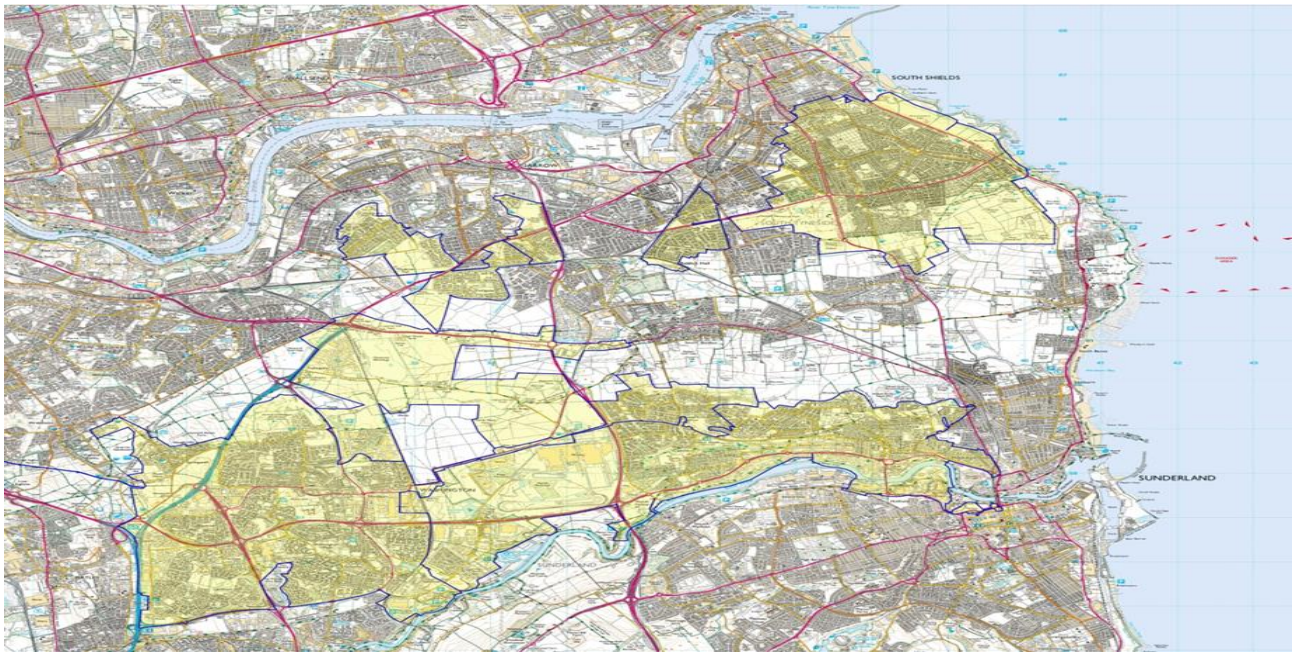
The Derwent North trunk main runs from Mosswood WTW to Washington West control. The main passes three significant assets on it way, Air valve 22, which is the most hydraulically sensitive point on the trunk main, the connection to the Carr Hill link main and air valve 26 near the site of the proposed new Springwell reservoir.



Mosswood WTW supplies a mean flow to Wearside of 75 Ml/d, with a maximum of 82 Ml/d and a minimum of 65 Ml/d depending upon production availability, water demand and raw water reservoir storage (Derwent IR / Kielder RW Transfer]. This supply can also be supplemented with water from the Tyne area via the Carr Hill Link main although network capacity constraints mean this is restricted to 3 days in total; 35Ml/d Day 1, 20Ml/d Day 2 and 10Ml/d Day 3. This connection is not usually used day to day due to one area receiving fluoridated water and the other not. It is anticipated that LHA's will likely soon align their policies on fluoridation so this constraint to cross zone transfer between Tyne and Central will be removed.



It is calculated that 99,000 customers between Air Valve 22 and Washington Control are not supported by strategic storage but supplied directly from Mosswood WTW final tanks 30 km away, so at most can be supplied for 6 - 8 hours from stored water. The highlighted areas in the diagram below show those regions of South Tyneside which are not supported by reservoir storage. Because of their elevation relative to other available water sources within the area these properties cannot be supplied from other system zones and are totally dependent upon the supply from Mosswood WTW.



Collectively, these properties have an average daily demand of 50.4 Ml and demand peaks at 63.7 Ml/d during summer. Mosswood clear water tanks (CWTs) have a design capacity of 13.5 Ml/d and it takes approximately 6 hours for water to travel the full length of the main. This means that these customers would at most be protected from any incident for 6 hours, but the network would most likely start to depressurise within a couple of hours with customers losing supply from 6-8 hours. The remaining population centers' supplied from the single Derwent North main has the benefit being supplied from a service reservoir, Downhill SR. However this reservoir only has 24-36 hours of available storage and will be reliant on our ability to utilise the limited cross zone transfer capability if this was available.

The customers in these areas are at risk of losing supply if the Derwent North trunk main fails or we have to stop water production at Mosswood WTW. There are two strategic mains crossings where a burst would be especially time-consuming and difficult to fix; the A1 [M] and the East Coast main line railway. Such mains repairs or the construction of above ground bypasses will take at least 2 to 3 days to complete. By that time we estimate that up to 150,000 customers in the South Tyne and Wearside are will have lost their water supply.

There would be a huge logistical and reputational impact if we lost supply to this number of properties as the number of customers involved takes the event beyond NW's ability to manage the situation.

Derwent North mains burst, 2012

We have only had 1 mains failure on this strategic main in the recent past (Figure 24). In 2012 a scour valve on the main catastrophically failed. It was fortunate that the burst was located just before the River Team strategic crossing next to the A1 [M].

Flood water was discharging directly into the River Team as shown below. After discussions with the Environment Agency it was agreed the environmental impact of the discharge of chlorinated water in to the water course was negligible and we were not required to isolate the main immediately.

This afforded our Regional Control and local operations team time to prepare for a full shut down of the Derwent North main and we were in Silver Incident mode for the duration of this event. For many of our staff this was their first experience of fully shutting down the flows in this main.

Figure 24 – Derwent North main failure at River Teams, 2010.

By careful network operation and utilisation of the cross zonal transfer we were able to maximise storage in Downhill SR, maintain supply to the 52,000 properties directly fed from the main and effect a repair to the valve which took around 18 hours to complete. Whilst we were fortunate on this occasion a catastrophic failure on this main requiring immediate isolation, whilst a low likelihood event has significant potential for a high consequence loss of supply event impacting up to 150,000 properties in South Tyneside and Wearside.
The objective of these schemes is to ensure future security of supply on the gravity supply arm from Mosswood WTW into South Tyneside and Wearside whilst ensuring that decisions around water quality are never compromised by sufficiency requirements.

Need for the investment / expenditure –

This scheme aims to address a number of specific risks identified from;

- A number of single point of failure risks identified on the Derwent North strategic main during our consequence of failure analysis;
- The likelihood of a failure at these single points on the Derwent North strategic main identified by the tendency to fail analysis;
- The lack of strategic storage on the Derwent North strategic main identified in the Wearside Strategic Storage Study;
- Recent asset failures on the Derwent North main.

Primary Risk

The primary risk that this investment will address is the impact from a catastrophic failure of the Derwent North strategic main. This is a single strategic main that supply's the northern areas of South Tyneside and Wearside. It is the only direct supply for 99,000 customers with no direct reservoir storage and very limited alternative supply capacity and supports up to 150,000 customers in total.

This main also has a number of strategic crossings [A1M, A194M, River Teams and East Coast main railway line] and we currently do not have a respond and recover capability sufficient enough to respond to such an event.

Secondary Risk

Secondary risks that this investment will address include a large loss of supply event lasting more than three days as a result of an issue stopping water production at Mosswood WTW. This

treatment works is the primary single source of water for the northern areas of South Tyneside and Wearside. Connectivity to neighbouring supply zones is limited in capacity and hydraulic transfer capability.

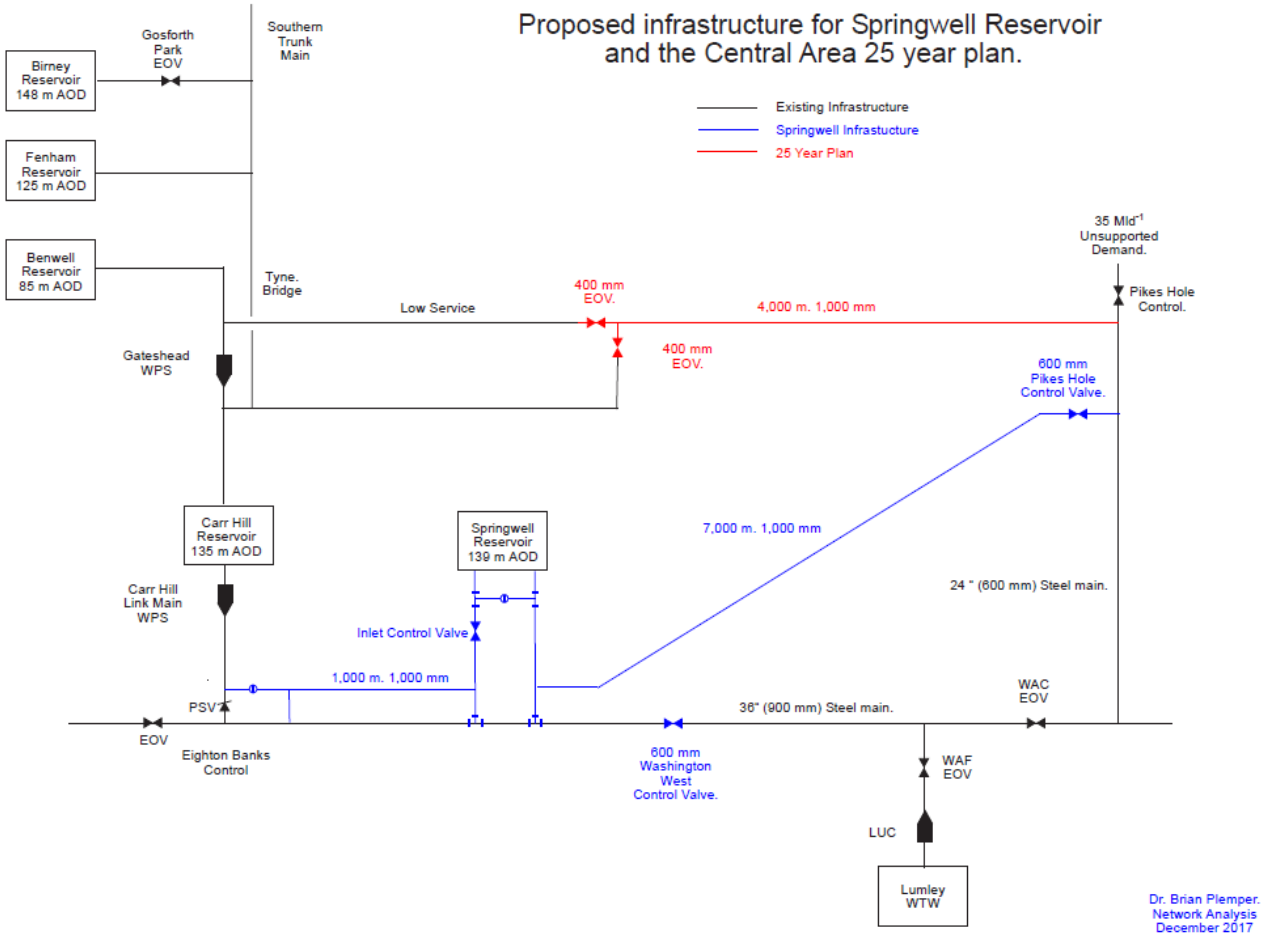
A number of strategic storage reservoirs, Including Downhill No1 are also approaching the end of their asset life (estimated to be within the next 15 – 20 years). We need to ensure we have the flexibility within our networks to manage future uncertainty and risk from these ageing assets.

Best Options for Customers -

We will construct a new 62Ml capacity service reservoir at Springwell in Gateshead and lay approximately 12.5km of new strategic trunk main, including fully automated flow control capability to provide both strategic storage and a secondary supply source for all those customers currently supplied directly and indirectly by the single Derwent North main (Figure 25). We will deliver the work concurrently in 2 distinct phases;

1. Construct Springwell SR with a 62Ml capacity including the laying of 1.5km of new 600mm main to directly connect the Tyne cross zonal transfer main (known as Carr Hill Link) to Springwell SR;
2. Lay 11km of 1000m main from Springwell SR to Pikes Hole, a key control point (KCP) for the South Tyneside network and then to Heworth in Gateshead creating a new cross zonal transfer from Central into Tyne to support an area of Tyne low service with a secondary alternative source of supply. All zonal transfers will include full flow monitoring and automated control capability which enables them to be managed from our Regional Control Centre using our Aquadapt network control software.

Figure 25 – proposed network configuration of South Tyneside



This investment will reduce the impact and duration from a loss of supply event by providing an additional two to three days of strategic storage to those customers both directly and indirectly supplied from both Mosswood WTW and the Derwent North main. In addition this investment will support the wider Wearside community in future years as other strategic service reservoirs become uneconomical to operate and repair.

Risk reduction benefit –

These schemes at Springwell and South Tyneside have been assessed by NWL's Asset Planning team and risk scored. This ensures we are able to assess this investment against all other schemes in a consistent and fair manner. The scheme has been scored as follows:

Resilience Project	Risk reduction benefit	Customers benefiting (Nr)	Capex (£m)	Opex (£m)	£ per customer benefited	Risk Score- Before	Risk Score - After	Risk Reduction delivered
Springwell SR -62Ml capacity	Provide strategic storage for up to 3 days	99,821	£16.20		£426.56	213.47	2.14	211.34

1.5km of 600mm main Carr Hill Link to Springwell SR	Provide additional strategic transfer capability		£3.00			170.78	4.27	166.51
7km of 1000 mm main from Springwell to Pikes Hole plus EOV control	Provide additional strategic transfer capability		£14.86			170.78	11.39	159.39
4km of 1000mm main between Heworth and Pikes Hole plus EOV control	Provide additional strategic transfer capability		£8.52			170.78	11.39	159.39

Using this assessment indicates that the risk to customers will reduce by 96% as a result of implementing the scheme.

Optioneering and scheme development –

The primary risk that a new service reservoir at Springwell, Gateshead and additional reinforcement of the strategic network in South Tyneside is aimed at addressing is a catastrophic failure of the Derwent North strategic main.

We have previously assessed both the consequence of such a failure of this main and the likelihood as part of analysis of our critical assets undertaken over recent years including looking at what options are available to us to reduce the consequence of a failure by implementing solutions that either reduce or remove the risk.

It should be noted that population counts often vary depending on when reports are undertaken and the data source used. However the error on populations served by critical assets is not material as the population sizes we reference are often very large and significant.

Consequence of Failure analysis – Derwent North

Within the Wearside distribution area, a total of 88 critical assets were identified. These include 3 treatment works, 19 strategic mains, 51 strategic crossings, 1 raw water reservoir, 3 raw water crossings, 3 key control point, 1 pumping station and 7 service reservoirs. The failure of any of these assets, even after taking any mitigation measures currently available to us would still result in the loss of supply to between 35,000 and 150,000 properties.

These assets were categorised into 6 groups based on the area affected:

1) Mosswood WTW: with 170,000 customers directly supplied from this works with no suitable alternative source of supply;
2) Derwent North main: with 99,000 customers supplied directly from Mosswood WTW;
3) Durham South main: with 70,000 customers supplied from Mosswood WTW via the Castleside WPS/SR;

4) Sunderland and South Tyne: with 150,000 customers supplied via Washington KCP's; 115,000 supplied from Downhill SR; 65,000 from Stoneygate SR; and 40,000 from Rainton KCP;
5) Honey Hill WTW: with 90,000 customers supplied via Mosswood WTW and the Derwent South main;
6) Wear Valley WTW: with 60,000 customers supplied from Wear Valley WTW.

For the Derwent North main (Bullet 2) each critical asset was assessed and a consequence score calculated as shown in Table 12.

Stakeholder workshops were held between Strategic Networks, Network Analysis, Water Quality and Asset Planning to discuss and identify potential options for mitigation of a catastrophic event affecting the assets above. The aim of the workshops was identify potential schemes that would reduce or remove the consequences of any of the assets failing (i.e. ranging from new valve to new WTW) and was based on the tacit technical knowledge and understanding these people had on this network. At the stakeholder meetings, options to improve the resilience of the network to mitigate against failure of critical assets resulting in a loss of supply impacting more than 10,000 properties were identified. This value was chosen as we had an alternative water respond and recover capability that would cope with events impacting less than 10,000 properties at that time. Our AMP7 plans are to increase this capability to c 50,000 properties by 2025.

The outputs from these workshops were a matrix linking the critical assets to the identified potential options. The impact of the option at mitigating against critical asset failure was then identified terms of whether the Risk Remained, the Risk Reduced or the Risk Removed. These matrixes for Derwent North main are detailed in Table 13.

It can be seen a number of options existing that could address some or all of the risks on the Derwent North main. **The most optimal solution identified was a service reservoir located at Springwell, Gateshead as it was assessed as removing the risk of a loss of supply to the 150,000 population should we have a failure of any of the 16 critical sections on this strategic main**.

Tendency to fail analysis

As the critical assets on the Derwent North main are underground strategic assets they have been included in the analysis we have undertaken to quantify the likelihood of them failing as described in previous sections of this business case. This is the TTF (tendency to fail) score and the strategic crossings on the Derwent North main is shown in Table 14.

This theoretical risk score incorporates both likelihood and consequence and is based on the likelihood and consequence of the failure. Of the 1773 strategic crossings in NW the theoretical TTF score ranges from **8.56** to **0** (no data).

The average score is **5.88** whilst the Derwent North crossings score from **7.2** to **5.16**. The average TTF score for Derwent North is **6.08**. The conclusion from this analysis would indicate that whilst the average tendency for this main to fail is no greater than other crossings some sections of this main score above average.

Overall we would conclude that a failure on this main would be assessed as low likelihood / high consequence.

Table 12- Consequence of Failure analysis – Derwent North critical assets and consequence scores

ASSET CONS OF FAILURE	ASSET REF	ASSET TYPE	Normal pop Supplied	Pop at risk post Mitigation after					Mitigation Comments	Area	Supply	CP0 ID
				8 HRS	1 DAY	3 DAY	TIME TO SUPPLY LOSS	POP SUPPLY LOSS				
W5 - Derwent North (Downstream Carr Hill Link)	W5	Strategic Main	270,000	50000	100000	150,000	1	150000	Downstream of Carr Hill Link, Max other sources deplete storage	Wear	Derwent North	I00000020091
W5 - Crossing Cut-Throat Lane		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020419
W5 - Crossing of A1 Smithy Lane		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020420
W5 - Crossing of A167 Durham Rd		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020421
W5 - Crossing of A182		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020422
W5 - Crossing of A194 Washington		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020423
W5 - Crossing of A68 Mosswood		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020424
W5 - Crossing of A692 Sunniside/Streetgate		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020425
W5 - Crossing of A694 Ebchester		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020426
W5 - Crossing of Ebchester Burn		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020590
W5 - Crossing of ECML Lamesly		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020591
W5 - Crossing of Letch Burn		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020592
W5 - Crossing of		Strategic	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent	I00000020593

Minor road Lamesly		Crossing									North	
W5 - Crossing of River Derwent Ebchester		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020594
W5 - Crossing of River Team Lamesley		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020595
W5 - Crossing of Shotleyfield Burn		Strategic Crossing	270,307	50,000	70,000	150,000	1	70000	Mosswood Sunderland	Wear	Derwent North	I00000020596

Table 13 – Derwent North Area Resilience Matrix including optioneering

	Options	W5-Derwent North (Down-stream Carr Hill Link)	W5-Crossing of A68 Moss-wood	W5-Crossing of Letch Burn	W5-Crossing of Shotley-field Burn	W5-Crossing of River Derwent Ebchester	W5-Crossing of A694 Ebchester	W5-Crossing of Ebchester Burn	W5-Crossing Cut-Throat Lane	W5-Crossing of A692 Sunniside /Streetgate	W5-Crossing of River Team Lamesley	W5-Crossing of Minor road Lamesley	W5-Crossing of ECML Lamesley	W5-Crossing of A1 Smithy Lane	W5-Crossing of A167 Durham Rd	W5-Crossing of A182	W5-Crossing of A194 Washington
Option 1	Springwell Reservoir with appropriate connections into South Tyneside and back into W5 - increased storage in the area; Increase 15" Low Service at Heworth into South Tyneside with connections at DixiLands/Whitemere Pool; Plus Carhill Pumping station.	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed	Risk Removed
Option 2	Valves and rider points at crossing	Risk Remains	Risk Remains	Risk Reduced	Risk Reduced	Risk Remains	Risk Remains	Risk Reduced	Risk Reduced	Risk Reduced	Risk Reduced	Risk Reduced	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains
Option 3	Dual Crossings (A68)	Risk Remains	Risk Removed	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains
Option 4	Dual Crossings (R. Derwent and A694)	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Removed	Risk Removed	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains
Option 5	Dual Crossings (River Team and Minor road Lamesley)	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Removed	Risk Removed	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains
Option 6	Dual Crossings (A182 and A194)	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Removed	Risk Removed
Option 7	Duplicate Main using alternative route - Cross A1 at Lamesely - Chowdene Bank - Hertford - A167	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Removed					Risk Remains	Risk Remains

Table 14– TTF score for Derwent North strategic crossings

Crossing. Id	Name	Main ID	Length	Material. Band	Diam	TTF.2017	syszone	Location
ANW-XNG700329	RIVER TEAM LAMESLEY	WTE-MN568130	2477.23	Steel	919	7.2	SZ10	RIVER
ANW-XNG701382	PONTBURN BRIDGE	WTE-MN547771	26.18	Steel	919	7.1	SZ10	RIVER
ANW-XNG700467	EBCHESTER BURN	WTE-MN568118	2929.08	Steel	919	7.1	SZ10	RIVER
ANW-XNG701382	PONTBURN BRIDGE	WTE-MN547770	1027.23	Steel	919	6.62	SZ10	RIVER
ANW-XNG700321	RAIL EAST HOUSE FARM	WTE-MN568062	785.03	Steel	600	6	SZ10	RAIL
ANW-XNG700468	LETCHBURN CROSSING	WTE-MN547630	213.44	Steel	919	5.9	SZ10	RIVER
ANW-XNG700218	RIVER DERWENT EBCHESTER	WTE-MN568180	993.67	Steel	919	5.9	SZ10	RIVER
ANW-XNG700469	SHOTLEYFIELD BURN	WTE-MN568198	657.01	Steel	919	5.9	SZ10	RIVER
ANW-XNG700224	A1(T) SMITHY LANE	WTE-MN547887	1236.58	Steel	919	5.7	SZ10	ROAD
ANW-XNG700226	A167 DURHAM ROAD	WTE-MN16250SN	539.37	Steel	919	5.64	SZ10	ROAD
ANW-XNG700222	A694 EBCHESTER	WTE-MN568211	1486.54	Steel	919	5.64	SZ10	ROAD
ANW-XNG700223	A692 SUNNISIDE / STREETGATE	WTE-MN547857	704.43	Steel	919	5.6	SZ10	ROAD
ANW-XNG700220	A68 MOSSWOOD	WTE-MN568137	1785.52	Steel	919	5.6	SZ10	ROAD
ANW-XNG700219	A194(M) WASHINGTON	WTE-MN568181	897.23	Steel	919	5.16	SZ10	ROAD
					Average	6.08		

Consequence of Failure analysis – Sunderland and South Tyne

For the South Tyneside mains and KCP's (Bullet 4) we have conducted a similar exercise on those mains and service reservoirs. This assessment highlights that the consequence risks are even greater in this part of the network with the loss of some KCP assets resulting in a loss of supply for over 50,000 customers within 7 hours (Table 15)

Table 15 - Consequence of Failure analysis – highest COF scoring Sunderland and South Tyne critical assets and consequence scores

Asset Set Cons of Failure	Asset Ref	Asset Type	Normal pop Supplied	Pop at risk post Mitigation after				
				8 Hrs	1 Day	3 Day	Time to supply loss	Pop Supply Loss
Washington West Control Total Loss of Supply		Key Control Point	270,000	50,000	100,000	150,000	0.5	150000
Washington Control		Key Control Point	225,000	50,000	100,000	150,000	0.5	150000
Downhill SR		Service Reservoir	115,000	115,000	115,000	115,000	0.3	115,000
Stoneygate SR		Service Reservoir	65,000	65,000	65,000	65,000	0.3	65000

Optioneering took place and a number of options were considered (Table 16). The most optimal solution identified was a service reservoir located at Springwell, Gateshead plus additional reinforcement of the South Tyneside strategic network would be the best solution to address the risks from a number of critical assets including the Derwent North main, KCPs and Downhill SR.

Table 16 – Sunderland and South Tyne Area Resilience Matrix including optioneering

Options		Washington West Control Total Loss of Supply	Washington Control	W22 - Washington to Hylton	Downhill SR	W25 - Downhill SR Outlet	SZ10-03 Downhill SR Outlet	Rainton Control	Stoneygate SR	W54 - Stoneygate Inlet	W56 - Stoneygate Outlet	W56 - Crossing of A690	W56 - Crossing of A19 Herrington Hill
Option 1	Springwell Reservoir with appropriate connections into South Tyneside - increased storage in the area; increase 15"Low Service at Heworth into South Tyneside with connections at DixiLands/Whitemere Pool; Plus Carhill Pumping station.	Risk Removed	Risk Removed	No issue, has been turned off in the past with no loss of supply to customers	Risk Removed	Risk Removed	Risk Removed	Risk Remains	No issue post August 12 when a bypass is to be installed	Risk Remains	No issue post August 12 when a bypass is to be installed	No issue	No issue
Option 2	Increase capacity of Lumley enabling more water into supply	Risk Reduced	Risk Reduced		Risk Remains	Risk Remains	Risk Remains	Risk Remains		Risk Remains			
Option 3	New Main from Springwell to Sunderland	Risk Reduced	Risk Reduced		Risk Reduced	Risk Reduced	Risk Reduced	Risk Remains		Risk Remains			
Option 4	Storage at Mill Hill	Risk Remains	Risk Remains		Risk Remains	Risk Remains	Risk Remains	Risk Reduced		Risk Remains			
Option 5	Bypass around Rainton from Stoneygate 12" to Mill Hill supply and increase BS and main to 26"	Risk Remains	Risk Remains		Risk Remains	Risk Remains	Risk Remains	Risk Removed		Risk Remains			
Option 6	High Moorsley Link Main with link on inlet to use head from Wear Valley Burnhope Main	Risk Remains	Risk Remains		Risk Remains	Risk Remains	Risk Remains	Risk Removed		Risk Remains			
Option 7	Duplicate W54	Risk Remains	Risk Remains		Risk Remains	Risk Remains	Risk Remains	Risk Remains		Risk Removed			

APPENDIX 3.2
WATER RESILIENCE

Tendency to fail analysis

TTF scores for the remainder of the strategic mains and crossings in the South Tyneside area are covered under the previous section. No TTF analysis has been conducted on the KCP's as these are predominantly classed as above ground assets located within secure buildings with additional security measures in place. Additional resilience investment at our highest risk KCP's, including in South Tyneside was identified during our resilience assessments at our top 63 'Too Critical to Fail' sites and will be delivered as a separate programme of resilience work between 2020 and 2025. **The risk from these assets is therefore considered low likelihood high consequence.**

Of the 357 service reservoir compartments assessed in ALFA the theoretical TTF score ranges from **4.27** to **1.17**. The average TTF score for service reservoirs in 2017 was **2.54** and in 2014 it was **2.52**. This small change reflects the slow deterioration of these predominantly below ground concrete structures.

For Downhill SR the TTF score ranges between **3.21** and **3.85** (Table 177). The improvement in scores between 2014 and 2017 reflect the ongoing inspection and remedial repairs we undertake as part of our reservoir maintenance strategy. All three reservoirs have been subject to planned cleaning and engineering inspection in the last 4 years. The replacement of Downhill No1, built in 1899 is identified in the Wearside Strategic Storage Study (Entec, 2011).

Table 17 - TTF score for Downhill SR

GIS.Id	Compartment	System Zone	Capacity	Year Built	Age	Tendency to Fail 2017	Tendency to Fail 2014	Difference
WTE-ST500067	Downhill North (2)	10	13.36	1926	91		3.895	
WTE-ST100150SN	Downhill East (1)	10	13.74	1899	118	3.715	4.075	-0.36
WTE-ST500068	Downhill West (3)	10	25.285	1985	32	3.215	3.475	-0.26

Overall we would conclude that a failure of this reservoir would be assessed as low to medium likelihood and high consequence.

The resilience workshop for the Wearside and South Tyneside confirmed that the construction of Springwell SR would provide resilience for the following critical assets in the Mosswood and Derwent North Supply Areas:

- Derwent to Mosswood below ground crossing of B6278
- Derwent to Mosswood below River Derwent crossing north pipeline
- Derwent to Mosswood Below River Derwent Crossing South Pipeline
- Mosswood WTW
- W5 - Derwent North (Downstream Carr Hill Link)
- W5 - Crossing of A68 Mosswood
- W5 - Crossing of Letch Burn
- W5 - Crossing of Shotleyfield Burn
- W5 - Crossing of River Derwent Ebchester
- W5 - Crossing of A694 Ebchester
- W5 - Crossing of Ebchester Burn
- W5 - Crossing Cut-Throat Lane
- W5 - Crossing of A692 Sunniside / Streetgate
- W5 - Crossing of River Team Lamesley
- W5 - Crossing of Minor road Lamesley

- W5 - Crossing of ECML Lamesley
- W5 - Crossing of A1 Smithy Lane
- W5 - Crossing of A167 Durham Rd
- W5 - Crossing of A182
- W5 - Crossing of A194 Washington

Therefore rather than duplication of the Derwent North Main (W5), or each individual strategic crossing along this main, storage at Springhill would continue to ensure supplies for up to 150.000 population was maintained for up to 3 days rather than the current 8 – 24 hours should a catastrophic failure occur at any of the above assets.

The construction of strategic storage at Springwell was also identified as the most appropriate mitigation for the South Tyne and Sunderland supply area in the event of failure of the following critical assets:

- Washington West Control Total Loss of Supply
- Washington Control
- Downhill SR
- W25 - Downhill SR Outlet
- SZ10-03 Downhill SR Outlet

It was noted that if Springwell SR was constructed with the appropriate connections allowing the supply of water back into Tyneside it would also help with resilience for a number of critical assets located in the Low Service, High Service and Gateshead Supply Areas. We will explore these opportunities further as part of the upcoming Tyne and Central strategic zonal studies aligned to our ambition for a fully integrated potable water grid for the NE of England by 2045.

Wearside Strategic Storage Study

The Wearside Strategic Storage study identified a new service reservoir would be required to address the current shortfall in strategic storage to South Tyneside as well as being providing a suitable long term solution to help address the continuing deterioration of the service reservoirs in South Tyneside and Wearside. As part of this study a number of options were considered for Springwell

Option 1 – Do nothing **Non Viable**

The risk of doing nothing is the risk posed to 52,147 properties not connected to a strategic storage reservoir in Wearside as well as a general storage deficit in the wider area. The 52,147 properties are fed directly by the Derwent main from Mosswood WTW. In the event of the WTW being out of supply, a burst on the 30 km North Derwent main we can supply these properties for up to 6 -8 hours. The Carr Hill link can provide up 30 ML on day one of an incident which is approximately half the daily demand of just 52.000 properties. After that the length of an interruption would vary depending on the cause but for a strategic asset failure we can expect it to take at least 24 -48 hours to resolve the problem. By 2040 Mill Hill 2, Downhill 1 and Ryhope SRs could all need to be de-commissioned due to age, condition and being situated on unsuitable terrain. This would reduce the overall storage in the Wearside area (258,308 props) by 50.6 ML (6 hours of demand) so the risk of a wide scale supply issue would be even greater.

All viable options were based on constructing a new service reservoir in Springwell village. Springwell was identified as the most suitable location through three main criteria for the new reservoir:

1. Site must be at least 8 acres to accommodate the required long term storage;
2. Must support 52,000 properties currently without storage;
3. Must be at a strategic point for connectivity so that the Ryhope, Downhill and Stoneygate supply areas can be fed from this site by expanding the reservoir over time.

In practice, meeting the above criteria required that:

- The storage should be located on or in close proximity to the existing Derwent North Pipeline;
- It should be upstream (west) of the first major take off at Washington West for connectivity;
- It should be as close to Washington West as possible to maximise resilience;
- The elevation needs to be low enough to allow flows from Mosswood to be maximised;
- The elevation needs to be high enough to supply properties downstream.

It should be noted that all solutions took into account of the Carr Hill link which can supply an estimated 30 ML into Wearside on day one, 20Ml on day 2 and 10Ml on day 3 of an incident. As Tyneside water is fluoridated it may not be supplied into Sunderland under the current LHA policy except in an emergency. This would mean that 60ML of water would only be available to support Wearside in emergencies but not currently during normal operations. A link directly from the supply pipe into the reservoir was considered a wise precaution so that the reservoir could be filled from two independent sources, and this was included in all options.

In terms of future water demand, the Wearside Strategic Storage study found that it was more likely that demand would decrease than increase over the following 15 years based on analysis of expected growth against reduced leakage and reduction in demand from industry. For this reason growth was not factored into the calculations.

Figure 26 - Wearside Storage Requirements Summary. Wearside Strategic Storage Study

Peak demand in Wearside	193.75 ML/d
Storage capacity in Wearside	121 ML
Deficit	72.75 ML/d
Peak demand for 52,146 props	63.7 ML/d
Storage requirement	63.7 – 72.75 ML
Carr Hill link supply capacity (from Tyne)	<30 ML/d
Revised storage requirement	33.7 – 42.75 ML
Total capacity of reservoirs with no more than 25 years life remaining	50.61 ML

The storage deficit of 72.75 ML in Wearside justifies building a reservoir and taking account of the Carr Hill link, this reduces to 42.75 ML. Approximately 63.7 ML of this resource is required to supply 52,147 properties currently without any storage. Springwell is in a strategic location to both supply this area and balance the current storage deficit in the whole of Wearside.

Feasibility Recommendation - Build initial 38.5 Ml capacity reservoir at Springwell and expand High Moorsley SR by 10 Ml. **Deemed Non-Viable**

The recommendation of the Wearside Strategic Storage study (Entec, 2011) was that we should build at two sites: Springwell and High Moorsley. The stakeholder group agreed that the proposal to expand High Moorsley was not cost beneficial because of the length of main required to connect this into the Wearside area and how this affected the costs as calculated for the feasibility report. It would make more financial sense to build a bigger reservoir at Springwell and meet the need for additional storage at much lower cost.

Option 1 – Build a 42.75 ML SR at Springwell

The 52,147 properties in Wearside fed directly by the Derwent North main from Mosswood WTW would have 24 hours of storage. In the event of failure at the WTW, a burst upstream on the North Derwent main, or if demand is greater than supply then their supplies would be protected, reducing the probability of loss of supply significantly. This option leaves a significant residual risk of failure

on the 3km stretch of main which would become the outlet of Springwell reservoir. This would become even more critical if the whole Wearside area were to depend on Springwell SR in future.

Option 2 – Build a 62 ML SR at Springwell and duplicate the outlet

Building a 62 ML reservoir at Springwell will balance the storage deficit in Wearside and protect customers against losing supplies as a result of a failure in the chain of supply upstream, and takes into account peak demand. However, the single outlet main would leave all of Wearside exposed to loss of supply in the event of a burst on that 3km stretch. This option therefore includes duplicating a short stretch of pipe from Carr Hill to secure supplies into the Wearside area in any emergency, upstream or downstream.

Option 3 – Build a 62 ML SR, duplicate outlet and connect to Stoneygate system

A full solution to the storage capacity issue in Wearside begins with a reservoir but must also include enhancements to the network to transfer the water to the whole area. The Stoneygate system carries a large proportion of the risk with a single compartment tank which is operable but difficult to isolate, and customer supplies / low pressures need to be carefully managed. A connection from Springwell into the system would be required.

Option 4 - Build a 92.75 ML SR at Springwell

The Entec study took a long term view of Wearside storage and anticipated future loss of storage capacity resulting from deterioration of assets and when this storage loss could potentially be made up at Springwell through phasing its construction. Building additional storage capacity at Springwell was identified as the solution to the problems we can anticipate over the next 15-40 years as well as to our storage deficit in the present, but a decision could be taken to build the complete reservoir solution at one time given the risks associated with existing reservoirs and the relatively short life expectancy. Building all the required storage at one time may be more efficient than phasing construction.

A new tank at Springwell could accommodate a catastrophic failure of any of the older reservoirs in Wearside whilst still providing greater availability of supplies than is currently present. We could therefore .afford to react to such a failure by reviewing the programme of expansion Springwell and accelerating plans if necessary.

Option 5 – Build a 92.75 ML SR at Springwell and duplicate the outlet

To link with Carr Hill as per option 2.

Non-viable options

Duplicate main from Mosswood & upsize onsite storage: the costs of duplicating 30km of main from Mosswood to Wearside would be vast. This would only secure the availability of storage from on-site tanks, enough to keep customers in supply for 6 -8 hours. To achieve 24 hours storage in Wearside, a large reservoir would have to be constructed at the WTW. Overall costs would be in excess of £40 million.

Expand / rebuild reservoirs on existing sites: There are very limited options in terms of expanding or rebuilding reservoirs on existing sites. The ground conditions are generally unsuitable for construction and very little land is owned by NW or available to purchase.

Timescale for delivery of each option

Delivery would be in AMP7 as the work is part of our enhancement package for Ofwat around resilience. The project is a key part of the 25 year resilience plan for this area. Capital costs and net additional operating costs;

Option 1: £11,976,300

Option 2: £17,964,053

Option 3: Not progressed at this time

Option 4: £29,968,056

Option 5: £32,449,287

Preferred option was Option 2, a new 62Ml service reservoir at Springwell with outlet duplication with a cost estimate of £17,964,053.

The best option to address these issues is to build a 62 ML reservoir at Springwell, which will secure supplies to all properties in the Wearside area by providing at least 24 hours of storage. Duplication of what would become the outlet of Springwell reservoir will increase the resilience of the asset and effectively reduce the risk to service in Sunderland and the surrounding areas. This solution will include a new link main to Carr Hill which will provide an additional 60Ml of water over 3 days. This solution will extend the available supply of water to South Tyneside and Wearside in the event of a catastrophic failure of the Derwent North main to 2-3 days. This should afford NW sufficient time to respond and recover from such a catastrophic failure on this critical pipeline.

It is recognised that linkages between a new Springwell SR and the Stoneygate system would still be required long term. Optioneering for these connections will therefore be considered in readiness for AMP8 and the wider central area strategic storage and resilience plan.

The option of a larger (90+ Ml) tank at Springwell was not considered justifiable on the basis that the majority of existing storage is likely to last another 15 years at least, and that is considered a cautious view taken by the feasibility study around the reliability of existing assets.

A full hydraulic assessment has been carried out on this proposed location and the construction of the reservoir. This has assessed the following criteria:

- AOD / height of tank;
- Flows and treated water levels vs pressures in the supply system;
- Reservoir capacity and footprint;
- Mains reinforcements.

The original optioneering has therefore been validated and the design in principle in terms of hydraulics has been determined for the new service reservoir.

In summary a number of our investigations and analysis indicate that a service reservoir of 62Ml capacity located at Springwell, Gateshead and additional mains reinforcement to address the current single source of failure risk from the Derwent North main is the preferred option to address the current highest consequence risks identified within this system. It should be noted that the South Tyneside mains reinforcement scheme is fully dependant on the construction of Springwell SR in order to deliver the risk reduction benefit and improvements in the resilience of the Derwent North and South Tyneside strategic network. Secondary schemes at Mosswood WTW [both enhanced and base capital funded] will influence the overall Derwent North and South Tyneside system resilience.

Land at Mount Lane, Gateshead

NW currently own land at Springwell Village, Gateshead which was purchased in 2017 in anticipation of the construction of a new service reservoir. As part of our PR19 planning we have commenced the process of applying for relevant planning permission for a 62Ml capacity service reservoir, the largest we can construct at this location (Figure 27).

We explored a total of three locations in the vicinity of Springwell Village and as part of the optioneering process two sites were discounted as not suitable due to network hydraulic and likely engineering and construction complexities. The selected location, Mount Lane shown in below was confirmed as the optimum location due to the size of the plot of land available and its location and elevation in relation to the Derwent North and Carr Hill Link mains.

The structure will be designed and built in line with the NWG design specification for service reservoirs and Regulation 31, and a full commissioning plan will be developed as part of that design.

Our water safety plan hazard risk assessment will also be re-evaluated upon successful commissioning of the reservoir into supply to reflect the changing risk to consumers around security of supply.

Figure 27 – schematic of proposed service reservoir at Mount Lane, Springwell Village Gateshead.

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

All costs for these schemes were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[28]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed costs for the Springwell SR and South Tyneside mains reinforcement is £42.58m totex.

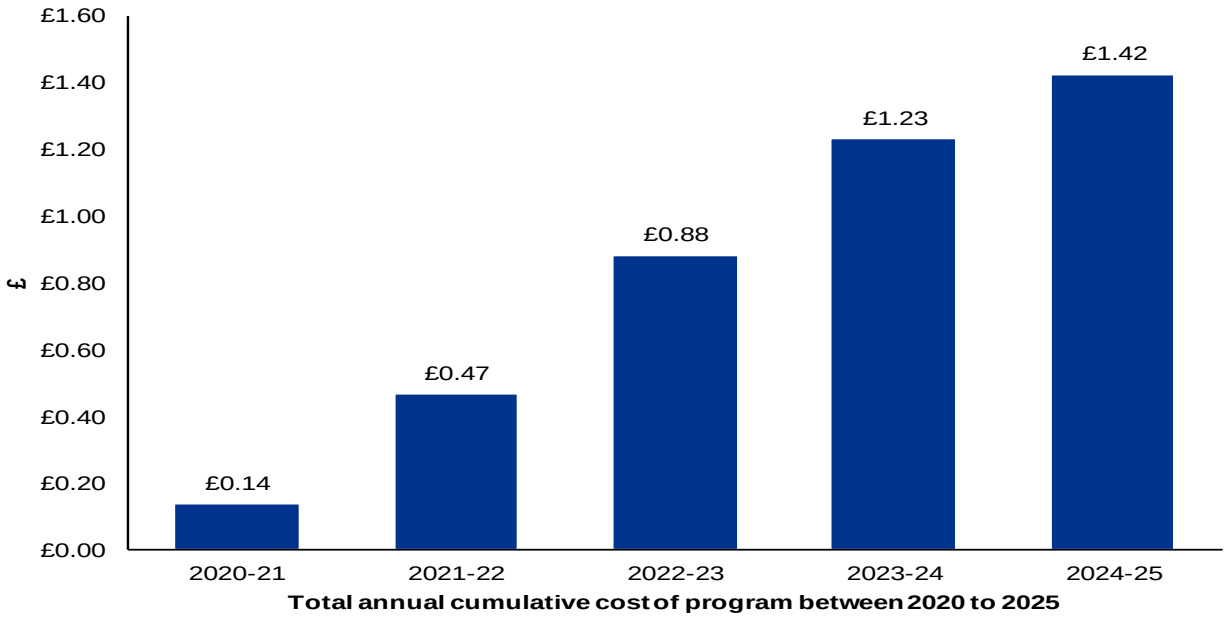
These costs were benchmarked and assured using a full iMod cost estimate using business as usual processes.

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance as previously described earlier.

[28] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology

Affordability

The impact of these enhancement investments on customer bills are shown below with this scheme costing customers a one off cost of £1.42 on their bill between 2020 and 2025[29].



This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[30] driving significant improvements to average customer affordability.

We shared details of our plans for Springwell and South Tyneside with customers in the Northumbrian area in a series of workshops held across the region. Customers from all areas were allowed to comment and indicate their support on all our resilience proposals even if they did not directly benefit from the improved resilience to service themselves.

Overall customer support for our plans to improve the resilience in our Central area was supported by 92**%** of our Northumbrian customers.

When all schemes were considered as a package **94%** of Northumbrian customers supported our proposals. Overall customer support can be summarised as follows:

Northumbrian Water proposal [Water]	Yes	No	Unsure
Our plans for Tyne area	84%	6%	10%
Our plans for Tees area	90%	6%	4%
Our plans for Central area	92%	2%	6%
Our plans for sites too critical to fail	90%	0%	10%
All water schemes as a package	94%	0%	6%

[29] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.

[30] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remain a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 2030[31] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

Stakeholder support -

Construction of Springwell SR has been commended for support by DWI (DWI Scheme reference: NNE_ESK03 – Springwell SR) as shown in the extract of the letter below. The Inspectorate supports this scheme as the proposals deliver improvements to mitigate residual risks to the wholesomeness of water supplied to consumers. They agree the proposals should be included by the company in its Final Business Plan as the scheme adopted a sound risk based approach to management of water supplies from source to tap using a water safety plan approach.

PERIODIC REVIEW 2019: Northumbrian Water

DWI Scheme reference: NNE_ESK03 – Springwell SR; FINAL DECISION LETTER – COMMEND FOR SUPPORT

The Inspectorate has assessed the scheme proposed by Northumbrian Water to construct a new service reservoir (Springwell) to improve the resilience of supplies to customers.

Based on the information submitted by the company, the Inspectorate commends for support the proposals to deliver improvements to mitigate residual risks to the wholesomeness of water supplied to consumers, and we agree that the proposals should be included by the company in its Final Business Plan. We consider that formal enforcement action and putting in place a legal instrument is inappropriate at this stage. We confirm that the proposed scheme is consistent with the requirements of Defra's Strategic Policy Statement published in September 2017.

We also confirm that the proposed scheme is consistent with the Inspectorate's guidance on principles for the assessment of drinking water quality provisions within the PR19 process, as set out in DWI Information Letter 03/2017, published on 12 September 2017. In particular, we are satisfied that the proposed scheme adopts a sound risk based approach to management of water supplies from source to tap using a water safety plan approach. The Inspectorate is prepared to review this decision should circumstances change significantly, or if new information becomes available.

Customer protection

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers. Details are included in the main body of this document and in Chapter 4: Measuring and Incentivising Success of our business plan.

Board assurance

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large

[31] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers".

Annex E –UV Treatment at Mosswood WTW

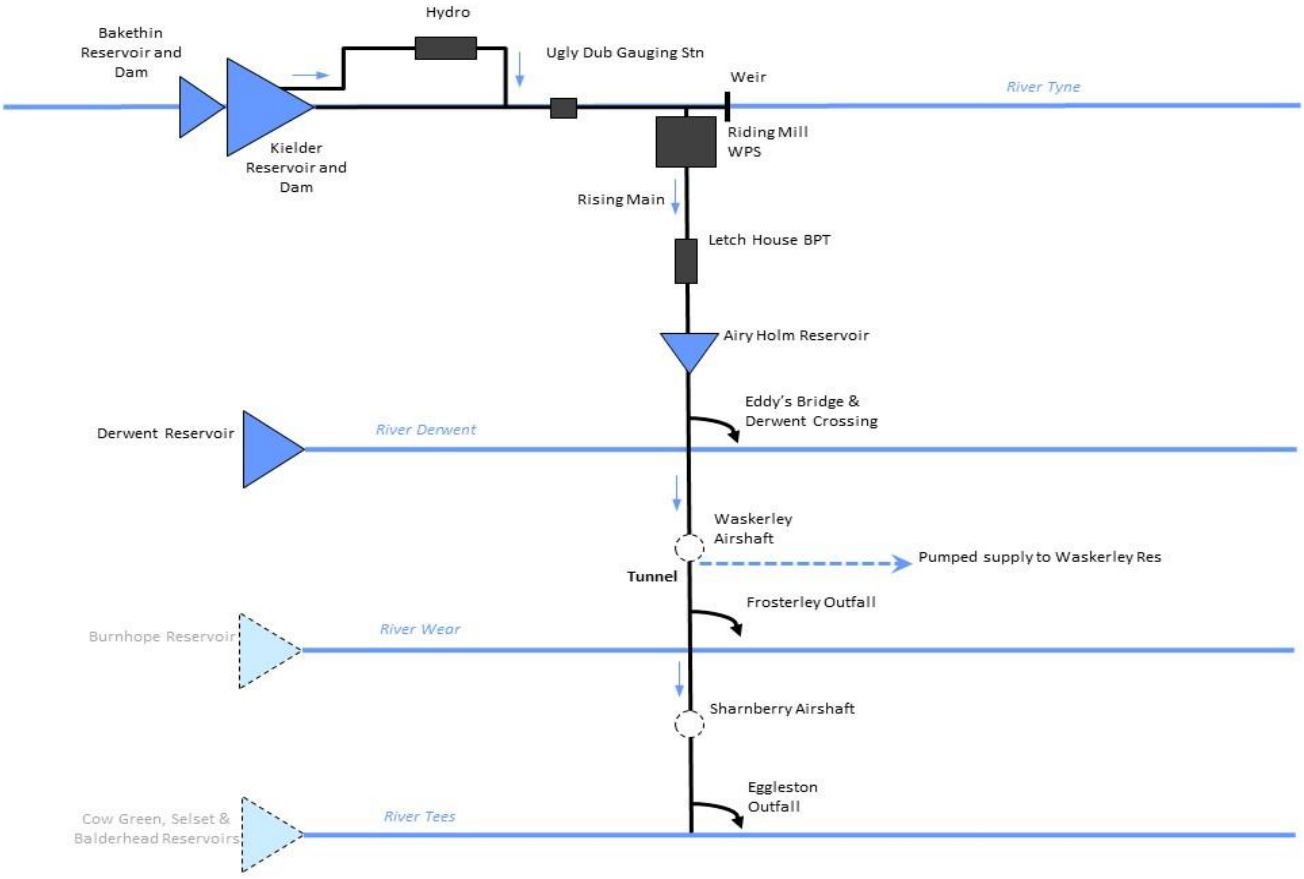
Name of claim	UV treatment at Mosswood WTW
Name and identifier of related claim submitted in May 2018	n/a
Business plan table lines w here the totex value of this claim is reported	WS2 – Wholesale capital expenditure by purpose Line 13
Total value of enhancement for AMP7	£7,900,000
Total opex of enhancement for AMP7	£0
Total capex of enhancement for AMP7	£7,900,000
Depreciation on capex in AMP7 (retail controls only)	n/a
Remaining capex required after AMP7 to complete construction	Expected to complete scheme by 2022 to 2023
Whole life totex of claim	n/a
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	0.65%
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	No
Need for investment/expenditure	Raw water deterioration
Need for the adjustment (if relevant)	Customer protection from loss or reduction of service risk
Outside management control (if relevant)	n/a
Best option for customers (if relevant)	Refer to main text of business case
Robustness and efficiency of claim's costs	Refer to main text of business case
Customer protection (if relevant)	Refer to main text of business case
Affordability (if relevant)	Refer to main text of business case
Board Assurance (if relevant)	Refer to main text of business case

Background Information -

Mosswood WTW supplies its demand centers by abstracting raw water from Derwent Reservoir or from the Tyne Tees Transfer System (TTTS) as shown in Figure 28. The WTW is situated within the Kielder WRZ.

The Kielder WRZ benefits from Kielder Reservoir and the Kielder Transfer Scheme. Kielder Reservoir, located in Northumberland, is the largest artificial lake in the United Kingdom by capacity holding 200 billion litres (200,000Ml) of water. The reservoir supports flow in the North Tyne to support abstractions of water further downstream. It also supports the Kielder Transfer Scheme which enables water to be transferred to the Wear, Derwent and the Tees rivers. Kielder Reservoir and transfer scheme collectively make the Kielder WRZ one of, if not the most resilient WRZs in the country.

Figure 28 - The Tyne Tees Transfer System



The TTTS comprises a pumping station at Riding Mill on the River Tyne, a rising main and gravity tunnel carrying water (when required) to Airy Holm Reservoir, the River Derwent, Mosswood WTW, Waskerley Airshaft, the River Wear and the River Tees.

At Riding Mill pumping station six pump units, each with a nominal fixed capacity of 1.05 cumecs (90 Ml/d), are installed. However an agreed supply capacity with Central Electricity Generating Board (CEGB) limits maximum abstraction flow to three pumps, about 270 Ml/d. All six pumps remain in commission and are tested periodically.

APPENDIX 3.2
WATER RESILIENCE

The steel rising main from Riding Mill to Letch House is 6.2km in length and 2m in diameter and the pumping head is approximately 205 metres. The concrete lined gravity tunnel from Letch House to Eggleston on the River Tees is 34km long and 2.91m in diameter. The rising main and tunnel are designed to remain charged and have a capacity of 230,000 m3. Airy Holm Reservoir forms a header tank on the tunnel system to correct any imbalance between rates of pumping and outlet discharge. It has a capacity of 220,000m3 and inflow to and draw-off from the tunnel is by means of a 5m diameter shaft connected to the reservoir floor. Airy Holm will normally be maintained near to full level in order to provide a reserve for releases. However, no spillway discharge should occur as a direct result of pumping at Riding Mill.

A direct connection links the tunnel with Mosswood WTW and can provide full substitution for the Derwent Reservoir resource and thus support the water resources for mid-Durham.

Raw water characterisation and effective disinfection

Water treatment works (WTW) are designed with the capacity to nullify pathogenic threat from the source raw water. This processing capability is limited by the design of the WTW and the number of treatment processes. The NWL independently assured disinfection policy (by WRc) sets out the treatment needs for effective disinfection. All WTW must be able to process the maximum disinfection challenge so as not to pass any risk through to customers.

To apply the policy a Site Specific Disinfection Assessment (SSDA) is carried out for each WTW based on raw water data to assign the risk category and treatment need as per the appendix in the policy. This is routinely carried out using a three year data set to incorporate raw water and risk changes. An excerpt from the policy is shown in Figure 29 below and this shows how raw water and treatment capacity needs (in disinfection terms) are defined.

Figure 29 – Raw water classification and CT Calculation

Risk category	Raw water risk categorisation				Treatment and disinfection requirements
	Typical water type	Max coliform result (cfu/100ml)	Viral risk	*Cryptosporidium* Risk	
Very Low	Pristine ground water	0 coliforms*	Negligible	Insignificant	Marginal chlorination, final water with a chlorine residual within the normal operating range, no CT requirement.
Low	Ground water	1-10 coliforms	Very low	Insignificant	Effective CT 15mg.min/L
Medium	Ground/ Surface water	>10-2000 coliforms	Low	Low - Moderate	2 log removal of *Cryptosporidium* Effective CT 15mg.min/L
High	Surface water	>2000-20000 coliforms	High	High	3 log removal of *Cryptosporidium* Effective CT 15mg.min/L
Very High	Surface water	>20000 coliforms	Very High	Very High	4 log removal of *Cryptosporidium* Effective CT 15mg.min/L

* One non-faecal coliform result of 1cfu/100ml within three years will not change pristine designation.

Three years historical raw water coliform data and consideration of other pathogenic risks in the raw water source will be used to assign a WTW to the correct level of classification.

Water quality of Derwent impounding reservoir and the Tyne Tees transfer

In Table 18 below it can be seen that there has been deterioration in the raw water quality within the impounding reservoir over the 2015/16/17 periods.

Table 18 - Raw water data (max) from Derwent reservoir

Year	Max of Coliforms (Presumed)	Max of E.Coli (Presumed)	Max of Colonies 2 Day 37 C YEA	Max of Colonies 3 Days 22 C YEA	Max of Cryptosporidium	Max of Colour Filtered
2008	500	250	50	650	0.513	83
2009	450	150	27	300	0.056	150
2010	200	100			0.176	63
2011	1500	550	950	15000	0.187	60
2012	1700	1050	300	5300	2.091	84
2013	1550	400			5	75
2014	350	150	50	150	2	52
2015	2000	400	13000	3300	5	72
2016	7250	1050	8600	150000	5.83	79
2017	5050	450	2	81	2	59

Historically Mosswood WTW receiving Derwent Reservoir input is classified as a medium risk. Using SSDA assessment, based on data from 2010-12, 2011-2013 and 2012-14 Mosswood WTW has the capacity to manage this risk.

Using SSDA assessment of Derwent reservoir, based on data from 2015-17, the raw water risk has changed and Mosswood WTW requires an asset intervention to increase disinfection capability.

Table 19 below shows the River Tyne input from the TTTS is also classified as a high risk. Mosswood WTW does not have the capacity to manage this risk. To mitigate this risk the input from the TTTS is reduced to no more than 20% of the WTW capacity; by blending the two raw water sources the site has the capacity to manage this risk.

Table 19 – Raw water data (max) from River Tyne

Year	Max of Coliforms (Presumed)	Max of E.Coli (Presumed)	Max of Colonies 2 Day 37 C YEA	Max of Colonies 3 Days 22 C YEA	Max of Cryptosporidium	Max of Colour Filtered
2008	5000	1600			4	100
2009	4550	2150	300	300	3	110
2010	5000	2800			28	110
2011	3450	700	300	300	2	98
2012	5000	1950	300	300	4	120
2013	5000	1700	250	500	5	73
2014	8850	5700	6800	15000		170
2015	6875	2700	300	4100	8	120
2016	7250	800	300	300	133	110
2017	10050	10050	300	300	17	130

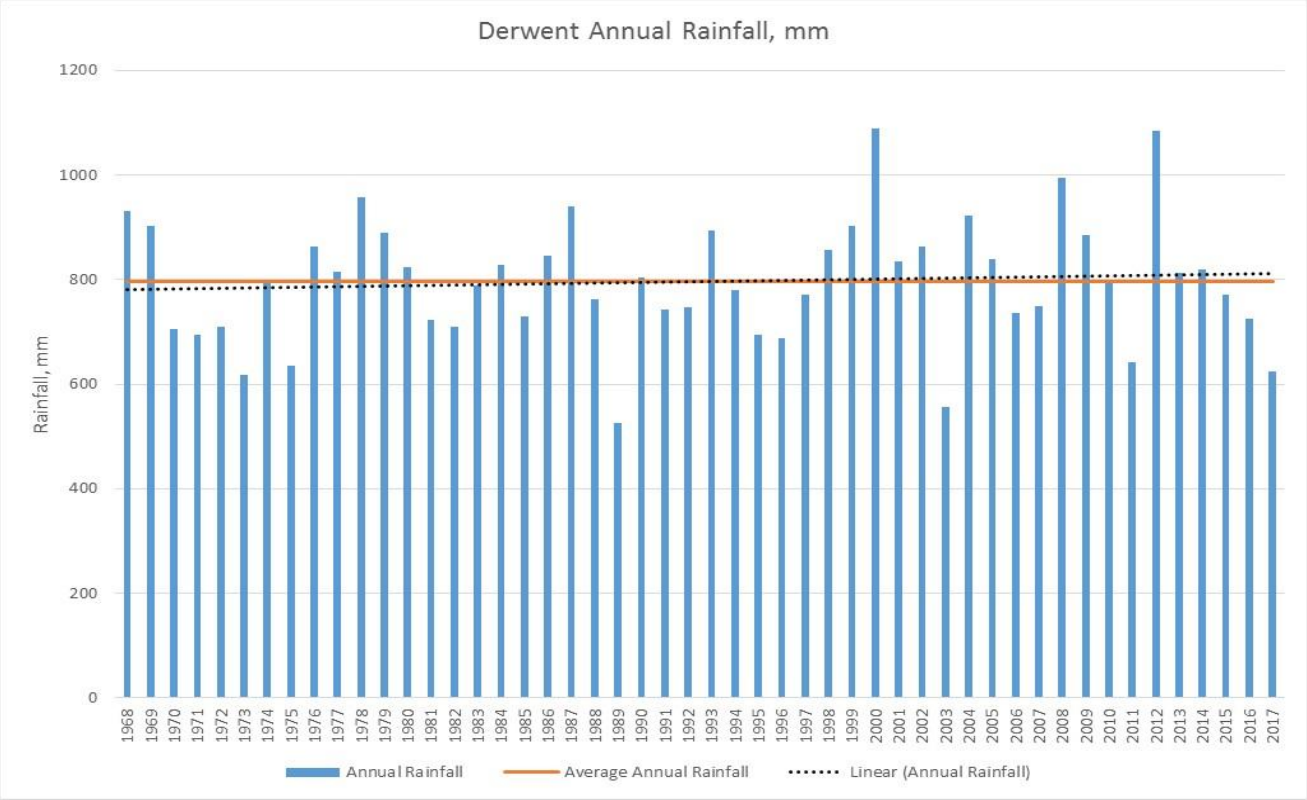
Derwent reservoir capacity performance

The average yield for Derwent reservoir has been calculated to be 139Ml/d, 23.8Ml/d of this is required for compensation release so that leaves an average yield of 115Ml/d available for treatment at Mosswood WTW. As Derwent reservoir level drops into the conservation zone support for Derwent is available by pumping TTTS water at Riding Mill. This replaces the compensation flow from the reservoir and enables the transfer of Tyne water onto Mosswood WTW for treatment.

Rainfall

Figure 30 below shows the historic annual rainfall in the Derwent catchment. It can be observed that there are several periods of below average rainfall lasting for a few years at a time. However the overall trend is actually a marginal increase in total annual rainfall.

Figure 30 – Derwent Annual Rainfall, mm. 1968 to 2017



Derwent Reservoir Levels

Figure 31 shows the historic levels of Derwent reservoir, as can be seen it is not unusual for the reservoir to be drawn down for several years. Typically the reservoir is only overcapacity and spilling once every five years.

Derwent Abstraction

Figure 32 shows the cumulative average yield since 2006 against the cumulative abstraction from Derwent. In recent years, post 2013, the abstraction has been greater than the average yield this coupled with the below average rainfall means increasing pressure to use the TTTS.

Figure 31 – Derwent IR level 1983 to 2017

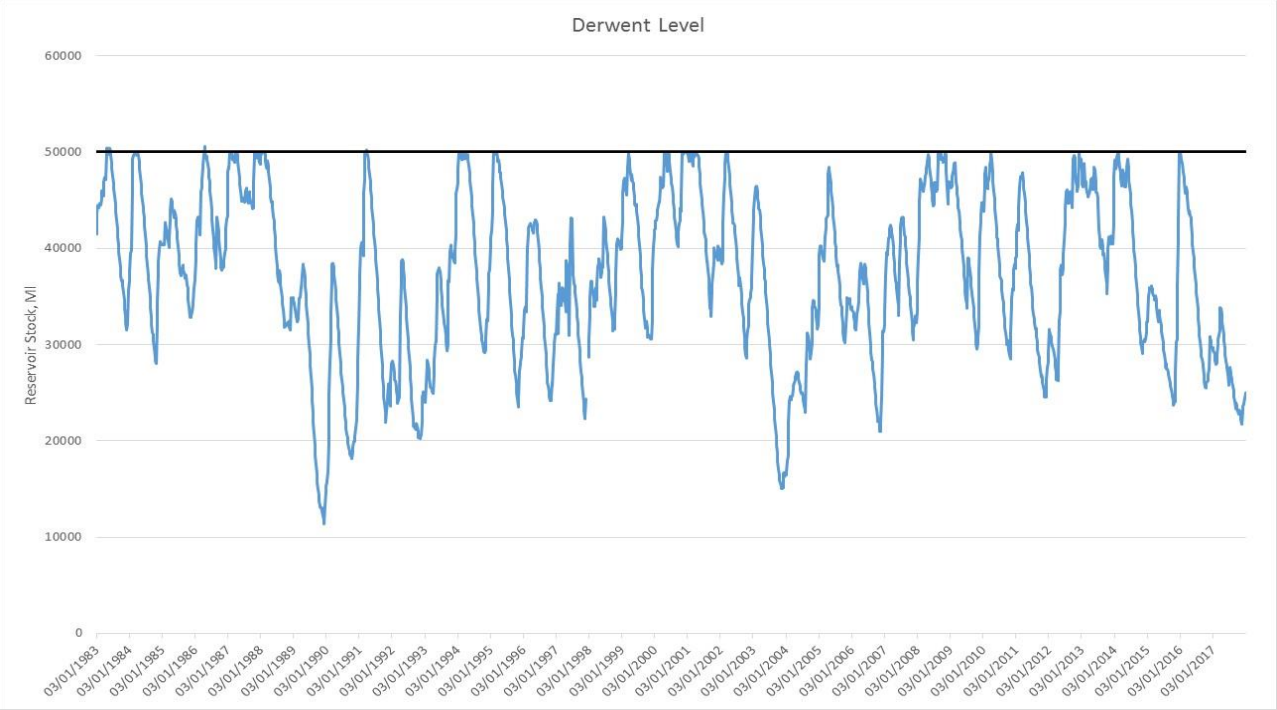
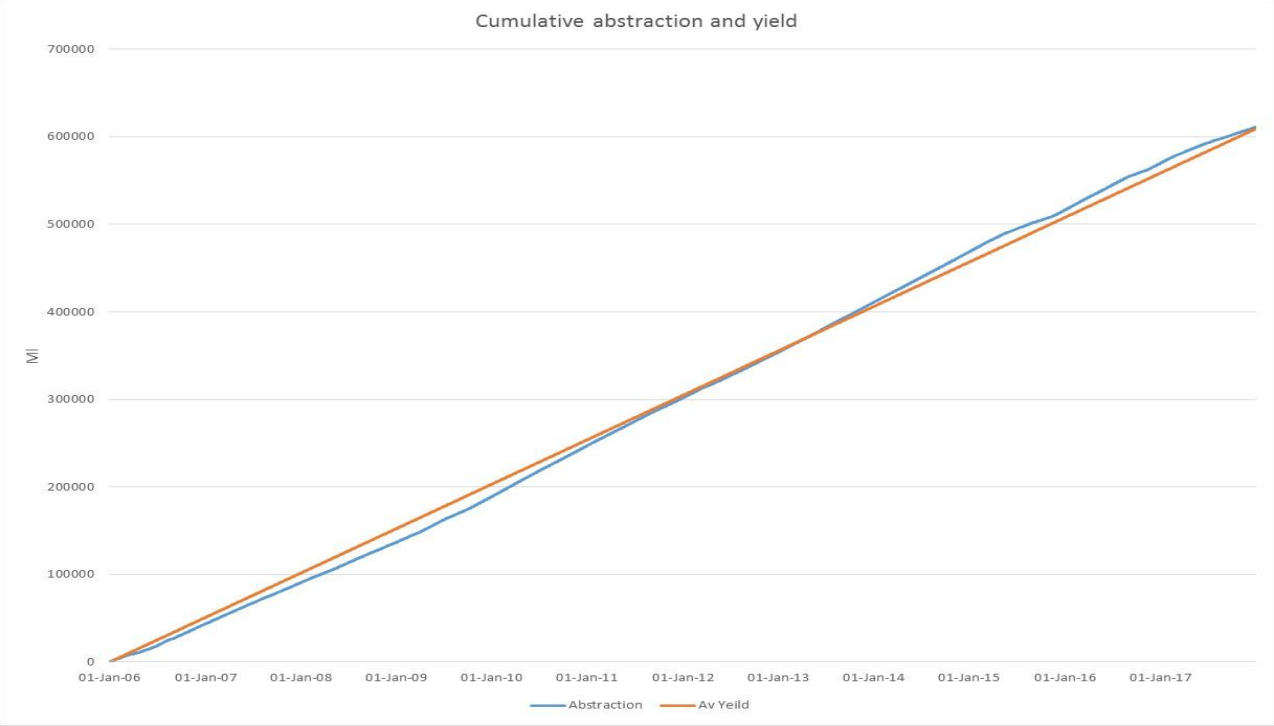


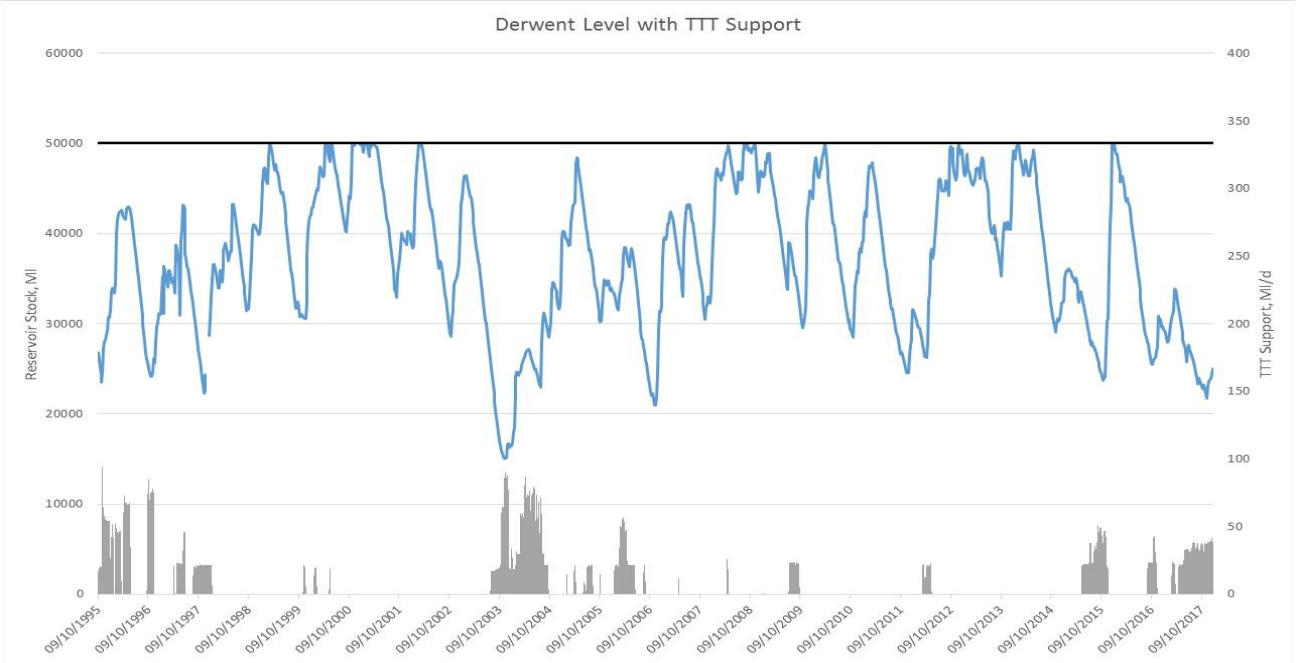
Figure 32 – Cumulative abstraction and yield of Derwent IR 2006 TO 2017



Riding Mill Support

Figure 33 shows Derwent level along with the Riding Mill flow to support Derwent / Mosswood. As can be seen the reservoir level is within its normal drawdown range but the level of support available from TTTS at Riding Mill has been restricted due to effective disinfection concerns.

Figure 33 – Derwent IR level with TTTS support 1995 to 2017



Summary

The recent low levels of rainfall, and subsequent low level of Derwent reservoir, are not outside historical norms for the catchment area. However, the quality of Derwent reservoir has deteriorated to a sustained level where it now presents a risk to effective disinfection.

It can also be seen that to support Derwent reservoir there is a continuous pressure to utilise the TTTS. Restricting the support available from the TTTS due to quality and treatment capacity critically reduces the resilience of the water supply system to this region.

An asset intervention is required to improve the treatment capacity and restore effective disinfection.

Need for the investment / expenditure –

This scheme aims to address a number of specific risks identified from;

- Consequence of Failure analysis;
- Water quality data for Derwent, TTTS and Mosswood WTW.
- Recent emerging issues.

Primary Risk

The primary risk is the impact due to emerging changes in catchment quality (bacteria) at Derwent reservoir impacting on the ability to maintain both water quality regulatory compliance and deployable output from Mosswood WTW; this WTW directly supplies 170,225 customers. The consequence of not being able to treat the cryptosporidium risk of this deteriorating raw water quality could therefore be supply restrictions impacting these customers.

Secondary Risk

The second risk is the reduction in resilience from the TTTS. The TTTS can substitute the entire output from Derwent reservoir to Mosswood WTW. However due to water quality regulatory compliance concerns this has been limited to 20%. This significantly reduces the flexibility of the

water supply system and changes the resilience of a significant portion of the Kielder WRZ. Due to weather pressure there is also need to restore the resilience of this system.

Best Options for Customers -

The proposed scheme is to install a new UV (ultra violet irradiation) treatment process at Mosswood WTW to address the changes to catchment water quality at Derwent reservoir (principally bacteria). This will ensure that the works can maintain its full deployable output all year and will remove the risks of supply restrictions to 170,225 customers caused by emerging changes in raw water quality at Derwent reservoir.

The UV reactors will be located after the existing filtration process.

Risk reduction benefit –

The scheme at Mosswood WTW has been assessed by NWL's Asset Planning team and risk scored. This ensures we are able to assess this investment against all other schemes in a consistent and fair manner. The scheme has been scored as follows:

Resilience Project	Risk reduction benefit	Customers benefiting (Nr)	Capex (£m)	Opex (£m)	£ per customer benefited	Risk Score Before	Risk Score After	Risk Reduction delivered
Install new UV treatment at Mosswood WTW to manage Derwent and Kielder TTTS crypto risk	Ability to manage crypto risk from all raw water	170,225	£7.90	£0	£46.40	301.11	5.71	295.40

Using this assessment indicates that the risk to customers will reduce by 98% as a result of implementing the scheme.

Optioneering and scheme development –

As already indicated the consequence of Mosswood WTW not being able to fully treat water from Derwent or TTTS would be unacceptable as the works typically supplies 170,225 customers.

The likelihood of microbiological (cryptosporidium) parameters increasing in concentration in Derwent reservoir raw water is unknown. The 2015 to 2017 data is worse than any in the previous 10 years, this indicates a deteriorating trend. Any asset intervention to improve disinfection efficacy must manage this risk and the risk posed by the TTTS high risk raw water quality and remove the quality restriction imposed on the transfer system to restore the system resilience.

The likelihood of further or increasing issues related to raw water deterioration is therefore considered to be **medium to high likelihood and medium to high consequence.**

Cryptosporidium can be removed from water by the following processes:

- Coagulation;
- Clarification and filtration;
- Ozone, membrane ultra filtration and UV irradiation.

APPENDIX 3.2
WATER RESILIENCE

Mosswood already utilises coagulation, clarification and filtration to get the current cryptosporidium risk reduction. Discussions with ozone technology supplies indicated that it would be too costly to achieve the required cryptosporidium log10 removal with ozone alone. Membrane ultra filtration would also be an expensive solution as it would normally be employed as an alternative to the current filtration system. Therefore UV was considered to be the only solution to progress to optioneering.

Options considered were as follows:

Option 0: Do nothing
Options 1 to 5: Install new treatment capability at Mosswood WTW

Option 0 - **Discounted**

Doing nothing is considered an unviable option. The risk and consequence to 170,225 customers is deemed unacceptable.

Treatment-Based Options

Mosswood WTW is currently designed to treat a seven day peak output of 152 Ml/d and an average annual output of 131 Ml/d. Changes to reservoir water quantity and quality is such that both output figures are not being met with output often lower.

In a summary report on Mosswood UV, produced by Interserve and Amec, Foster, Wheeler five UV installations options were considered in respect of addressing the cryptosporidium risk from Mosswood WTW. All the options included variants around using new UV reactors in order to address raw water deterioration and cryptosporidium risks. The options considered are summarised as follows:

Option 1 - **Discounted**
Install duty/standby UV reactors downstream of existing rapid gravity filters. Relocate chlorine dosing downstream of new UV reactors and install new pumping station (with dry and wet wells) to maintain flow to and from UV reactors. This option was discounted on the basis of excessive cost.

Option 2 - **Discounted**
Install duty/standby UV reactors downstream of existing rapid gravity filters. Relocate chlorine dosing downstream of new UV reactors and install new pumping station (wet well only) to maintain flow to and from UV reactors. This option was discounted on the basis of excessive cost.

Option 3 - **Discounted**
Install duty only UV reactors downstream of existing rapid gravity filters and chlorine. Install new pumping station (wet well only) to maintain flow to and from UV reactors. This option was discounted on the basis of excessive cost.

Option 4 - **Discounted**
Install duty only UV reactors on each outlet main downstream of disinfection and pH conditioning treatments. This option was rejected as while it is very similar to option 5, there is no duty standby provision for the UV reactors.

Option 5 – **Recommended**
Install duty standby UV reactors on each outlet main downstream of disinfection and pH conditioning treatments.

Option 5 was selected to progress as; it has acceptable costs and offers a robust resilient solution. It results in lower additional UV power costs and additional pumping in the outlet mains. It provides validated treatment for cryptosporidium and e-coli, with potential for future proofing should higher levels of treatment be required. There is no significant impact on WTW production, although maximum flow in one outlet main could be reduced from 86 Ml/d to 82 Ml/d. It does not introduce significant risk to water quality through disinfection by-products.

Evaluation of the options identified Option 5, duty/standby UV reactors on WTW outlet mains as the preferred option.

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

All costs for these schemes were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[32]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed cost for Mosswood UV is £7.90m totex.

These costs were benchmarked and assured using traditional unit rates as part of the business as usual processes.

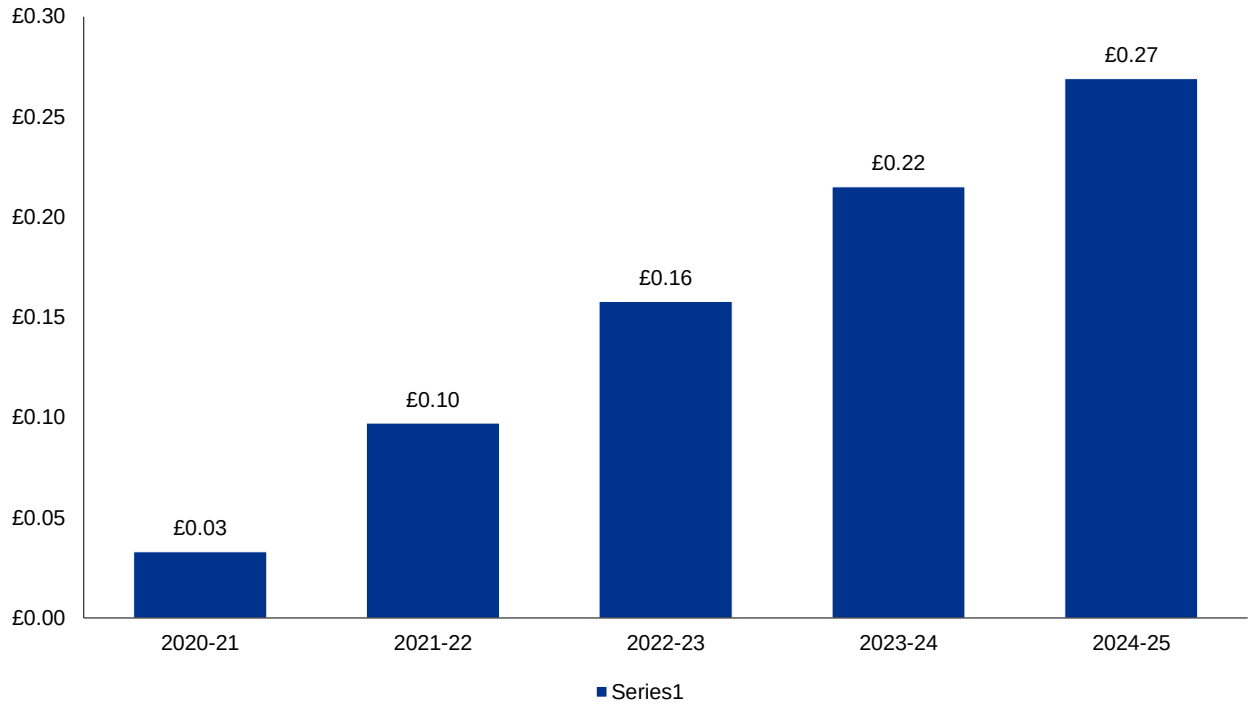
The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance as previously described earlier.

Affordability

The impact of these enhancement investments on customer bills are shown below with this scheme costing customers a one off cost of £0.27 on their bill between 2020 and 2025[33].

[32] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology.

[33] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.



This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[34] driving significant improvements to average customer affordability.

We shared details of our plans for Mosswood with customers in the Northumbrian area in a series of workshops held across the region. Customers from all areas were allowed to comment and indicate their support on all our resilience proposals even if they did not directly benefit from the improved resilience to service themselves.

Overall customer support for our plans to improve the resilience in our Central area, including Mosswood UV was supported by 92**%** of our Northumbrian customers.

When all schemes were considered as a package **94%** of Northumbrian customers supported our proposals. Overall customer support can be summarised as follows:

Northumbrian Water proposal [Water]	Yes	No	Unsure
Our plans for Tyne area	84%	6%	10%
Our plans for Tees area	90%	6%	4%
Our plans for Central area	92%	2%	6%
Our plans for sites too critical to fail	90%	0%	10%
All water schemes as a package	94%	0%	6%

Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remain a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty

[34] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

by 2030[35] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

Stakeholder support

This scheme is subject to provisional support by DWI (minded to Support), further assessment is taking place and Final Descision Letters will be provided in due course. These will be circulated to Ofwat when received.

Customer protection

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers. Details are included in the main body of this document and in Chapter 4: Measuring and Incentivising Success of our business plan.

Board assurance

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers".

[35] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

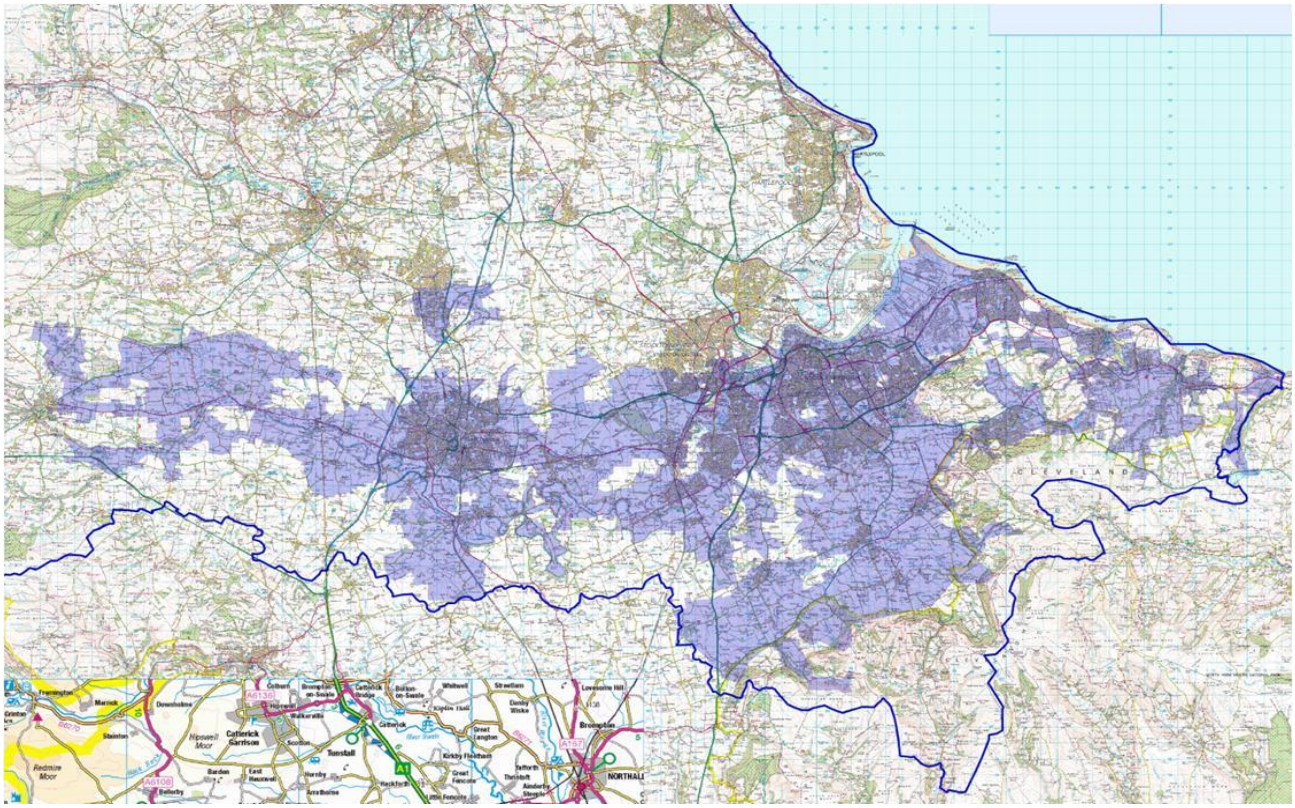
Annex F – Lartington Mains and Tees strategic mains reinforcement

Name of claim	Lartington Mains and Tees strategic mains reinforcement under DWI Regulatory 28 Notice
Name and identifier of related claim submitted in May 2018	n/a
Business plan table lines w here the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line 14
Total value of claim for AMP7	£42,650,000
Total opex of claim for AMP7	£0
Total capex of claim for AMP7	£42,650,000
Depreciation on capex in AMP7 (retail controls only)	n/a
Remaining capex required after AMP7 to complete construction	Expected to complete schemes by 2025
Whole life totex of claim	n/a
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	Yes approximately £31m for the Lartington main replacement element only
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	3.56%
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	No
Need for investment/expenditure	Enhanced resilience
Need for the adjustment (if relevant)	Customer protection from loss of service risk
Outside management control (if relevant)	n/a
Best option for customers (if relevant)	Refer to main text of business case
Robustness and efficiency of claim's costs	Refer to main text of business case
Customer protection (if relevant)	Refer to main text of business case
Affordability (if relevant)	Refer to main text of business case
Board Assurance (if relevant)	Refer to main text of business case

APPENDIX 3.2
WATER RESILIENCE

Background Information -

The Teesside strategic network supplies the major urban areas of Middlesborough, Stockton-on-Tees and Darlington. The network also supplies the rural settlements to the west of Darlington and coastal areas in East Cleveland. The estimated population is 645,000. Our plan for Teesside is to address the asset failure risk and improve overall network resilience that could impact over 255,000 customers as shown below.



The area has enduring links to heavy industry, however this is in decline. This has increased the inherent water quality risks within the strategic network caused by from low pipeline velocities caused by a now oversized strategic transfer mains network as well as poor service reservoir turnover due to overcapacity in strategic storage. All have the potential to adversely impact and cause:

- Drinking water quality deterioration;
- Discoloured water contacts;
- Taste and odour contacts.

There are also issues relating to the age and condition of our assets. Assets in poor condition and at high risk of failure can effectively be considered as inoperable. Inoperable and failing assets have the potential to adversely impact and cause:

- Bursts
- Low pressure
- Interruptions to supply (ITS)

The network which carries water from Lartington Water Treatment Works (WTW) to Longnewton Service Reservoir (SR) via Whorley Hill SR is known to have critical defects. These have been caused by corrosion, increased overburden stresses, and general weakening of the pipe over their 100 to 120 year operation lifetime. Failures have occurred in the past causing major damage to property and affecting 200,000 customers across Teesside (Figure 34).

In addition recent repairs on the pipelines have proven to be a protracted process due to the risk associated with working on these assets and some of the operational costs involved. A recent repair, on the Deepdale viaduct over the River Tees has cost over £1million to complete compared with a similar repair on Tyneside of £150,000k

Figure 34 – Evidence of asset deterioration of T4 main, Darlington

A schematic (Figure 35) of the existing Tees network is shown below with the key mains and service reservoirs highlighted.

Throttled line valves are being used to regulate pressure and flow along T3, T4, T9 and T10 as the AoD between Lartington and Longnewton SR is up to 162.8m. The high risk of operating these valves and the reluctance by operational staff to do so essentially makes these pipes inoperable. This restriction in operational flexibility means we are:

- Unable to easily utilise the full deployable output capability of Lartington WTW;
- Have poor ability to control the flow of water into Longnewton SR which creates a knock on impact to the effective operation of the remaining downstream network, including Maltby and South Lackenby SRs;
- We carry a significant risk of a catastrophic pipeline failure due to pressure transients and surges when we attempt to operate these mains. This has the potential to cause a large water quality event due to discolouration of water supplies affecting up to 250,000 properties;
- An inability to operate the network as cost efficiently as possible as we are unable to maximise the use of the gravity sourced water across the Tees supply zone.

Need for the investment / expenditure –

This investment aims to address a number of specific risks identified from;

- A number of single point of failure risks identified on the Derwent South strategic main during our consequence of failure analysis;
- The likelihood of a failure at these single points on the Derwent South strategic main identified by the tendency to fail analysis;
- Teesside Strategic Network Study 2017;
- Condition assessment analysis on the Lartington mains;
- Historic asset failures experienced on the Lartington mains.

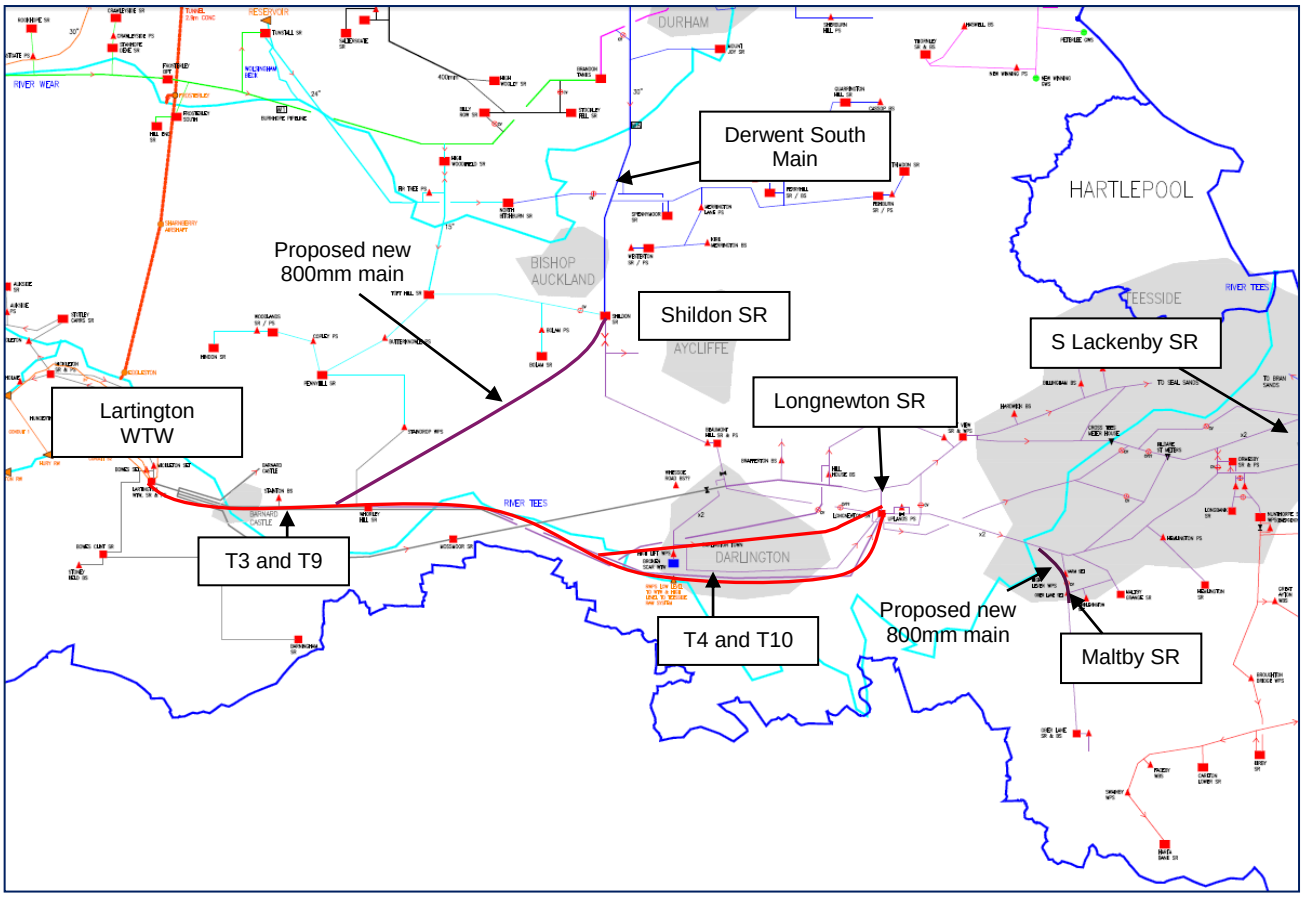
APPENDIX 3.2
WATER RESILIENCE

Primary Risk

The primary risk we have identified for the Tess network is the poor strategic transfer capability due to asset condition and capacity between Lartington WTW and Teesside. 18,000 properties are directly fed off this part of the network and a sudden and catastrophic failure on some of these strategic mains (T3, T4, T9 and T10) presents a wider water quality risk to over 200,000 properties. This presents an unacceptable water quality failure and loss of supply risk lasting between two and three days for a large urban population centre.

We are also unable to fully utilise the abundant raw water and treatment capacity from our Tees system to address the risk from a catastrophic failure of the single Derwent South main supplied from Mosswood WTW. The Derwent South strategic main is only supplied from Mosswood WTW and is the single source of water for 50,000 properties with no alternative means of supply other than strategic storage (24-36 hours). A failure of this main will also lead to a rapid deterioration of water quality leading to customers rejecting this water. We currently do not have a respond and recover capability sufficient enough to respond to such an event.

Figure 35 – Tees schematic showing key mains and locations including proposed new mains



Secondary Risks

Secondary risks that this investment will address include the water quality and reliability of supply risks caused by significant overcapacity within the strategic mains network and service reservoirs. This is primarily due to the decline of heavy industry reducing overall water demand over recent years. This presented opportunities for long term rationalisation of the network and a reduction in future capital investment and operational costs to maintain and replace these assets.

The operational constraints in place to manage this risk are restricting our ability to deliver long term resilience and risk reduction in the wider Tees system whilst poor transfer capability and

interconnectivity within the Tees system restricts our ability to the entire Tees network from both the major water treatment works.

Best Options for Customers -

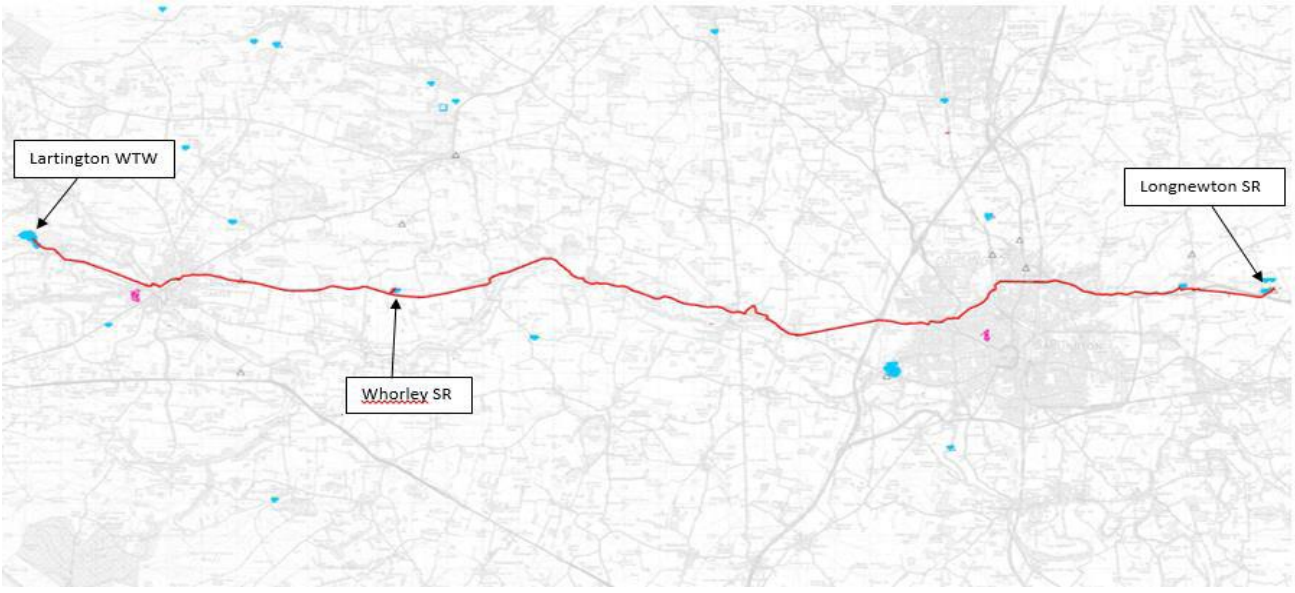
We will maximise the operational and resilience benefit from the new main by improving the interconnectivity of the Tees network and create a strategic transfer capability from Tees to support the Derwent South strategic main. We will deliver the work concurrently in 2 distinct phases – Lartington WTW to Longnewton SR mains renewal and Whorley SR to Shildon SR/WPS.

Phase 1 -

1. We will replace 75km of trunk main ((T3, T4, T9 & T10) with 37.5km of new 800mm main between Lartington WTW and Longnewton SR (Figure 36). We will also provide a second source of supply to 18,000 properties in Darlington by installing additional cross connectivity to the new 800mm main;
2. We will utilise the new 800mm Lartington main and lay 6km of new 800mm main to improve the water quality performance and operability of Maltby SR and the wider Tees strategic network;
3. We will fully utilise the new 800mm Lartington main and modifications to Maltby SR operability and undertake additional modifications to Ormesby WPS. This then enables the abandonment of Longnewton SR, South Lackenby SR and Uplands Water Booster Station (WBS).

Phase 1 should be considered as a single scheme and will need to be completed in sequential order to fully deliver the water quality, reliability and resilience benefits identified in the Tees Strategic Network Study.

Figure 36 – Route option for the new 800mm main between Lartington WTW and Longnewton SR.



Phase 2 -

1. We will lay 16km of new 800mm water main from the new 800mm main supplying Whorley SR [Tees] to Shildon SR [Central]. This pipeline will provide up to 83Ml of strategic transfer capability between the Tees and Central system zones;
2. We will construct a new 55Ml WPS at Shildon SR supplied from the new 800mm strategic transfer main connecting into the Derwent South main. This provides a resilient secondary

source of supply to this single strategic main and also enables Tees to support the Mosswood WTW supply zone in the event of issues or restrictions at this major treatment works.

Phase 2 schemes should be considered as a single scheme and will need to be completed in sequential order to fully deliver the resilience benefits for the Derwent South main and Mosswood WTW.

Risk reduction benefit –

These schemes have been assessed by NWL's Asset Planning team and risk scored. This ensures we are able to assess this investment against all other schemes in a consistent and fair manner. The scheme has been scored as follows:

Resilience Project	Risk reduction benefit	Customers benefiting (Nr)	Capex (£m)	Opex (£m)	£ per customer benefited	Risk Score Before	Risk Score After	Risk Reduction delivered
Replace 37.5km of 600mm with single 800mm St main	Reduce risk of pipe failure, improve operability	255,871	£14.08		£55.02	551.00	91.83	459.16
Cross connections into C60/60a for Darlington	30K benefit from second supply point	27,758	£0.21		£89.38	83.77	16.75	67.01
New inlet/outlet arrangement at Maltby SR	Remove cause of risk		£5.40			34.41	6.88	27.53
16km of 800mm main from Whorley to Shildon [link to Central scheme]	Reduce no of props impacted		£19.20			88.70	14.78	73.92
Mods to Ormesby WPS	Remove source of risk	38,374	£0.16		£18.24	77.83	2.08	75.75
Abandon Uplands WBS	Remove future base totex costs		£0.06			50.00	0.00	50.00
Abandon Long Newton SR	Remove source of risk		£0.24			50.00	0.00	50.00
Abandon South Lackenby SR	Remove source of risk		£0.24			90.00	0.01	89.99

Using this assessment indicates that the risk to customers will reduce by 87% as a result of implementing the scheme.

Optioneering and scheme development –

The primary risk that the replacement Lartington main and additional reinforcement of the strategic network in Teesside and Central is aimed at addressing is:

- A failure on the current twin strategic mains supplying water from Lartington WTW into Teesside;
- Reducing the risk of large loss of supply and/or water quality events by improving network interconnectivity and implementing a pipeline management approach to reduce the risks from discolouration at customers taps due to rapid changes in water velocity;

- Addressing overcapacity within the system due to a decline in water demand from heavy industry over recent times;
- Enabling the transfer of up to 83Ml of potable water from the Tees to Central system zones to remove the risk from a catastrophic failure of the Derwent South strategic main.

We have previously assessed both the consequence of a failure (COF) of our critical assets and the tendency to fail (TTF) as part of analysis undertaken over recent years. This included looking at what options are available to us to reduce the consequence of a failure by implementing solutions that either reduce or remove the risk.

We have also completed the Tees Strategic Network Study in 2017 which considered not only COF and TTF but also water quality performance, asset condition and capacity and system resilience. It should be noted that population counts often vary depending on when reports are undertaken and the data source used. However the error on populations served by critical assets is not material as the population sizes we reference are often very large and significant.

Consequence of Failure analysis

Within the Teesside distribution area, a total of 48 critical assets have been identified. These include 2 treatment works, 10 strategic mains, 29 strategic crossings, 1 raw water reservoir, 1 raw water pumping station and 5 water pumping stations. The failure of any of these assets, even after taking any mitigation measures currently available, would still result in the loss of supply to between 20,000 and 250,000 customers. These assets can be categorised into 4 groups including the Lartington supply area with a population of approximately 130,000 properties supplied from Lartington WTW.

For the Lartington supply area each critical asset was assessed and a consequence score calculated (Table 20). As this analysis only considered a total loss of supply if the asset failed the twin Lartington pipes (T3, T4, T9 & T10) which are being replaced were not considered as having a high COF risk. It was assumed that a catastrophic failure would likely only impact one of the pipes and the other main could maintain supplies to the Lartington area. No optioneering was therefore considered to mitigate for the failure of these mains other than isolate and repair.

T3, T4, T9 and T10 were considered as having a low COF. This analysis took no consideration of the asset condition (internally and structurally) or the impact on network water quality during such an event.

Similar assessments were undertaken for the Tees supply area which contains Longnewton and South Lackenby SRs. It was determined that as customer supplies could be maintained if either structure failed. **Longnewton and South Lackenby SRs were considered as having a low COF.**

Derwent South main

Within the Wearside distribution area, a total of 88 critical assets were identified. These include 3 treatment works, 19 strategic mains, 51 strategic crossings, 1 raw water reservoir, 3 raw water crossings, 3 key control point, 1 pumping station and 7 service reservoirs. The failure of any of these assets, even after taking any mitigation measures currently available to us would still result in the loss of supply to between 35,000 and 150,000 properties.

These assets were categorised into 6 groups including Durham South main with a population of approximately 150,000 supplied from Mosswood WTW via the Castleside WPS/SR:

For the Derwent South main each critical asset was assessed and a consequence score calculated (Table 21). The outputs from these workshops were a matrix linking the critical assets to the identified potential options. Options to mitigate the risk from the critical asset failure was then

identified in terms of whether the Risk Remained, the Risk Reduced or the Risk Removed. These matrixes for Derwent South main are detailed in Table 22.

It can be seen a number of options existed that could address some the risks on the Derwent South main. However no single solution was identified at that time that would remove all the risk from these critical assets with the risk of up to 145,000 customers losing supply within 1 day in some instances. This risk was subsequently considered as part of the scope of the Tees Strategic Network Study completed in 2017.

Tendency to fail analysis

As the critical assets on the Lartington main are underground strategic assets they have been included in the analysis we have undertaken to quantify the likelihood of them failing as described in previous sections of this business case. This theoretical risk score incorporates both likelihood and consequence and is based on the likelihood and consequence of the failure. Of the 1773 strategic crossings in NW the theoretical TTF score ranges from **8.56** to **0** (no data). The average score is **5.88**

The 255 Lartington and Tees strategic crossings greater than 10m in length score from **3.15** to **8.16**. The average TTF score for Lartington and Tees is **5.71**. The conclusion from this analysis would indicate that whilst the average tendency for these mains to fail is no greater than other crossings some sections of this main score significantly above average.

Table 20- Consequence of Failure analysis – Lartington critical assets and consequence scores

ASSET CONS OF FAILURE	ASSET REF	ASSET TYPE	Normal pop Supplied	Pop at risk post Mitigation after					Mitigation Comments	Area	Supply	CP0 ID
				8 HRS	1 DAY	3 DAY	TIME TO SUPPLY LOSS	POP SUPPLY LOSS				
T9 - Lartington SR Outlet Single Main?	EKP LA	Strategic Main	320,000	0	12,000	12,000	15	130,000	Normal 120Mld B Scar 80Mld Shil Imp 10Mld. Bscar 160, Shil Imp 20Mld 30Mld short. Lose B Castle & rural 1 day. Check single outlet main status???	Tees	Lartington	I00000020176
T15 - Conduit 15		Strategic Main	210,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020418
Hury		Raw Water Reservoir	275,000	0	0	0	15	100000	Max 20Mld available from Lartington, increase Broken Scar + shildon. Requires significant valving.	Tees	Lartington	I00000020310
Lartington TW	EKP LA	Treatment Works	335,000	0	12,000	12,000	15	130,000	Normal 120Mld B Scar 80Mld Shil Imp 10Mld. Bscar 160, Shil Imp 20Mld 30Mld short. Lose B Castle & rural 1 day.	Tees	Lartington	I00000020175
T15 - Crossing of Whessoe Rd		Strategic Crossing	210,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020417
T15 - Crossing of Scur Beck		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020414
T15 - Crossing of Deepdale Beck		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020334
T15 - Crossing of A67 Barnard Castle		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020330
T15 - Crossing of Gill Beck		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020337
T15 - Crossing of Thorsgill Beck		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020415
T15 - Crossing of Manyfold Beck		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020339
T15 - Crossing of River Grete		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020340
T15 - Crossing of Forcett Railway		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020336
T15 - Crossing of River Tees		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020342
T15 - Crossing of Piercebridge Beck		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020335
T15 - Crossing of A67 Carlbury		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020331
T15 - Crossing of Ulnaby Beck		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020416
T15 - Crossing of Cocker Beck		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020333
T15 - Crossing of A1(M)		Strategic Crossing	175,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020329
T15 - Crossing of Green Lane		Strategic Crossing	100,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020338
T15 - Crossing of River Skerne		Strategic Crossing	100,000	0	0	0	5	80000	B scar +80, shildon import possibly 20Mld short	Tees	Lartington	I00000020341

Table 21 - Consequence of Failure analysis – Derwent South critical assets and consequence scores

ASSET CONS OF FAILURE	ASSET REF	ASSET TYPE	Normal pop Supplied	Pop at risk post Mitigation after					Mitigation Comments	Area	Supply	Additional Comments	CP0 ID
				8 HRS	1 DAY	3 DAY	TIME TO SUPPLY LOSS	POP SUPPLY LOSS					
W6 - Derwent South Mosswood to Shildon	W6	Strategic Main	150,000	13,000	13,000	150,000	3	150000	no alternate supplies	Wear	Durham		I00000020099
Castleside SR		Service Reservoir	150,000	30,000	145,000	145,000	0.5	145,000	2 tanks, if one is still in service then there are no failures. If both fail, no bypass facilities available. Derwent South main will immediately begin to drain down and direct supplies lost. The rest will survive on storage for approximately 24hrs. Possible x connection at Alum waters could be utilised, however would require control facilities to be installed to allow this to be used in a safe and controlled manner. This would considerably reduce the impact on supplies.	Wear	Durham		I00000020106
Durham Pumps (Mosswood - Castleside)	EKP MW	Pumping Station (potable)	150,000	0	145,000	145,000	1	145,000	Will be immediately reliant upon system storage. Will begin to lose supplies after 24hrs. Possible x connection at Alum waters could be utilised, however would require control facilities to be installed to allow this to be used in a safe and controlled manner. This would considerably reduce the impact on supplies.	Wear	Durham		I00000020107
W6 - Crossing of River Deerness		Strategic Crossing	80000	7,000	7,000	80,000	3	80000	no alternate supplies	Wear	Durham		I00000020317
W6 - Crossing of A690		Strategic Crossing	65000	7,000	7,000	80,000	3	80000	no alternate supplies	Wear	Durham		I00000020324
W6 - Crossing of River Wear		Strategic Crossing	65000	7,000	7,000	80,000	3	80000	no alternate supplies	Wear	Durham		I00000020326
W7 - Sacriston to High Moorsley	W7	Strategic Main	18,000	7,000	7,000	80,000	3	80000	no alternate supplies	Wear	Durham		I00000020327
SZ11-06 Derwent to Ferryhill SR	SZ11-06	Strategic Main	45,000	0	0	45,000	2	45000	no alternate supplies	Wear	Durham		I00000020636
W31 - Sacriston Outlet	W31	Strategic Main	40,000	40,000	40,000	40,000	0	40,000	no alternate supplies	Wear	Durham		I00000020637
Sacriston SR		Service Reservoir	40,000	40,000	40,000	40,000	0.5	40000	The service reservoir site consists of two separate compartments. No problem if only one out. If both out, can be bypassed however still awaiting a PRV, etc to be installed. The installation of the PRV would allow the SR to be bypassed in a safe manner (although may be WQ issues) allowing all supplies to be maintained.	Wear	Durham		I00000020638
W29 - Witton Rd Sacriston	W29	Strategic Main	11,000	11000	11000	40,000	2	40000	no alternate supplies	Wear	Durham		I00000020642
W30 - Sacriston Inlet	W30	Strategic Main	40,000	0	0	40,000	2	40000	no alternate supplies	Wear	Durham		I00000020643
SZ11-04 Auton Stile Inlet	SZ11-04	Strategic Main	35,000	0	0	35,000	2	35000	no alternate supplies	Wear	Durham		I00000020737

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Table 22 - Durham Area Resilience Matrix including optioneering

Options		Durham Pumps (Mossw ood - Castleside)	W6 - Derw ent South Mossw ood to Shildon	Castleside SR	W6 - Crossing of River Deerness	W6 - Crossing of A690	W6 - Crossing of River Wear	W29 - Witton Rd Sacriston	W30 - Sacriston Inlet	Sacriston SR	W31 - Sacriston Outlet	W7 - Sacriston to High Moorsley	SZ11-06 Derw ent to Ferryhill SR	SZ11-04 Auton Stile Inlet
Option 1	**Replace PRV at Dyke Nook - Allows Honey Hill water into South Durham and Automation of Brunhope Main/W6 Main link valve and pressure monitoring. (Alum Waters)**	Risk Reduced	Risk Reduced	Risk Reduced	Risk Reduced	Risk Reduced	Risk Reduced	Already Duelled	Can be bypassed - BP to confirm bypass has sufficient capacity	Can be bypassed - BP to confirm bypass has sufficient capacity	Can be bypassed - BP to confirm bypass has sufficient capacity	Can be bypassed w ith W32 as far as Leamside and then 400 to High Moorsley SR. - BP to confirm bypass has sufficient capacity	Risk Reduced	Risk Reduced
Option 3	**Reverse flow from Beaumont Hill - Already Possible**	Risk Reduced	Risk Reduced	Risk Reduced	Risk Reduced	Risk Reduced	Risk Reduced						Risk Reduced	Risk Reduced
Option 4	**Castleside SR Reservoir Bypass - currently only each compartment**	Risk Remains	Risk Remains	Risk Removed	Risk Remains	Risk Remains	Risk Remains						Risk Remains	Risk Remains
Option 5	**Valves and rider points at crossing**	Risk Remains	Risk Remains	Risk Remains	Risk Reduced	Risk Remains	Risk Remains						Risk Remains	Risk Remains
Option 6	**Dual Crossing of A690**	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Removed	Risk Remains						Risk Remains	Risk Remains
Option 7	**Dual Crossing of River Wear**	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Removed						Risk Remains	Risk Remains
Option 8	**Supply area from SZ12 by installing Pumping Station**	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains						Risk Removed	Risk Remains
Option 9	**Dual main from Spennymoor SR to Ferryhill SR**	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains						Risk Removed	Risk Remains
Option 10	**Dual Auton Stile Inlet**	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains	Risk Remains						Risk Remains	Risk Removed

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Condition assessments

To support the theoretical TTF scores for the Tees mains condition assessments were also undertaken on T3, T4, T9 and T10 to verify the asset condition and expected asset life left in these pipes (Figure 37).

The main findings from these assessments indicated that:

- T3 laid in 1892 had defects deeper than the critical defect depth at all three inspection locations, thus the pipe may be at risk of structural failure along the majority of its length if corrosion patterns are similar. Remaining asset life of 0-34 years;
- T4 laid in 1910 had a number of known failures of the main likely due to it being constructed to Class C pit cast grey iron, consideration into replacing this section should be considered as the material class may be too low for the pressures the pipe is likely to see;
- T9 laid in 1917 had a number of defects deeper than the critical depth calculated for the major road loading at all inspection locations, remediation/replacement at the crossings should be considered;
- T10 laid in 1918 had corrosion pitting defects identified at the inspection locations deeper than the predicted critical defect depth under both major road loading and field loading putting the main at risk of structural failure due to a critical defect.

Figure 37 – Mains condition assessment findings for T3, T4, T9 and T10 strategic mains (AESL, 2012)

AESL Ref	Conduit No	NWL Area	AESL Report Number	Pipeline Section	Buried / Exposed / Tunnel	Nominal Diameter	Material	Date laid	Remaining life to Structural Failure (years)
2413-002	T3	Tees	RP4153	Lartington WTW To Whorley SR	Buried	25"	Cast Iron	1892	6 to 34
2413-003	T4	Tees	RP4162	Whorley Reservoir to Coniscliffe	Buried	25"	Cast Iron	1910	0-83
2413-006	T9	Tees	RP4156	Lartington WTW To Whorley SR	Buried	27"	Cast Iron	1917	0-82
2413-007	T10	Tees	RP4157	Whorley Reservoir to Coniscliffe	Buried	25"	Cast Iron	1918	0-32

Overall we would conclude that a failure on T3, T4, T9 and T10 mains would be assessed as medium to high likelihood / high consequence

Of the 357 service reservoir compartments assessed in ALFA the theoretical TTF score ranges from **4.27** to **1.17**. The average TTF score for service reservoirs in 2017 was **2.54** and in 2014 it was **2.52**. This small change reflects the slow deterioration of these predominantly below ground concrete structures.

For the Lartington and Tees reservoirs subject to our AMP7 resilience plans the TTF score ranges between **1.63** and **3.91** (Table 23). The average TTF score was **2.50.**

Table 23 - TTF score for Lartington and Tees strategic service reservoirs

GIS.Id	Compartment	System Zone	Capacity	Built	Age	Tendency to Fail 2017	Tendency to Fail 2014	Difference
WTE-132799	Maltby Grange North (1)	15	55	1987	30	3.915	3.855	0.06
WTE-167352	South Lackenby East (1)	15	34.807	1978	39	3.535	3.535	0

WTE-ST700848	Maltby Grange South (2)	15	55	1987	30	3.135	3.075	0.06
WTE-ST700840	South Lackenby West (2)	15	36.59	1978	39	3.115	3.115	0
WTE-249710	Long Newton East (1)	15	20.3	1984	33	2.335	2.335	0
WTE-ST700846	Long Newton West (2)	15	20.3	1984	33	2.165	2.165	0
WTE-ST700880	Whorley Hill West (2)	14	0	1996	21	1.785	1.725	0.06
WTE-ST500076	Whorley Hill East (1)	14	20	1996	21	1.635	1.575	0.06

Overall we would conclude that a failure of these reservoirs would be assessed as low likelihood and low/medium consequence (primarily a water quality impact).

Tees Strategic Network Study

Details on the purpose and our approach to delivering the Tees Strategic Network Study (a copy can be provided if required) is covered in more detail in the main body of the business case (p15).

Analysis focused upon the strategic mains, water pumping stations, service reservoirs and all their ancillary assets that convey water from our water treatment works to the boundaries of our district metered areas. The Tees Strategic Network Study also covered the raw water assets which transfer to the inlets of our treatment works. We have undertaken a significant period of modelling and scenario testing for the Tees network. From the basis of a 'blank canvas' we started to reconstruct the Tees network with key strategic assets and modeled the predicted network performance. We assessed each scenario against performance measures that covered both quantity and quality. These included water age, system pressure and mains velocities that would increase the ability of the network to be self-cleansing wherever practicable.

Optioneering – Lartington to Longnewton SR

Based on the consequence analysis, condition assessments and the current restrictions on operation flexibility the options to refurbish or abandon T3, T4, T9 and T10 was quickly discounted and the 'Do Nothing' option was not deemed acceptable based on the known risks. We identified five possible options for the Lartington WTW to Longnewton SR transfer mains:

1. Single new pipe from Lartington WTW to Shildon SR;
2. Single new pipe from Lartington WTW to Whorley Hill SR then to Shildon SR;
3. Single new pipe from Lartington WTW to Whorley SR to Longnewton SR;
4. Single new pipe from Lartington WTW to Beaumont SR;
5. Single new pipe from Lartington WTW to Whorley Hill SR to Beaumont SR.

Option 4 and 5 were discounted following initial assessment as it was felt they offered similar benefits in regards to transfer capability to Options 1 and 2. We therefore fully modeled and scenario tested Options 1, 2 and 3.

Options included a choice of 600mm, 800mm and 1400mm gravity mains and/or a water pumping station. Cost estimates ranged from £180m (full gravity transfer) to £67m (mix of gravity and network pumping). Using estimated annual opex costs it was determined that the option of including additional network pumping capacity offered the best value for customers even though it would increase energy consumption and therefore have a larger carbon footprint over the next 25 years;

Option 2 and 3 were determined as the most suitable option from a hydraulic performance and resilience capability. Analysis and modelling indicated a new single main; with an approximate

diameter of 800mm from Lartington WTW to Longnewton SR via Whorley Hill SR was the best technical solution to address the risks these assets presented to customers. This enables a new 800mm main to be laid from Whorley SR to Shildon to provide resilience to the Derwent South main and Mosswood WTW.

Option 2 and 3 will allow NW to:

- Maximise the deployable output from Lartington WTW and fully utilise gravity supplies into Teesside;
- Ensure this strategic transfer main is fully operable;
- Provide flexibility of use during both “business as usual” and incident scenarios;
- Resolve current water quality risks caused by a pipeline failure by enabling the application of our pipeline management process onto this section of the strategic network;
- The new main will improve resilience into the Tees, providing a reliable supply that reduces the risks previously identified on 20 strategic crossings on Conduit 15 (Table 20);
- Improve the resilience of supply to the 18,000 properties in Darlington currently directly fed from a single treatment works. The new main will enable then to be supplied from both treatment works;
- Address the risks on the Derwent South main by connecting a new main from Whorley Hill SR to Shildon SR. Shildon SR is a strategic transfer point between the Tees and Central supply areas.

Optioneering - Longnewton and Maltby Grange Service Reservoirs

Longnewton and Maltby Grange SRs have a particularly close hydraulic relationship Longnewton SR has a capacity of 46Ml. Maltby Grange SR is one of the largest in the company and has a capacity of 109Ml. It operates on a fill and draw basis using a single inlet/outlet main. Uplands WBS is connected to the outlet of Longnewton SR and pumps water in order to fill Maltby Grange SR. This arrangement means that turn over of Maltby SR is difficult to manage and can take several weeks depending on network demand. This is causing:

- Water quality issues linked to high age of water (chlorine degradation, taste and odour issues, and potential coliform failures) and;
- Reduces the operability of the strategic network by limiting the amount of water we can store and use at Maltby Grange SR (currently operating at 60% of full capacity i.e. 60Ml).

The modeled options were:

1. Do nothing
2. Abandon Longnewton SR and Uplands WPS and retain Maltby Grange SR (with a new inlet/outlet arrangement)
3. Abandon Maltby Grange SR and Uplands WPS and retain Longnewton SR.

Modeling indicated that Option 1 was the most suitable technical solution to address this risk. Benefits from this option include;

- Maltby Grange is located downstream of the Eaglescliffe Pipe Bridge (a CNI site). Should there be an outage at this strategic crossing, the water in Maltby Grange SR would remain available to support demand in Teesside unlike if we retained Longnewton SR.
- Installing a new separate outlet main at Maltby Grange will address current operational restrictions and allow us to maximise the strategic storage capabilities of this site and reduce the risk to water quality by improving reservoir turnover to 4 days;
- Reduce future operational and capital costs by fully utilising the gravity supply from Whorley SR without the need for additional pumping of water..

Optioneering - South Lackenby Service Reservoir

South Lackenby SR is used to balance demand when Ormesby to Nunthorpe WPS is running. Declining demand and a lack of network control between Whorley Hill SR and Longnewton SR is

causing operational issues at South Lackenby SR including discharges of water into the environment due to the overflowing of this reservoir at times of low demand.

The modeled options were:

1. Do nothing
2. Abandon South Lackenby SR in parallel with reconfiguring Ormesby to Nunthorpe WPS.

Modeling and consequence and tendency to fail analysis indicated that Option 2, the abandonment of South Lackenby SR was the most suitable once the new main is laid between Lartington and Longnewton and modifications at Maltby SR and Ormesby WPS were completed. This solution addresses the overcapacity issues of this network and reduces the risk from an asset failure of supply interruptions, water quality failures and environmental impact from overflowing of potable water into local watercourses.

It should be noted that this mains reinforcement and water pumping station scheme is fully dependant on the laying of the new 800mm main between Lartington and Longnewton in order to deliver the risk reduction benefit and improvements in the resilience of the Derwent South strategic network.

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

All costs for these schemes were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[36]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed cost for the Lartington Mains and Tees strategic mains reinforcement schemes, including the new link to Shildon SR/WPS is £42.65m totex.

These costs were benchmarked and assured using a combination of full iMod cost estimates using business as usual processes or in the case of Shildon WPS an assessment and forecast based on benchmarking against historical spend on similar types of schemes.

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance as previously described earlier.

Affordability

The impact of these enhancement investments on customer bills are shown below with this scheme costing customers a one off cost of £1.46 on their bill between 2020 and 2025[37].

[36] For further detail on the cost estimation approach, please see separate ument on cost assessment for enhancement schemes- NWL PR19 Costing methodology.

[37] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.

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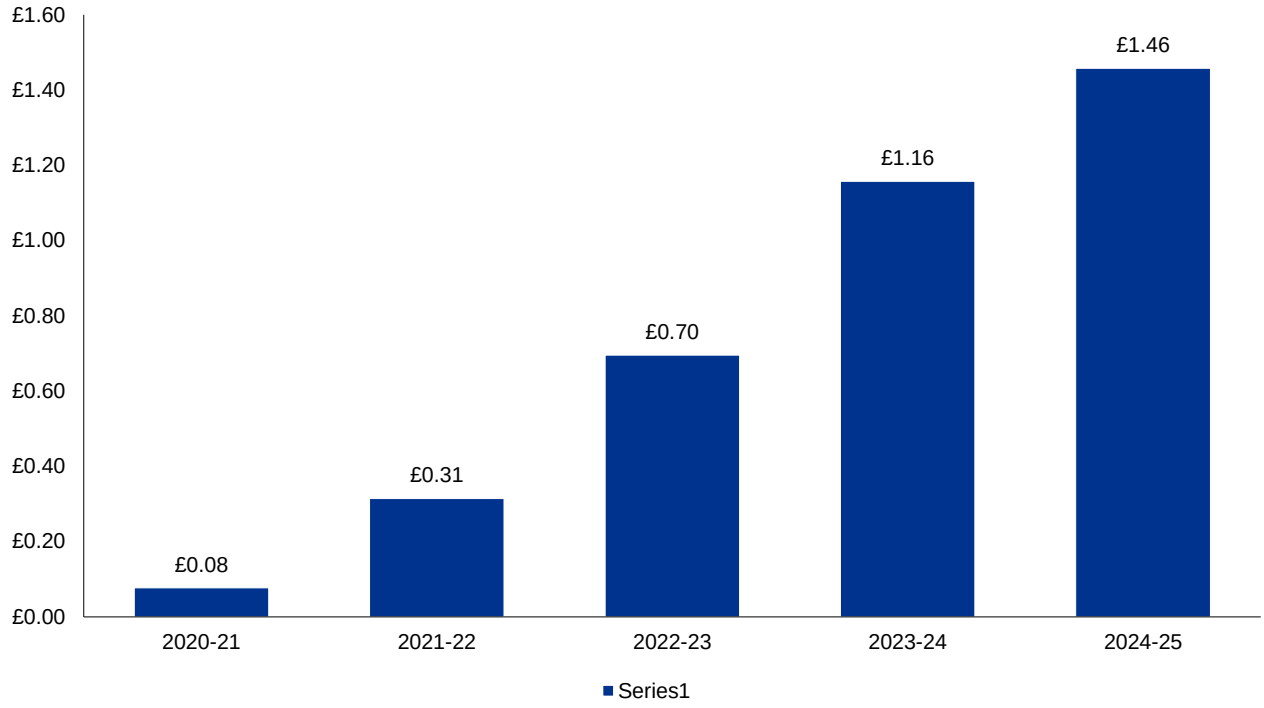

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[38] driving significant improvements to average customer affordability.
We shared details of our plans for Teesside and Central with customers in the Northumbrian area in a series of workshops held across the region. Customers from all areas were allowed to comment and indicate their support on all our resilience proposals even if they did not directly benefit from the improved resilience to service themselves.

Overall customer support for our plans to improve the resilience in our Tees and Central area was supported by 90 and 92**%** of our Northumbrian customers respectively.

When all schemes were considered as a package **94%** of Northumbrian customers supported our proposals. Overall customer support can be summarised as follows:

Northumbrian Water proposal [Water]	Yes	No	Unsure
Our plans for Tyne area	84%	6%	10%
Our plans for Tees area	90%	6%	4%
Our plans for Central area	92%	2%	6%
Our plans for sites too critical to fail	90%	0%	10%
All water schemes as a package	94%	0%	6%

Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remain a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty

[38] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

by 2030[39] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

Customer protection

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers. Details are included in the main body of this document and in Chapter 4: Measuring and Incentivising Success of our business plan.

Stakeholder support

DWI Scheme reference: NNE_ESK 4 – Tees Discolouration - DWI supports the need for the Tees and Central schemes to secure compliance with the manganese and iron drinking water quality standards and supported their inclusion in the Final Business Plan, subject to the caveats listed in the attachment shown in Figure 38.

In this instance the Inspectorate intends to issue a Notice under Regulation 28(4) of the Water Supply (Water Quality) Regulations 2016, as amended, that requires the Company to mitigate the risk of manganese and iron, that has been identified as a potential danger to human health from the water supplied from Lartington WTW. It is expected that the Company will continue to monitor treated water manganese and iron concentrations.

Board assurance

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers".

Figure 38 – Periodic Review 2019: Summary of DWI letter of support DWI NNE_ESK 4

Water company:	Northumbrian Water
DWI scheme reference(s):	NNE_ESK 4
Scheme name:	Tees Discolouration
Proposal:	Reduce the levels of iron and manganese in treated water, supplied via Lartington WTW.
Supporting evidence:	Risk assessment reports for T201 Lartington WTW To Longnewton dated 06 November 2017. Annex A Tees Discolouration dated 29 December 2017 from Alan Brown to the Drinking Water Inspectorate.

[39]See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

Conclusion:	Subject to the caveats listed below, the Inspectorate supports the need for the following scheme: • The laying of new mains from Lartington WTW to Longnewton SR • The laying of new mains from Whorley Hill SR to Shildon SR • Installation of a new outlet main from Maltby Grange SR to conduit 67 • Commencement of a programme of pipeline condition assessments • Separation of conduit 53 and conduit 67 • The moving of Nunthorpe PS to Ormesby SR outlet • Ongoing optimisation of WTW's for the removal of Iron, Manganese, Aluminum and Turbidity • Ongoing uni-directional flushing of DMAs, prioritised based on customer contacts. • Ongoing training of field operatives • Ongoing pipeline management strategy • Improved reservoir and catchment management strategies to reduce metal loadings into the treatment works
Timescale:	Completion date: 2035
Estimated cost:	Estimated capital costs: £66,850,000.00
Legal Instrument Required:	Notice under Regulation 28 (4)

Caveats:

DWI has no role in determining proportional allocation of expenditure. Where DWI technical support is given, this should not be taken by the company to imply that the scheme will be partially or wholly funded as a Quality item.

Schemes that require a legal instrument are considered necessary to meet statutory drinking water quality requirements. These schemes will be transposed to formal programmes of work by DWI as soon as possible and their implementation and completion will be monitored, audited and closure confirmed by DWI.

Annex G – 63 Too Critical to Fail Sites

Name of claim	Water Too Critical to Fail sites
Name and identifier of related claim submitted in May 2018	n/a
Business plan table lines w here the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line 14
Total value of claim for AMP7	£8,340,000
Total opex of claim for AMP7	£0
Total capex of claim for AMP7	£8,340,000
Depreciation on capex in AMP7 (retail controls only)	n/a
Remaining capex required after AMP7 to complete construction	Expected to complete all schemes by 2025
Whole life totex of claim	n/a
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	0.7%
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	No
Need for investment/expenditure	Enhanced resilience measures to address risk from natural and manmade hazards impacting 63 sites deemed too critical to fail
Need for the adjustment (if relevant)	Customer protection from risk of a loss or reduction in service
Outside management control (if relevant)	n/a
Best option for customers (if relevant)	Refer to main text of business case
Robustness and efficiency of claim's costs	Refer to main text of business case
Customer protection (if relevant)	Refer to main text of business case
Affordability (if relevant)	Refer to main text of business case
Board Assurance (if relevant)	Refer to main text of business case

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Background Information

In July 2007 parts of the UK suffered from the wettest summer since records began. Extreme rainfall resulted in widespread flooding across England and Wales. Around 55,000 properties were flooded and the country experienced the largest loss of essential services since World War II. In Gloucestershire, Mythe water treatment works was flooded causing 350,000 people to be without mains water for 17 days.

Following the flooding, Sir Michael Pitt (Pitt, 2008) was tasked with undertaking an independent and comprehensive review of the event. In his review Pitt highlighted the need for "urgent and fundamental changes in the way the country is adapting to the likelihood of more frequent and intense periods of heavy rainfall," and indicated that "better planning and higher levels of protection for critical infrastructure are needed to avoid the loss of essential services such as water and power."

Following the Pitt Review, the Government and Ofwat identified the need for our critical national infrastructure to be more resilient to adverse events. In its 2011 publication 'Keeping the Country Running, Natural Hazards and Infrastructure', resilience planning was widened to also include other extreme events such as attack, damage or destruction from other hazard group.

Hazards can be either natural or man-made. The frequency and severity of some of these hazards may be changing due to climate change and other global trends. Others may not have previously been considered by the business due to their very low probability i.e. they have not happened in the industry in recent history.

These natural and man-made hazards can be summarised as either:

- Episodic individual (natural or man-made) events such as floods, fire or power cuts
- Accidents including air, road and rail crash;
- Loss of external systems including power-cuts, disruption in communications and the provision of services that are inputs to water service systems;
- Combinations of circumstances (scenarios) involving aspects of each of the above, for example storms leading to flooding leading to traffic disruption, power cuts and communications disruption.

There is a clear distinction made between the likelihood of these types of hazards impacting NW s ability to maintain service to customers and the more likely ones such as asset deterioration causing pipe leaks and bursts which we address through general asset management. We already undertake a significant amount of resilience planning as part of normal business activity in relation to improving our response to hazards that have the potential to cause interruptions to our customer's water supply. Our resilience planning included investigations to understand the potential impact coastal, surface and fluvial flooding could have on our water treatment works as per recommendations by the Pitt (2008). In addition a number of operational sites and strategic mains and crossings are monitored via both alarms and CCTV from our 24/7 Security and Alarm Monitoring Unit (SAMU).

Our AMP7 plans aim to start to align with governmental, regulatory and industry understanding and expectations on critical infrastructure resilience. We have considered risk mitigation measures aligned against the four components of resilience (Table 24). Water network resilience is secured through a combination of the 4Rs to deliver the most cost effective and proportionate risk management response to the hazards.

As described in the main body of this business case we have reviewed our critical assets to determine the likely consequence of a failure of the asset, measured by a loss of water supply and number of properties likely to be impacted. This work enabled us to start to better understand the consequence of catastrophic loss of our strategic assets. Determining the likelihood of such events occurring was more difficult to quantify as our experience and therefore historical reference data from such events is often limited.

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Tendency tree analysis can also be used to prioritise assets for investment. This analysis uses the physical characteristics of an asset and determines its tendency to fail. Tendency to fail is expressed as a dimensionless score and has no statistical meaning. It provides a measure of relative likelihood rather than an absolute level. Tendency to fail does not include contributory factors such as extreme weather, chemical shortage, terrorist attack or regional power failure.

Table 24 - Four measures of system resilience

Resilience Measure	Description	Examples
Resistance	Protection of assets from hazards	• Flood protection measures at WTW's. • Additional security measures at highest risk sites
Reliability	Design of assets such that they operate effectively under a range of conditions	• Mechanical and electrical plant capable of operating under e • Robust proactive maintenance and operational policies for critical assets
Reserve	Availability of spare capacity in the network or the ability for services to be provided through other parts of the network	• New network mains connectivity (including consideration of connections from other neighbouring water utilities) • Additional strategic storage capacity • Robust supply chain removes risk from loss of a single supplier of chemicals
Response & Recovery	Planning, preparation and exercising for the response to an event.	• Contingency Plans setting out operational response for the loss of key strategic assets • Increase staff skills for event management by undertaking incident management training

From this analysis we identified an initial 63 sites highest priority sites across Northumbrian, Essex and Suffolk that we deemed 'too critical to fail' (TCTF). That was, post any mitigation that was available to us a failure of the asset would result in an unacceptably high number of customers losing their water supply, probably for an extended duration. A breakdown of asset type and region is shown in Table 25.

Table 25 – Too critical to fail sites by location and type

Asset Type	Northumbrian	Essex	Suffolk
Water treatment works	8	3	2
Key Control Points	4	0	0
Service Reservoirs	10	4	4
Water Pumping Stations	11	9	3
Raw Water Reservoir	3	0	0
Raw Water Pumping Station	2	0	0
Total	**38**	**16**	**9**

In order to determine the current risk of these hazard types NW commissioned Arcadis to develop and deliver a Resilience Assessment of our TCTF sites, applying the methodology Arcadis had developed through application on other clean water supply areas, notably with United Utilities. This approach was acknowledged by Ofwat as good example of 'industry best practice'. The Arcadis Resilience Assessment is a consequence-led approach that quantifies resilience by "customers at risk".

63 TCTF sites, including service & raw water reservoirs, pumping stations, key control points, and treatment works were considered and five of the most likely hazards were defined; surface flooding, fire, loss of power, extreme weather, and malicious damage.

The objective was to quantify site resilience and this was achieved through the assessment of 2 scenarios based on pre and post risk mitigation:

- Baseline
- 2030 assumptions

Need for the investment / expenditure

This TCTF scheme aims to address a number of specific risks identified from;

- Low likelihood hazard events beyond NWs ability to influence
- Consequence of Failure analysis;
- Historic events of a similar nature;

Primary Risk

We had a limited understanding of the likelihood and current resilience against a range of natural and manmade hazards that have the potential to impact the operation of our sites. We currently have 63 operational water sites that are deemed 'too critical to fail'. Such events would be classed as low likelihood high consequence and we currently do not have a respond and recover capability sufficient enough to respond to such an event on that scale.

Secondary Risks

We have a requirement as part of our commitments to Defra and our customers to better understand our current resilience at all of our sites and develop a long term, cost beneficial plan to mitigate against the risks and consequences when these or similar hazards occur.

Best Options for Customers

Based on the recommendations from the Arcadis / NW analysis for the 63 TCTF sites we will;

- Deliver a targeted program of resilience improvements across all 63 sites at a cost of **£8,340,000**. This will involve the implementation of appropriate measures based on risks and likelihoods and will be based around the 4Rs of resilience including improved respond and recover capability. This investment will reduce the impact and duration of a service failure impacting 942,000 customers in total currently supplied from these 63 sites.

Mitigation measures will include increased boundary protection, permanent or temporary flood protection, fire protection systems and emergency response plans. Investments will reduce the risk from and duration of a three day plus loss of supply event caused by natural and man-made hazards impacting the operation of these critical sites. This is in addition to or supportive of our approach to understanding and mitigating the impacts from climate change.

Our long term plans to understand and mitigate risks from external hazards across all our operational sites will be further refined between 2020 and 2025. Work is ongoing to develop our

approach but we are confident the proposed schemes deliver the most cost beneficial range of investment or actions needed to address current and future site and system risks from natural and manmade hazards. A summary of our proposed 2020 -2025 programme is shown in Table 25

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Table 26 – Proposed programme of improved resilience at too critical sites to address natural and manmade hazard risks.

Site name	Baseline risk category	Intervention	Future risk category (post intervention)	Respond, resist, recover	Total scheme cost
Birney Hill P.S.	HIGH	•Install flood doors •Permanent flood protection •LV Generator •Loss of Power mitigation survey •Risk specific Emergency Response Plan	LOW	Respond Resist Recover	£385,428.68
Broken Scar River Intake Pumps	HIGH	•Install flood doors •Permanent flood protection •LV Generator •Loss of Power mitigation survey •Full fire suppression •Risk specific Emergency Response Plan	MODERATE	Respond Resist Recover	£395,428.68
Broken Scar TW	HIGH	•Install flood doors •Permanent flood protection •LV Generator •Loss of Power mitigation survey •Risk specific Emergency Response Plan	LOW	Respond Resist Recover	£440,000.00
Horsley TW	HIGH	•Full fire suppression •Risk specific Emergency Response Plan	MODERATE	Respond Resist Recover	£170,000.00
Mosswood TW	HIGH	•Full fire suppression •Risk specific Emergency Response Plan	LOW	Respond Resist Recover	£170,000.00
Ormesby PS	HIGH	•Install flood doors •Permanent flood protection •Fire detection system •Risk specific Emergency Response Plan	LOW	Respond Resist Recover	£135,428.68

Washington Control	HIGH	•Upgrade Security (SEMD) •Risk specific Emergency Response Plan	LOW	Respond Recover	£20,000.00
Barsham final contact tank	HIGH	•Install flood doors •Permanent flood protection •Risk specific Emergency Response Plan	LOW	Respond Resist Recover	£125,428.68
Chigwell	HIGH	•Full fire suppression •Risk specific Emergency Response Plan	LOW	Respond Resist Recover	£170,000.00
Chigwell Raw Water	HIGH	•Full fire suppression •Flood doors •Rapidly deployable flood barrier •Raise panels •Risk specific Emergency Response Plan	LOW	Respond Resist Recover	£175,571.03
Chigwell Treated Water	HIGH	•Full fire suppression •Flood doors •Rapidly deployable flood barrier •Raise panels •Risk specific Emergency Response Plan	LOW	Respond Resist Recover	£175,571.03
Hanningfield	HIGH	•Install flood doors •Permanent flood protection •Full fire suppression •Risk specific Emergency Response Plan	HIGH	Respond Resist Recover	£987,115.70
Hanningfield PS 3A	HIGH	•Full fire suppression •Risk specific Emergency Response Plan	MODERATE	Respond Resist Recover	£30,000.00

Heaton Grange SR	HIGH	•Upgrade Security (SEMD) •Risk specific Emergency Response Plan	LOW	Respond Recover	£77,643.14
Layer	HIGH	•Install flood doors •Permanent flood protection •Upgrade Security (SEMD) •Full fire suppression •Risk specific Emergency Response Plan	MODERATE	Respond Resist Recover	£987,115.70
Layer High Lift	HIGH	•Install flood doors •Permanent flood protection •Full fire suppression •Risk specific Emergency Response Plan	MODERATE	Respond Resist Recover	£135,428.68
Lower Hall PS	HIGH	•Full fire suppression •LV Generator •Loss of Power mitigation survey •Risk specific Emergency Response Plan	LOW	Respond Resist Recover	£290,000.00
Ormesby Paterson Stream	HIGH	•Install flood doors •Permanent flood protection •Fire detection •Risk specific Emergency Response Plan	MODERATE	Respond Resist Recover	£677,464.80
Whittle Dene WTW	HIGH	•Full fire suppression •Risk specific Emergency Response Plan	MODERATE	Respond Resist Recover	£170,000.00
Broken Scar PS	MODERATE	•Flood doors •Rapidly deployable flood barrier •Raise panels •LV Generation •Loss of Power mitigation survey •Risk specific Emergency Response Plan	LOW	Respond Resist Recover	£425,571.03

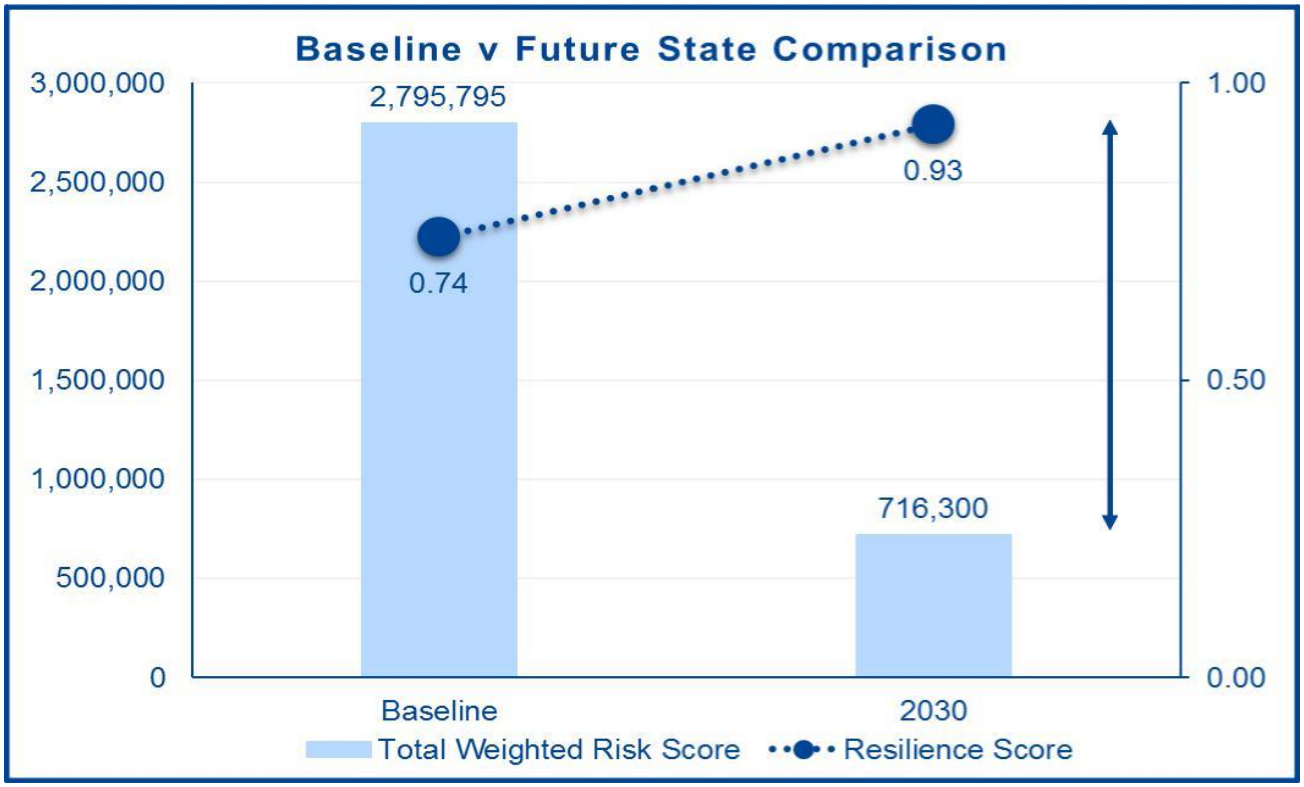
Honey Hill TW	MODERATE	•Fire detection system •Risk specific Emergency Response Plan	LOW	Respond Recover	£120,000.00
Ovingham River Intake Pumps	MODERATE	•Fire detection system •Risk specific Emergency Response Plan	LOW	Respond Recover	£30,000.00
Barsham PS1	MODERATE	•Flood doors •Rapidly deployable flood barrier •Raise panels •Fire detection system •Risk specific Emergency Response Plan	LOW	Respond Resist Recover	£175,571.03
Herongate PS	MODERATE	•Fire detection system •Risk specific Emergency Response Plan	LOW	Respond Recover	£30,000.00
Hullbridge PS	MODERATE	•Fire detection system •Risk specific Emergency Response Plan	LOW	Respond Recover	£30,000.00
Lartington	MODERATE	•Fire detection system •Risk specific Emergency Response Plan	LOW	Respond Recover	£170,000.00
Remaining 36 sites	LOW	• Risk specific Emergency Response Plan	LOW	Respond Recover	£720,000.00
					£7,418,767
		Risk 12.5%	£927,346	Total programme	£8,346,113

Risk reduction benefit

The overall site resilience of the 63 sites has been assessed using the Arcadis methodology and risk scoring approach. This is a measure of resilience rather than risk.

Baseline scenario - This analysis evaluated the current situation across the 63 TCTF sites. The results serve as the primary guidance out of the Arcadis report, highlighting areas where further investigation or resilience work may be focused. The assessment required some assumptions to be made.

2030 scenario - This analysis demonstrated the changes in resilience resulting from planned or predicted work over the next two AMPs. With a scenario representing a proposed future state for the TCTF sites, certain assertions have been required to complete the analysis. These are in addition to the assumptions made for the baseline scenario.



We are proposing to complete all the recommendations from the 2017 Arcadis study across AMP

Current Risk (Do nothing above current control measures) – **0.74 out of 1** (Arcadis derived resilience score)

Future Risk (Deliver TCTF schemes) – **0.93 out of 1**

Resilience Improvement – **0.19** or a **25% improvement in overall resilience**

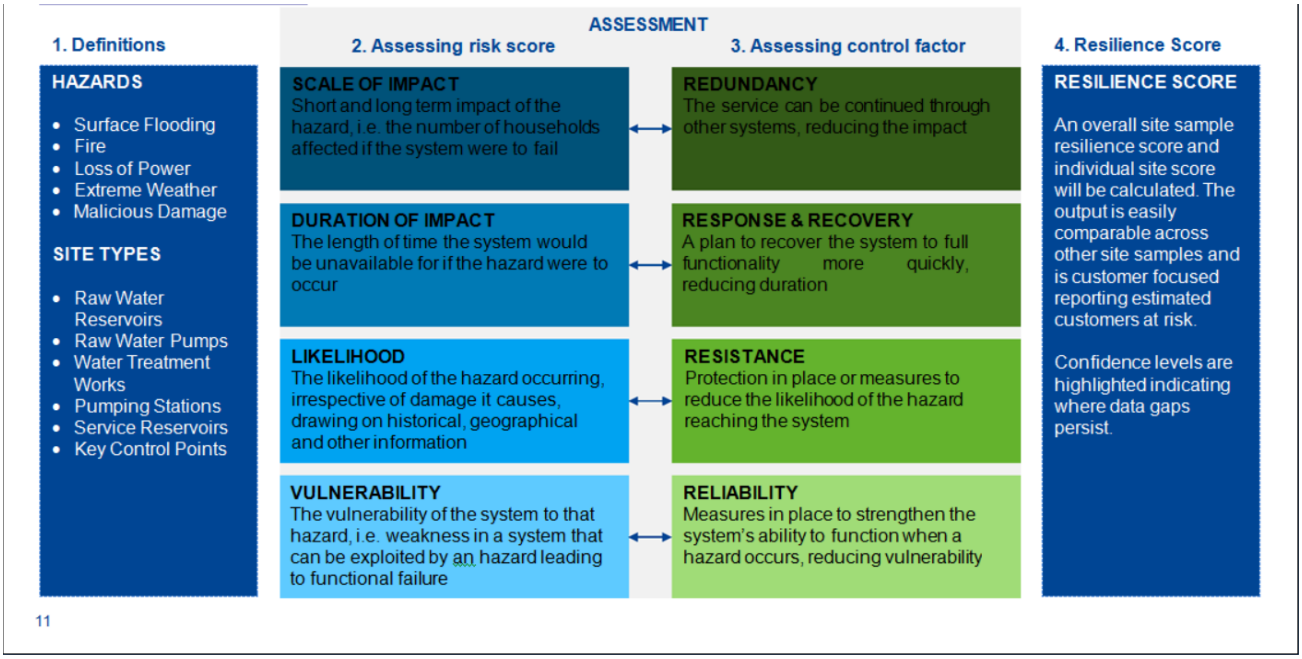
Optioneering and scheme development

The approach to determine our baseline and 2030 resilience scores framed resilience within a risk and controls environment and was implemented in four key stages, embedding the risk calculations to create a one to one relationship between the four risk elements and the corresponding control factors (Figure 39).

It enabled us to better understand the risk drivers, i.e. scale of impact, duration, likelihood or vulnerability, and target appropriate resilience response, i.e. redundancy, response & recovery, resistance or reliability.

APPENDIX 3.2
WATER RESILIENCE

Figure 39 – Methodology for determining resilience scores at TCTF sites



A consequence-led approach then focused on service continuity and was based on a definition of resilience aligned to Ofwat's thinking. It put customers at the heart of investment decisions and enabled consideration of interventions beyond capital expenditure. The risk calculation reflected this by building on the international J100 resilience framework developed by the US Department of Homeland Security and the UK Cabinet office 4 Rs.

To enable an accelerated assessment of the hazards and develop an understanding of the corresponding resilience response, standard question sets using multiple choice answers based on the defined scoring mechanism were used during workshops attended by site owners and operators.

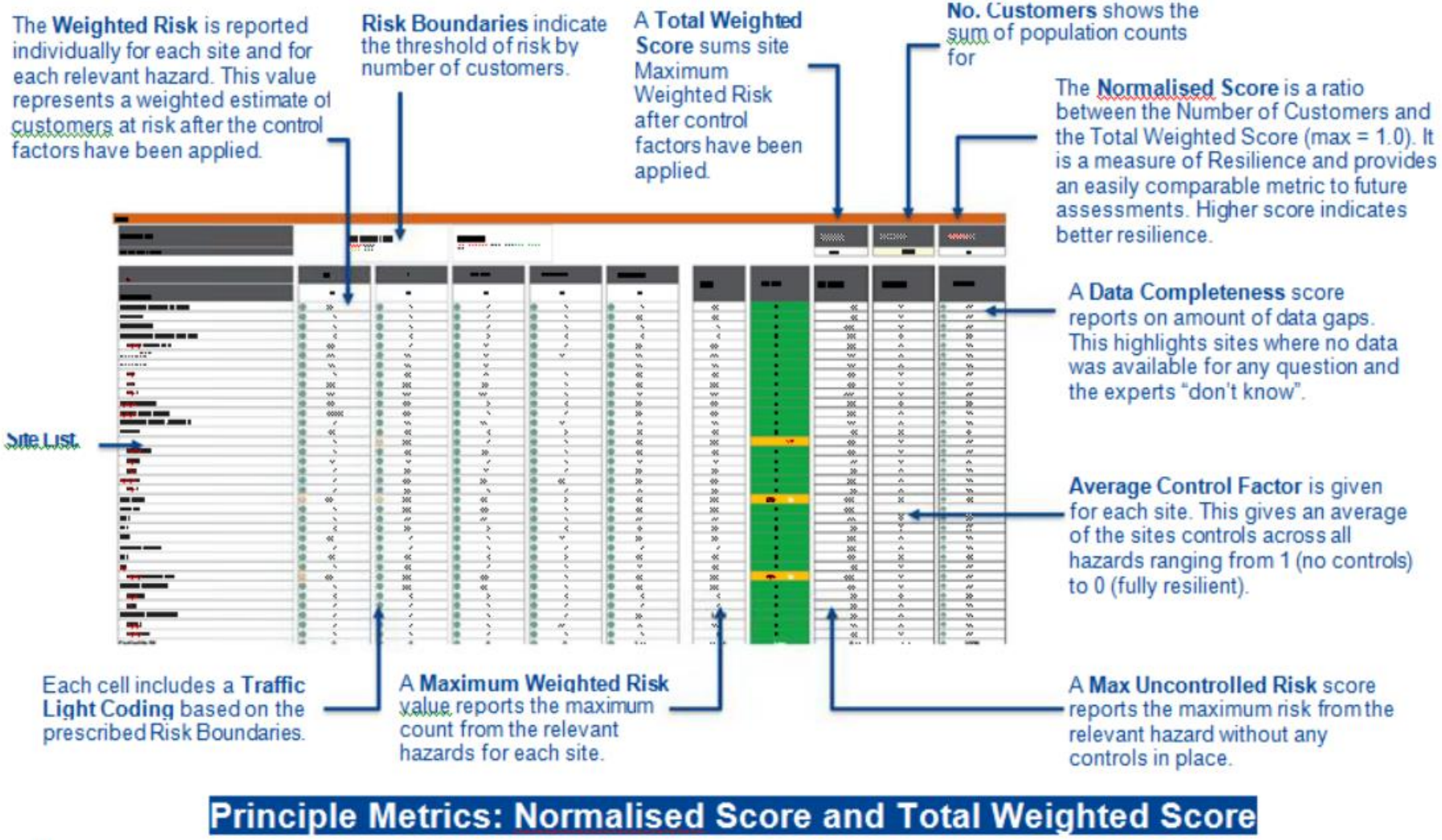
Simple questions, designed to ensure a good level of common understanding and drive consistency and comparability were used. Each question results in a score between 0 and 1, depending upon the multiple choice option selected. In some cases the potential impact to customers varies more significantly between the options than in others. For example, the difference between sites flooding once versus never is substantial, whereas the difference between a site flooding four or five times is less significant.

The following measures were considered when assessing the quality of the data provided to complete the resilience assessment:

1. Data source: how the data has been obtained;
2. Accuracy: the data is a true reflection of the physical entity it represents;
3. Completeness: a complete set of data is available for each asset data record and all assets are recorded;
4. Consistency: data has been provided from a consistent understanding of the requirements;
5. Timeliness: data is up to date and reflects the current state of an asset (not used for professional judgement)

From this we were able to calculate the resilience score for each of the 63 TCTF sites. These were recorded in an Excel based modelling tool which can be expanded to incorporate the remaining operational sites in the future. An overview of this is shown in Figure 40.

Figure 40 – Resilience scoring spreadsheet developed alongside Arcadis Consulting, 2017



From this analysis we were able to identify those TCTF sites that were particularly vulnerable to certain hazards and identify risk mitigation solutions. We were able to assess the benefit each solution provided in regards to the resilience score for the site so only the most cost effective solution would be implemented based on resilience benefit.

A summary of our proposed programme at our TCTF sites is shown in Table 25. It indicates the most appropriate hazard specific risk mitigation measure that is required to improve overall site resilience to the hazard. Solutions may involve the installation of a full fire suppression system or a partial system but would aim to improve the site resilience category from **High Risk** to **Moderate** or **Low Risk**.

One site, Hanningfield still scored High Risk despite significant resilience investment being planned. This is primarily due to the fact this is a key source of water to a large part of Essex with limited alternative sources of supply and our ability to mitigate this risk from natural and manmade hazards would involve significant network reinforcement for what is a low likelihood but high consequence type event.

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

All costs for these schemes were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[40]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed cost for Too Critical to Fail sites is £8.34m totex.

These costs were benchmarked and assured using a PR19 Costing Tool created from iMod base estimates. The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance as previously described earlier.

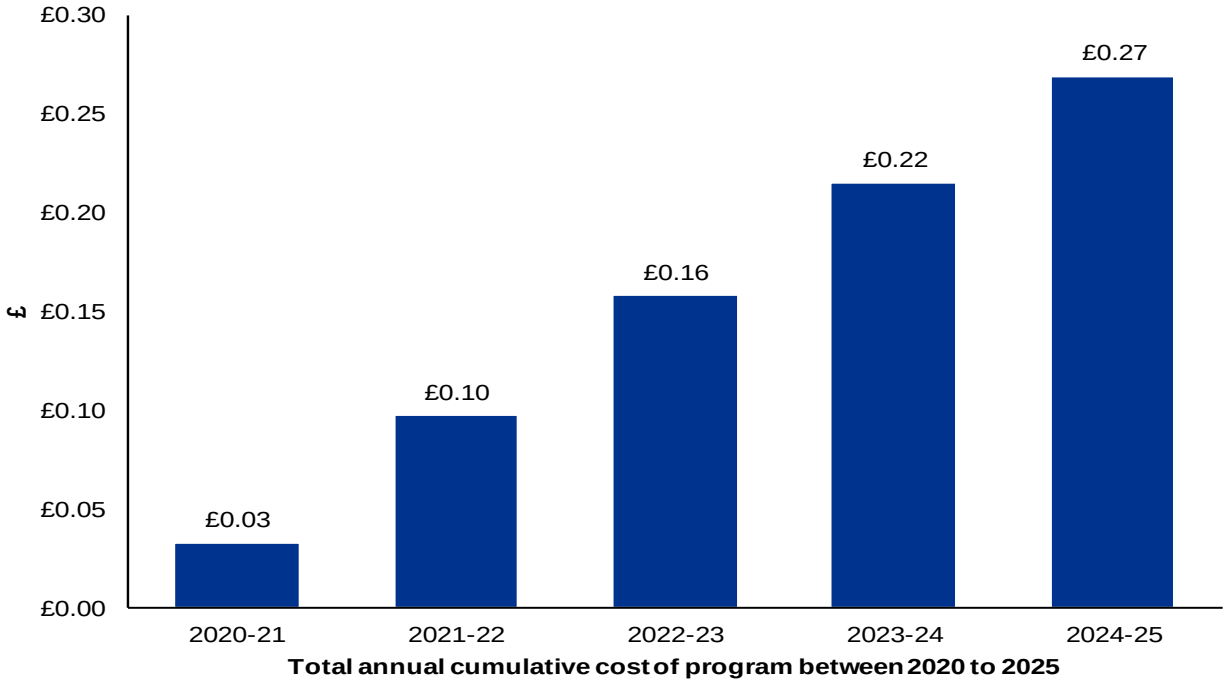
Because of the cost uncertainty with these types of investment schemes we are including a risk allowance of 12.5% has been added to our estimated scheme costs due to the uncertainty of the site specific interventions and eventual costs. Final schemes and costs will only be fully understood once risk based site surveys have been completed at our highest risk sites. It is proposed that any surplus enhanced funding will be used to deliver improved resilience benefits to additional operational sites based on risk prioritisation or returned to customers at the end of the five year programme as part of the incentive delivery mechanism we have proposed for our enhanced resilience programme.

Affordability

The impact of these enhancement investments on customer bills are shown below with this scheme costing customers a one off cost of £0.27 on their bill between 2020 and 2025[41].

[40] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology.

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[42] driving significant improvements to average customer affordability.



We shared details of our plans for Too Critical Sites with customers in the Northumbrian and Essex and Suffolk areas in a series of workshops held across the region. Customers from all areas were allowed to comment and indicate their support on all our resilience proposals even if they did not directly benefit from the improved resilience to service themselves.

Overall customer support for our plans to improve the resilience at our 63 TCTF sites was supported by **100%** of our ESW customers and **90%** of our Northumbrian customers.

When all schemes were considered as a package **94%** of Northumbrian customers supported our proposals. Overall customer support can be summarised as follows:

Northumbrian Water proposal [Water]	Yes	No	Unsure
Our plans for Tyne area	84%	6%	10%
Our plans for Tees area	90%	6%	4%
Our plans for Central area	92%	2%	6%
Our plans for sites too critical to fail	90%	0%	10%
All water schemes as a package	94%	0%	6%

[41] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.

[42] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remain a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 2030[43] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

Customer protection

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers. Details are included in the main body of this document and in Chapter 4: Measuring and Incentivising Success of our business plan.

Board assurance

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers".

[43]See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

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WINEP DWPA ENHANCEMENT BUSINESS CASE

WS2 - Wholesale water capital and operating enhancement expenditure by purpose Line 17

APPENDIX 3.2

WINEP DWPA

Name of claim	Water Industry National Environment Programme (WINEP) enhancement – Drinking Water Protected Areas (DWPAs)	
Name and identifier of related claim submitted in May 2018		
Business plan table lines where the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line 17	
Total value of enhancement for AMP7	£2,965,968	
Total opex of enhancement for AMP7	£0	
Total capex of enhancement for AMP7	£2,965,968	
Depreciation on capex in AMP7 (retail controls only)	n/a	
Remaining capex required after AMP7 to complete construction	None as all schemes expected to be delivered in AMP 7	
Whole life totex of enhancement	n/a.	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	N/A	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	0.247% of Water totex (£1.2B)	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		No
Need for investment/expenditure	Fulfil requirements of WINEP.	
Need for the adjustment (if relevant)	n/a	
Outside management control (if relevant)	n/a	
Best option for customers (if relevant)	n/a	
Robustness and efficiency of claim's costs	P18	
Customer protection (if relevant)	P24 Section 9	
Affordability (if relevant)	P16	
Board Assurance (if relevant)	Board assurance on FBP	

APPENDIX 3.2

WINEP DWPA

1. Executive Summary

This enhancement scheme is a named scheme in our part of the Water Industry National Environment Programme (WINEP) thus making it a regulatory requirement. It will meet regulatory drivers relating to Water Framework Directive Drinking Water Protected Areas, and support deliver of measures contained within the DWI undertakings.

Completion of this scheme is mandatory and Ofwat and the Environment Agency expects funding requirements to be accounted for in the Company's PR19 Business Plan.

This enhancement relates to Catchment Management schemes designed to help us deliver our outcomes that we 'supply clean, clear drinking water that tastes good' and 'provide a reliable and sufficient supply of water'. The scheme will aim to deliver water quality and wider environmental improvements through working with land managers, using funded, targeted interventions to help them make improvements to their farming or other land management practices.

The total cost in AMP7 for this scheme is £2.97m.

In 2016 we conducted customer research on River Water Quality. The outcome was that customers were strongly supportive of improvements in River Water Quality. Delivery of WINEP is a statutory requirement and hence not dependent on customer support, however our plan is stronger for knowing that customers do support this. Focus group research (Explain, 2014) found that most participants (87%) agreed with NWL going above and beyond government requirements and spending more of customers' money on protecting wildlife and habitats. Recent workshops (Explain, 2017) indicated that participants expect NWL to be speaking to and working with the Environment Agency and other environmental organisations on environmental issues.

Generally speaking, customer engagement is less relevant for this enhancement as it derives from a statutory programme of work (the WINEP) and is therefore mandatory, regardless of customer opinion. However, engagement has been carried out with the Water Forum and other interested stakeholders in NWL's operating area all of whom are supportive of the scheme. We shared our WINEP proposals with the Water Forums in April 2018 and they were supportive.

In summary, successful delivery in customer benefit terms, will be completion of the agreed WINEP programme as detailed in Appendix 1 of this document.

2. Context and Scope

This expenditure is classified as enhancement rather than base maintenance because it is included in the Water Industry National Environment Programme (WINEP) and completion of the WINEP will enhance the capacity and quality of services beyond current levels and support our environmental outcomes. The DWI have been engaged on our proposals and have requested that the associated Catchment Management Undertakings are revised accordingly. When responding specifically to our approach to managing metaldehyde risk, DWI stated,

"We support the continuation of all catchment management initiatives throughout catchments to reduce risks to drinking water from all emerging risks".

APPENDIX 3.2
WINEP DWPA

There is a regulatory driver for the scheme, Drinking Water Protected Areas (DrWPA), which has been included by the EA specifically to cover catchment management schemes to address deteriorating water quality in DrWPA.

This business case relates to the business plan table WS2 Line 17 WINEP Drinking Water Protected Areas and WS18 - Explaining the 2019 Final Determination for the water service, block B, line 3 'Number of catchment management schemes'.

The Drinking Water Inspectorate (DWI) confirmed in its guidance note *"Long term planning for the quality of drinking water supplies'* (Sept,17) that it expects that water companies will always plan to meet their statutory obligations for drinking water quality. These mean that water post treatment should always comply with all drinking water standards (prescribed concentration values or PCVs).

Northumbrian Water's overall drinking water quality compliance indicates that this has not always been achieved, with pesticides (particularly metaldehyde) and cryptosporidium being a cause of non-compliance. Looking ahead, metaldehyde is expected to no longer pose a risk to meeting our compliance target due to the restriction on outdoor use by DEFRA, which essentially represents a total ban, which comes into force in June 2020. The Annual Performance Report for 1 April 2016 to 31 March 2017 confirms that the overall drinking water quality target was 99.940%, with the level actually achieved being 99.936%. As stated in NWL Service Policy Document 'Supplying clean drinking water – Improving ODWQ compliance' our aim is to achieve 100% compliance with the Overall drinking water quality (ODWQ) compliance measure for our customers. It is also to sustain 100% compliance in a changing world to meet our Future Horizons 2040 goal.

If some pesticides, such as propyzamide, clopyralid, carbetamide and bentazone reach our raw water intakes in high concentrations, our existing treatment processes, GAC and ozone, cannot reliably reduce concentrations to below the drinking water standard. The DWI acknowledges this by agreeing Pesticide Undertakings with water companies. For NWL, this means that monitoring programmes both at our intakes and within the wider catchments are maintained and that farmers are engaged with to (i) ensure that they are aware of the problem and (ii) inform them how they can reduce the loss of diffuse agricultural pollutants from their farms. For NWL, pesticide undertakings are currently in place for Whittle Dene, Warkworth, Horsley, Lumley and Broken Scar water treatment works in the northern operating area and Barsham, Chigwell, Hanningfield, Langford, Langham, Layer, and Ormesby water treatment works in the southern operating area. The DWI expects that water companies include PR19 catchment schemes in their WINEP for each of the catchments with pesticide undertakings albeit that they should not be a straight continuation of AMP6 schemes.

As an addition to tackling diffuse pollutants from agriculture, we also plan to fund peatland restoration work within the North Pennines Area of Outstanding Natural Beauty. This work will form part of the wider Heritage Lottery Tees-Swale project whose target area covers 829km2 in Upper Teesdale and Upper Swaledale. This element of the scheme aims to deliver on biodiversity priorities and deliver habitat creation and improvement, in line with our ambition to deliver a multiple benefit scheme, with a secondary benefit being the protection of water quality at Lartington WTW from increasing concentrations of DOC, POC, colour and sediments.

Both Ofwat in *'Delivering Water 2020: Our final methodology for the 2019 price review'* (Dec,17) and the DWI in their *'Guidance Note: Long term planning for the quality of drinking water supplies'* (Sept,17) refer to catchment management as being an integral part of the 'source to tap approach'. The DWI states that 'catchment approaches should remain the first consideration in all source to tap risk assessments'. Ofwat states that they 'expect companies to take advantage of and work with

natural processes, where appropriate, such as sustainable urban drainage systems (SuDs) and catchment management approaches'.

Given the risk posed by agricultural pollutants and Ofwat and DWI's expectations, this business case presents how Northumbrian Water will reduce agricultural pollutants in the catchments from which it abstracts water.

The enhancement we are proposing comprises catchment management schemes that will provide:

- Advice;
- Capital grants to land managers to implement measures that will reduce the loss of diffuse pollutants from their farm yards and land; and
- Provide match funding to support the Tees-Swale Heritage Lottery Funded Project restoring eroded peatland in Teesdale.

This expenditure will help to reduce levels of contaminants entering watercourses thus helping to achieve ODWQ compliance.

The scheme will help support two of NWL's customer outcomes, namely that we 'supply clean, clear drinking water that tastes good' and 'provide a reliable and sufficient supply of water'.

In a wider context, it will also deliver on our environmental outcome that 'we help to improve the quality of rivers and coastal waters for the benefit of people, the environment and wildlife'. A key part of this proposal will be to look at how our catchment work impacts the wider environment and how NWL can work more closely with external partners to deliver multi-benefits.

3. Customer and Stakeholder Expectation

The expected scope of DrWPA measures to be included within the PR19 WINEP is set out in the Environment Agency's 'PR19 Driver Guidance – Drinking Water Protected Areas' (Environment Agency, Jan 2017). At a high level this states the Environment Agency's expectation that 'water companies should develop measures to reduce pollution that is reaching their abstractions, these are known as catchment measures and should be developed for safeguard zones'.

Discretionary Enhancements Customer Research

Customer engagement is less relevant for these enhancements as they derive from a statutory programme of work (the WINEP) and are therefore obligatory, regardless of customer opinion. However, various pieces of customer research carried out on behalf of NWL indicate that customers generally support NWL's environmental aspirations.

Focus group research (Explain, 2014) found that the vast majority of participants when asked about 'spending more of customers' money across a number of environmental activities' generally supported this and agreed with NWL going above and beyond government requirements. 94% of respondents agreed that NWL should be working to reduce pesticides and chemicals from river water and 87% agreed on protecting wildlife and habitats (6 focus groups, 52 respondents). Further research called 'Defining the Conversation', carried out in 2016 and 2017 indicated that customers expect NWL to be speaking to and working with the Environment Agency and other expert environmental organisations on environmental issues and when considering how to manage our performance in the wider environment.

In March and April 2018, we conducted two phases of deliberative qualitative research with customers to explore their acceptability for a range of discretionary enhancement schemes. The

schemes were presented in the context that in 2020 customers' bills would be reduced by 10% and that the schemes could be funded by making the 10% reduction smaller. When reviewing the results of the engagement, we considered customers' acceptability to be anything over 70%. This was based on CCWater's Threshold of Acceptability research that was carried out for PR14.

The second phase of research was conducted because in the first phase a number of customers stated that they did not know if they accepted the schemes. We discussed this with our Water Forums and agreed that we should carry out additional engagement to understand why this was, and what information we would need to provide to customers to allow them to answer the acceptability question. The results from the acceptability engagement were discussed with our Water Forums, who welcomed the generally very high levels of customer support for the schemes. Members did not agree on a definitive threshold for support in percentage terms, however some views shared were that anything over about 60% would be acceptable. All our enhancements were included in our overall acceptability research, where our plan was supported by 91% of customers.

WINEP

In 2016 we conducted customer research on River Water Quality. The outcome was that customers were strongly supportive of improvements in River Water Quality.

Whilst this enhancement scheme is regulatory driven, we have still consulted with our stakeholders including engagement with the Water Forum.

As part of our PR19 stakeholder engagement a series of 'Thinking Ahead' workshops were held in the NW area in early 2017 at which stakeholders were invited to help us understand where common interests lay and to identify opportunities to deliver partnership projects. Stakeholders from a wide range of organisations were personally invited to participate including EA, NE, Rivers Trusts, RSPB, NFU, local councils, Wildlife Trust, Forestry Commission and local Universities. In the NW area five workshops were held, one to cover each of the already well-established Catchment Based Approach Partnership (CaBA) areas, as well as a further regional workshop in September which aimed to take a more strategic look across the region. In the ESW area a single regional workshop was held due to the fact the CaBA is not so well established. The outputs of these workshops are available on request.

A key theme identified across the workshops was a desire to take a catchment or landscape scale approach and to widen out the scope and involvement beyond single partner focus and to deliver multiple benefits. This is summarised in the attached pack above under 'Thinking Ahead Key Themes Synthesis'. The theme 'Upstream Land Management and Water Stewardship' talks about an opportunity to widen out scope and involvement beyond single partner focus and to deliver multiple benefits. Particularly in the ESW area partners felt our AMP6 Pesti-wise programme was too single-issue focused, on pesticides, and that opportunities for wider benefits were missed. We have taken that feedback on board and have included a wider range of measures across our PR19 proposal but also two specific projects which will focus on multi-benefits and partnership delivery.

NWL has ensured, through liaison with local Environment Agency Fisheries, Biodiversity & Geomorphology Teams, and via escalating issues with the Environment Agency national consistency panel, that our plans meet their expectations. We have agreed with the EA that these schemes should be included in the WINEP because these catchments are either covered by a DWI pesticide Undertaking or that we have a known water quality issue that is affecting our overall drinking water quality compliance. These schemes were agreed through ongoing liaison with the EA through email, telephone conversations and face to face meetings. The latest version of the WINEP3, issued 30th March 2018, confirms the Environment Agency's acceptance of the

programme. A full version of the current WINEP can be viewed here https://data.gov.uk/dataset/a1b25bcb-9d42-4227-9b3a-34782763f0c0/water-industry-national-environment-programme although an updated version is expected at the end of March 2019.

The scope of each individual DrWPA WINEP line will be further developed between now and December 2018 as Measures Specifications Forms are completed.

In summary, successful delivery in customer benefit terms, will be completion of the agreed WINEP programme.

4. Current and Historical Service Delivery and Expenditure

In AMP6 much of NWL's catchment work has been focused through the 'Pesti-wise' programme: https://www.eswater.co.uk/your-home/environment/Pesti-wise.aspx

Pesti-wise was launched in April 2015 and aims to work with farmers and their agronomists to deliver practical guidance and on-farm solutions that helps minimise pesticide run-off and supports sustainable agriculture.

Key objectives include:

i) Prove the concept that voluntary action can reduce raw water concentrations of key pesticides in catchment water-bodies; and
ii) Determine the level of engagement, adoption of best practice, and scale of investment, required to achieve the observed pesticide reductions.

The desired outcome is to reduce average and peak pesticide concentrations at the sub-catchment outlets, compared to a control catchment and the pre-intervention dataset.

Through the Pesti-wise programme we have achieved good levels of engagement across all 5 pilot catchments, although engagement in the Whittle Dene catchment has been lower than the others. We have however gained a wealth of experience of what works and what doesn't, and the team continues to improve its ability to get farmers on board. AMP6 Pesti-wise Engagement figures are summarised below:

Catchment	Total Area Engaged (1.1 visit) %	Total Area Engaged (1.1 visit, event or telephone call) %	Additional Comments
Roxwell Brook	92	100	
Layer Brook	77	92	Remaining 8% held by 19 different landowners i.e. lots of very small land holdings
Dickleburgh Stream	92	94	
Tyelaw Burn	51	84	90% if none arable land excluded
Whittle Dene	33	48	Estimate 65% if non-arable land excluded from total land area value

The Pesti-wise grant scheme ran from April 2015 until February 2017, during which time a total of 51 Pesti-wise grant offers were made across the five pilot catchments and total grant funding of £373,707 has been paid out for improved pesticide application equipment and handling facilities.

Full analysis of any improvement in water quality will be undertaken at the end of the five year programme. Broadly speaking metaldehyde levels have been lower both in frequency and concentration but we have had three relatively dry autumn / winter periods which means the programme has not been challenged fully. It is therefore not deemed reasonable to draw conclusions at this stage until we have the full AMP6 dataset. We have however seen some encouraging results in one of the NW catchments in year 2 of the programme with the test catchment having no results for metaldehyde above 0.1ug/l while the control had 30% of weekly samples 0.1ug/l, including a peak of 0.8ug/l.

The programme activity is summarised below

- 120 one to one farm visits completed to date
- Pesti-wise grants offered for 54 equipment items and 24 infrastructure items.
- Pesti-wise grants accepted for 43 equipment (23 pelleters, 8 auto-section cut-off, 6 straw rakes, 2 drainage racks, 3 pre-emergence markers, 1 set low drift nozzles, 1 light bar) and 18 infrastructure items (8 wash-down areas, 7 roofing, 5 biofilters).
- £373,707.69 paid as grants for improved pesticide application equipment and handling facilities.
- High frequency water quality monitoring at 9 sites

5. Forward Looking Analysis

We have a target to achieve 100% ODWQ compliance and we know that there are chemicals, such as metaldehyde, and other contaminants such as cryptosporidium that put us at risk of failing to achieve this. While there are contaminants that are extremely difficult to treat for and current treatment may not be 100% reliable (e.g. for metaldehyde), there are also other contaminants that can make treatment difficult and costly which also creates risk of compliance failures. Catchment Management can therefore play a key role in addressing this risk where complete removal of pollutants via water treatment is not technically feasible, helping to achieve our ODWQ target. If we do not intervene we therefore risk failing to meet our ODWQ target.

Although no specific forecasting has been undertaken, there are a number of risk factors to consider, a key one being climate change, which has the potential to have a significant impact on WQ. Climate change forecasting is predicting wetter winters and drier summers as well as more extreme rainfall events. Rainfall plays a key role in transportation of contaminants to water and if rainfall events do become more extreme this creates an increased risk of pesticides etc. being washed off the land as well as increased soil erosion, increasing sediment loading to rivers. This could also impact our ability to undertake abstraction management, as drier summers could mean lower reservoirs levels and a more urgent need to fill reservoirs thus exacerbating the conflict between filling the reservoirs and not taking contaminated water. Climate change may also impact cropping patterns, it may bring opportunities to grow new crops, or expand the geography over which some are grown, for example maize, which could introduce associated pesticides into areas where we have not seen them before. It could also cause the spread of some weeds / diseases into areas they are not currently seen, again introducing pesticides we haven't historically seen. (CCRA Agriculture Sector Report, 2012).

Whilst preparing our Business Plan, a big uncertainty in terms of metaldehyde specifically was the future of the product. Defra was consulting on its future which included a potential total or partial ban. On 19 December 2018, Defra announced restrictions on the use of metaldehyde to protect wildlife (https://www.gov.uk/government/news/restrictions-on-the-use-of-metaldehyde-to-protect-

wildlife?utm_source=74416da4-a7d3-4abc-97fe-5e2af95e4696&utm_medium=email&utm_campaign=govuk-notifications&utm_content=immediate).

These restrictions represent a complete ban on outdoor use and will come into force in spring 2019 until when it will be legal to sell metaldehyde, with the use-up period running until the end of June 2020. The only alternative product which will remain on sale, ferric phosphate, poses not risk to water quality.

We feel that this ban on use is highly likely to reduce the risk of metaldehyde concentrations above the drinking water standard reaching our raw water intakes. Therefore, we will not require the product substitution schemes initially proposed for our AMP7 DWPA WINEP and this element of our scheme, a total of £1.3m, has been removed. Guidance from the Environment Agency has also confirmed that payments for product substitution should not continue after 30 June 2020. We will continue to monitor water quality to determine the impact of the ban and quantify any remaining risk; and also support the ban by raising awareness of the restrictions, engaging with land managers and farmers in our catchments to ensure they understand the restrictions and the actions required.

Another big uncertainty is the future of farm subsidy post-Brexit. Clearly we do not want to be funding interventions which farmers could get funding for from elsewhere. As we do not have any detail on the future of subsidies we have assumed that we will need to provide support for the specific interventions we want to see. Almost all of the current farmer subsidy available come from EU Common Agricultural Policy and there is no guarantee our own government would continue at the same level of funding. Currently Defra priority areas do not align with our own, hence many farmers are not eligible for the funding we believe is required, for example only a very limited area of our catchments are water priority areas and hence most of the farmers we work with are not eligible for water capital grant items from Countryside Stewardship. We currently see no indication that any shortfalls would be made up elsewhere either, particularly in the case of work relating specifically to reducing pesticides. Typically speaking, the levels of pesticides we detect are only of concern for drinking water quality standards and do not have an environmental impact so there is no driver for other organisations to make investments. More broadly speaking, there may be opportunities to run partnership projects tackling diffuse pollution more generally, but again many partners such as EA, NE and Rivers Trusts rely on European funds so we expect other sources of funding to be scarce.

Water quality is unlikely to improve on its own – we have nothing concrete to indicate farming practices will change to any significant degree in the immediate future, we have to assume that farming will continue as per the status quo which we know does cause problems for water quality. Without appropriate investment into catchment management we are unlikely to see any improvement, there is no incentive for farmers to make changes to their practices of their own accord. There is a risk water quality could get worse, especially given the uncertainties of Brexit i.e. potential loss of subsidies as described above, resulting in changes in farming practices such as loss of features currently protecting water e.g. bufferstrips, if grant funding support for such interventions is no longer available. Many farmers have been reluctant to sign up to currently available Stewardship schemes because of uncertainties (NFU, Mar18, https://www.nfuonline.com/news/latest-news/delivery-of-countryside-and-environmental-stewards/) and if farming subsidies change significantly, which current government policy would suggest they will, this could at the very least cause a few turbulent years until farmers get on board with a new scheme. NWL believes this uncertainty does pose a risk to water quality and although we do not currently know the future of farm subsidy, for the purpose of PR19 we believe we have to assume the worst i.e. that we could see future deterioration in water quality, hence failing to deliver on Article 7 and putting us at risk of failing to meet ODWQ targets. Investment in catchment management is therefore required to manage this risk.

6. Option Appraisal

Option 1 - Do nothing

We know there are a number of catchment-derived water quality risks which cannot be fully managed through water treatment alone. Therefore opting to 'do nothing' poses a risk to final water compliance and associated risk to reputation due to the effect on NWL position in national DWI tables. As catchment schemes are specified in the WINEP as the preferred option to meet Article 7 objectives, i.e. no deterioration of WQ, failure to deliver would mean failure to comply with the WINEP programme. For the catchments with DWI Undertakings, we have agreed to implement enhanced catchment management activities, so again doing nothing would mean failing to comply with this requirement.

Option 2 – Continuation and Enhancement of AMP6 Pesti-wise programme

Pesticides (particularly metaldehyde), colour and cryptosporidium can compromise NWL's Overall Drinking Water Quality (ODWQ) compliance. In order to achieve compliance there are three key options, address contamination at source through catchment management, do not take contaminated water (abstraction management) and more traditional treatment options.

Abstraction Management is the action of reducing or stopping abstraction at the river intake when water quality, as confirmed by online monitors or same day laboratory analysis, is poor. Abstraction management is effective at managing diffuse pollution when reservoir storage is healthy. However, when this is not the case, for example in dry years, there is less scope for abstraction management which increases the risk of failures. This could be further exacerbated by climate change, as summers get drier and winters get wetter, and rainfall events become more extreme. Drier summers could mean lower reservoir levels due to both lower rainfall but also increased demand. This means when the refill period comes there could be greater urgency to fill the reservoirs, regardless of water quality. Abstraction management has always been a balance between having enough water and not taking contaminated water, this is likely to get more significant with climate change. Therefore, abstraction management needs to be used in conjunction with other options and as abstraction management is considered business as usual it is not considered in this proposal.

Currently, there is no affordable treatment process for metaldehyde removal and other contaminants can be difficult and/or costly to remove. The DWI's expectation is that catchment management should remain the first consideration and NWL also has a regulatory responsibility to deliver catchment schemes as part of the WINEP and also the DWI undertakings so catchment management is the focus of this proposal.

For AMP7, NWL plans to implement a grant scheme that will replace Pesti-wise with a new scheme that will consider a wider range of diffuse pollutants and measures, supported by a new grant delivery system that will be developed. NWL intends to build a scheme which will allow other stakeholders such as the Environment Agency, Natural England and Rivers Trusts to bring in money that will fund other ecosystem service improvements that are not a priority to NWL. This could include habitat improvements, reducing flood risk and wider ecosystem services such as Health, Wellbeing, Recreation and Access. We will set-up or develop existing Catchment Partnership steering groups to agree priorities in each area and to monitor progress.

The proposed PR19 Drinking Water Protected Areas schemes are to grant fund land managers to make land management changes that will:

i. reduce pesticides, sediment, phosphorus and nitrate loss from fields and farm yards to water courses and our water abstraction intakes; and
ii. reduce cryptosporidium risk and colour at NWL's water abstraction intakes.

This proposal continues to build upon the now widely accepted principles and practices of catchment management and we expect the majority, if not all, of NWL's competitors will be continuing with the catchment management approach next AMP.

In developing these proposals, three mechanisms for delivering catchment improvements have been considered:

i. **Paid for product substitution:**

The only way to be sure of reducing metaldehyde levels is to reduce metaldehyde use. One option to achieve this is to offer paid for product substitution (PfPS). This is when a third party pays the difference between the cost of a cheaper, less preferred, product and a preferred but more expensive alternative product. Product substitution schemes can target (i) all farms in a specific catchment; or (ii) specific farmers who have high risk fields or are farming in high risk areas of wider catchments.

When we were preparing our Business Plan the long term future of metaldehyde, and therefore the duration for which a PfPS scheme would be required, was still unclear, as we awaited the decision on the re-authorisation of products containing metaldehyde. In January at 'The UK Expert Committee on Pesticides', it was noted that Defra would put a submission to Ministers seeking a view on whether metaldehyde products should be re-authorised, and if so on what basis. It was also noted that Defra "were considering imposing restrictions on geographical areas in which metaldehyde could be used to help ensure compliance with drinking water quality legislation". (*Full Minutes of the meeting of the UK Expert Committee on Pesticides (ECP) held on 30 January 2018).* On 19 December 2018, Defra announced restrictions on the use of metaldehyde to protect wildlife (https://www.gov.uk/government/news/restrictions-on-the-use-of-metaldehyde-to-protect-wildlife?utm_source=74416da4-a7d3-4abc-97fe-5e2af95e4696&utm_medium=email&utm_campaign=govuk-notifications&utm_content=immediate).
These restrictions represent a complete ban on outdoor use and will come into force in spring 2019 until when it will be legal to sell metaldehyde, with the use-up period running until the end of June 2020.

We feel that this ban on use is highly likely to reduce the risk of metaldehyde concentrations above the drinking water standard reaching our raw water intakes. Therefore, we will not require the product substitution schemes initially proposed for our AMP7 DWPA WINEP. Guidance from the Environment Agency has also confirmed that payments for product substitution should not continue after 30 June 2020. We will continue to monitor water quality to determine the impact of the ban and quantify any remaining risk; and also support the ban by raising awareness of the restrictions, engaging with land managers and farmers in our catchments to ensure they understand the restrictions and the actions required.

ii. **Capital Grant Schemes:** Land managers are invited to apply for a capital grant to fund a catchment measure (for example, a bio-filter to reduce pesticide loss from the

farm yard). It is intended that a 75% grant is provided with the remaining 25% cost being funded by the applicant. The reason for this ratio is we want the scheme to be attractive enough i.e. the farmer may not do it without support, but we want them to be invested in it, hence not offering 100% funding. This ratio has been tested through Pesti-wise and we have had good take up from the farmers. NWL consider this to be an appropriate method for delivering catchment improvements such as biofilters, which can reduce pesticide loss from the farm yard by up to 99%. There is no legal requirement for a farmer to install a biofilter and experience has shown us that farmers are unlikely to go down this route without support, because of the upfront costs. As up to 40% of pesticide in rivers come from the farm yard, this is a significant improvement. Capital Grant Schemes are also in line with how other government schemes work such as Natural England's Catchment Sensitive Farming Capital Grant Scheme. They are therefore something farmers are already familiar with which should encourage uptake. NWL's proposed AMP7 Capital Grant Scheme will not duplicate any other Capital Grant Scheme. NWL's target catchments differ from those such as Natural England's Catchment Sensitive Farming Priority Areas which are focused on protecting Sites of Special Scientific Interest rather than Public Water Supply Abstraction Intakes.

iii. **Reverse Auctions:** Reverse auctions, like standard auctions, are competitive bidding systems. In a reverse auction sellers compete to supply buyers with a specified good or service, enabling buyers to locate the most competitive sellers. Unlike standard auctions in which multiple buyers compete to buy goods from a single seller, in reverse auctions, multiple sellers compete to sell goods to a single buyer. The effect is that in a reverse auction sellers bid prices down while in a standard auction buyers bid prices up.

In markets with multiple sellers (farmers) and a single buyer (us), reverse auctions could help to efficiently allocate a limited budget. In a reverse auction whose goal is to purchase environmental goods or services, farmers may bid to take a specified number of hectares of land out of production, so that pesticides and nitrates are not used. This is known as arable reversion. Once the auction closes, all bids are then ranked from lowest to highest, allowing the administrators of the auction to determine which bids are most competitive. As part of the bid, sellers include the length of the contract they are willing to enter into.

Reverse auctions can be delivered through a paper based system or through web platforms such as that offered by EnTrade, https://www.entrade.co.uk/. The former has been used by the West Country Rivers Trust, although feedback is that a paper based system is slow and not a true auction in that farmers can only bid once. Web platforms are fast and are a true auction as bidders can amend their bid until the auction closes.

There are a number of risks associated with reverse auctions:

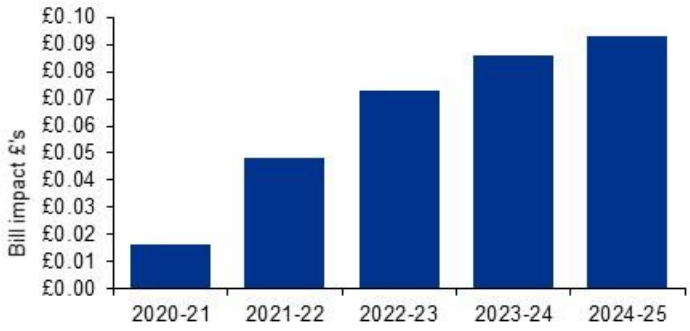
- Following meetings with EnTrade, NWL has concluded that reverse auctions can work well for reducing nutrients but are unlikely to work as well for pesticides. This is because, under EnTrade's current system, pesticide options are limited to PfPS (see above) or arable reversion, the latter not being considered cost beneficial. This is because in order to see a reduction in pesticides you would need to take vast areas of land out of production and the cost would be prohibitive. Arable reversion is also likely to be extremely unpalatable to the

farmers as doing so at a significant scale would completely alter their core business, i.e. taking enough land out of production to effect water quality.
- Internal stakeholders felt that the web platform fees were too high (over £100K over 5 years) and that this money would be better spent on funding interventions.
- The best outcome for NWL might not be achieved if an insufficient number of farmers, or farmers in the highest risk areas, did not participate in the scheme, resulting in water quality benefits not being realised.
- Farmers may be dissatisfied if they spend time preparing a bid, which is subsequently unsuccessful, thereby damaging the relationship between the farmer and NWL and impacting reputation.

Given the above points, reverse auctions do not form part of NWL's PR19 proposals. The preferred option is to offer a capital grant scheme which will address contaminants but also help to deliver the wider environmental benefits our stakeholders are demanding.

Affordability

The impact of these enhancement investments on customer bills are shown below[1].



[

Overall the analysis shows that the bill impacts would be an increase of around £0.09 a year by 2024/25.

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum2 driving significant improvements to average customer affordability.

The scheme proposed is material to the long-term stability and health of the customer service, and will contribute to a robust future network. This is in the context of an AMP7 plan which customers fully support.

Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remains a concern particularly for some low income

[1] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.
[2] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 20303 and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

7. Preferred Plan / Option

NWL is proposing a preferred programme which is a capital grant scheme to address contaminants and also help to deliver the wider environmental benefits our stakeholders are demanding.

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.
All costs for the WINEP Drinking Water Protected Areas scheme were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[4]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed costs for the WINEP Drinking Water Protected Areas scheme are £2.97m Capex.
These costs were benchmarked and assured using a combination of traditional unit rate build up estimates and assessment and forecasting of historical spend.

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[5]. This review has assessed the WINEP Drinking Water Protected Areas scheme costs as Green that is NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

The estimated annual spend profile table below is based on the following allocation:

Year 1: 30% of the AMP7 total
Year 2: 30% of the AMP7 total
Year 3: 20% of the AMP7 total
Year 4: 10% of the AMP7 total
Year 5: 10% of the AMP7 total

DESCRIPTION	2020/21	2021/22	2022/23	2023/24	2024/25	Total
	£m	£m	£m	£m	£m	£m
Capex	0.89	0.89	0.59	0.30	0.3	2.97

[3] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWL_PR19_Interactive_FINAL_RS.pdf
[4] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology
[5] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

Opex	-	-	-	-	-	-
Totex	0.89	0.89	0.59	0.30	0.3	2.97

The following process has been used to identify the totex required to deliver the activity:

i. Appropriate upstream catchment interventions have been identified using NWL's in-house expertise gained through previous and current AMP catchment management work and output from our PR19 catchment workshops held in both the ESW and NW catchments;
ii. The area of land or number of holdings to be targeted has been estimated. However, it should be noted that there is further work to do to confirm the target areas. This includes using new rainfall run-off models, which have only recently become available, to confirm pesticide / nutrient loading from main river tributaries;
iii. The cost of the interventions has been estimated using experience from delivering our AMP6 Pesti-wise programme and from published Government Countryside Stewardship scheme grants; and
iv. The intervention costs have been multiplied up by the target area (ha) or the number of holdings.

The best available information has been used to develop the costs and all costs included have been assured by NWL's internal Cost Assurance team. The cost confidence in each business case as a whole has been assessed using the following methodology:

- **Green** - Over 75% achieving Green RAG status
- **Amber** – Over 65% achieving Green or over 90% achieving Amber RAG status
- **Red** – Not achieving Green or Amber.

The WINEP – DrWPA programme is assessed as 100% Amber.

Furthermore, the cost assurance process and associated costs generated for the water WINEP - DrWPA enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018. This review has assessed all water WINEP enhancement costs as 'AMBER', namely that NWL has evidenced that the costs used are robust and consistent with good industry practice.[6]

The detail of how the WINEP DrWPA programme will be delivered will be developed, in consultation with the Environment Agency and other external partners over the next 6 months, with detailed Measures Specification forms for each catchment being completed by December 2018. Below is an extract from the WINEP which provides currently available detail on the interventions we plan to undertake in each catchment. While the detailed scope of works in each catchment, remains to be defined, all these are 'Green' schemes within the WINEP so are 'confirmed' in that sense.

[6] NWL PR19 Enhancement Assurance - Summary Report Rev B, Mott MacDonald, July 2018

APPENDIX 3.2

WINEP DWPA

Extract from WINEP3 (taken 15th March 2018, does not reflect change in PfPS, EA update due in March 2019

Water Company	Scheme Name / Name of Investigation	Driver Code	Measure Type	Investigation Scope	Implementation Scope
Northumbrian Water	Fell Sandstone Nitrate Investigation	DrWPA_INV	Catchment Investigation	Investigate nitrate sources; identify mitigation measures to be implemented in PR24	n/a
Northumbrian Water	Upper Tees Peatland restoration	DrWPA_ND	Catchment Measure	n/a	Restoration of blanket bog to reduce colour and avoid need for treatment at downstream water works.
Northumbrian Water	Upper Wear Peatland restoration	DrWPA_ND	Catchment Measure	n/a	Restoration of blanket bog to reduce colour and avoid need for treatment at downstream water works.
Northumbrian Water	Warkworth DrWPA	DrWPA_ND	Catchment Measure	n/a	Provide additional enhancements to PR14 work to including a wider range of measures to protect water quality, from both pesticides, nutrients and bacteria. Specifically, this will include product substitution for Metaldehyde and various water protection measures to address Cryptosporidium. This will cover areas outside of the original PR14 catchment - i.e. the whole Warkworth Safeguard Zone.
Northumbrian Water	Whittle Dene DrWPA	DrWPA_ND	Catchment Measure	n/a	Provide additional enhancements to PR14 work to including a wider range of measures to protect water quality, from both pesticides, nutrients and bacteria. Specifically, this will include product substitution for Metaldehyde and various water protection measures to address Cryptosporidium. This will cover areas outside of the original PR14 catchment - i.e. throughout the whole Whittle Dene Safeguard Zone.

Essex & Suffolk Water	DrWPA - River Stour	DrWPA_ND	Catchment Measure	n/a	Move towards creating a Stour Catchment Partnership (as per Chelmer and Blackwater and Waveney) to bring in external partners. Work with partners to deliver farmer engagement, newsletters and events to provide advice on the storage, handling and application of pesticides, fertilisers and manure; soil management; water course protection; environmental stewardship and general farm environmental management.
Essex & Suffolk Water	DrWPA - Lower Stour	DrWPA_ND	Catchment Measure	n/a	Move towards creating a Stour Catchment Partnership (as per Chelmer and Blackwater and Waveney) to bring in external partners. Focus for delivery on direct inflows to Abberton Reservoir i.e. flows which cannot be managed through abstraction management offer paid for product substitution for metaldehyde. Funding for sediment traps and ponds to slow the flow and reduce runoff from the land. Grant funding for biofilters/biobeds and washdown areas to reduce pesticide losses from farmyard. Subject to OFWAT support and funding.
Essex & Suffolk Water	DrWPA - River Chelmer	DrWPA_ND	Catchment Measure	n/a	Continue our work through the Chelmer & Blackwater Partnership to include a focus sub-catchment (to be agreed by partnership), farmer engagement, newsletters and events to provide advice on the storage, handling and application of pesticides, fertilisers and manure; soil management; water course protection; environmental stewardship and general farm environmental management.
Essex & Suffolk Water	DrWPA - River Waveney	DrWPA_ND	Catchment Measure	n/a	Paid for product substitution for metaldehyde, on highest risk fields across catchment. Funding for sediment traps and ponds to slow the flow and reduce runoff from the land. Grant funding for biofilters / biobeds and washdown areas to reduce pesticide losses from farmyard. Specific sub-catchment still to be defined, may be offered to multiple sub-catchments/wider area of catchment. Subject to OFWAT support and funding.

The perceived risk of the programme failing to deliver the expected outcomes and proposed mitigation is summarised in Appendix 2.

8. Performance Commitments

Given the driver for catchment management is ultimately to increase our overall drinking water compliance, it would seem logical that a performance commitment should be set around an improvement in intake raw water quality. However, it is important to note that in the case of pesticides (particularly metaldehyde), by far the greatest influence on raw water quality is the weather. For example, metaldehyde is often used in wet weather when slug pressure is high. If we were to have a run of wet summers and autumns, the risk of metaldehyde failures would be significantly higher. We do not have any regulatory control over land managers and so we are at their discretion as to whether they take our advice and offers. Therefore setting a performance commitment for drinking water catchment management would be a significant risk, both in terms of company reputation and financially, if an ODI were attached. Lengthily discussions were had with the Water Forum about possible ODIs but ultimately it was agreed that an ODI for catchment was not appropriate. For example we could have had an ODI on delivery of grant funding which would have been easy for us to achieve but we felt it did not add any value for customers.

We do however feel it is important to have a target and as such the favoured proposal is as follows:

Number of drinking water catchments supported by catchment management partnerships or CaBA delivery groups by 2025.

Current Performance: 4 out of 9 (Chelmer, Blackwater, Waveney, Bure)
Target Performance: 9 out of 9 (current plus Stour, Tyne, Tees, Wear, Coquet)

The justification for this is we have well established and highly regarded agri-advice partnerships in the ESW operating area which provide a key role in our catchment delivery. There was strong support at both our NW and ESW PR19 Catchment Management Stakeholder Workshops in 2017 for all priority catchments to have an agri-advice partnership or delivery group.

It is currently agreed that we will not have this as a formal performance commitment but will use it in setting out our ambition, either via a goal or a section in the business plan narrative.

9. Customer Protection

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed. We are proposing a cost adjustment mechanism for enhancement costs that will protect customers against late or non-delivery of those enhancement schemes. Full details of our enhancements delivery incentive mechanisms are included in Chapter 4: Measuring and Incentivising Success of our final business plan. More detail specific to the cost adjustment mechanism proposed for WINEP schemes is also provided in Appendix 3.9. The latter sets out a proposed cost adjustment mechanism to be applied in the event of discrepancies in scale between the assumed Water Industry National Environmental Programme (WINEP) at the time of the Final Determination in December 2019 and the confirmed programme in 2021.

10. Alignment with Stakeholder Needs

PR19 Catchment Management Stakeholder Workshops were held in June and November 2017 for ESW and NW respectively. Stakeholders indicated a high level of support in principle for NWL's PR19 environmental objectives and general programme. Their key points were that NWL should not be single-issue focused; and that the terms of reference of the existing agri-advice catchment partnerships in the ESW should be refreshed and that terms of reference should be created for new agri-advice groups in the NW area. The details of the delivery mechanisms for this proposal will be built over the remainder of 2018 and will be done in conjunction with our partners. We will work through existing catchment partnerships and the CaBA groups to ensure that our plan meets with their expectations and seeks opportunities to work together to deliver multi-benefits and best value for money.

NWL has ensured, through ongoing liaison with the local Environment Agency FBG team, that our plans meet their expectations. Customer focus groups, held across NWL supply areas, during 2017 indicated a high level of support in principle for our PR19 environmental objectives and general programme. Our Water Forum members expect that we will deliver these investigations and solutions promptly.

11. Board Assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers"[7].

[7] See Board Assurance Statement

Appendix 1: Cost Breakdown

The table below summarises the proposed offerings to land managers. These will be offered either directly by NWL or through existing or new catchment partnerships – to be confirmed. The offers will be delivered by our catchment advisors supported by an Asset Investment project manager (as in AMP6).

Catchment	Item	Total Area (ha)	Unit	No. Of Holdings	Units per holding	Unit Qty	Unit Price	Incurred in multiple years?	Total Price	Source	Total
Whittle Dene SGZ	Trough	5100	each	50	2	100	110.0	-	11,000	Cost and spec as per CSS (p4, option LV7)	**321,280**
Whittle Dene SGZ	Trough Pump	5100	each	50	2	100	220.0	-	22,000	Cost and spec as per CSS (p3, LV5)	
Whittle Dene SGZ	Post-and-wire fencing (per metre)	5100	metre	50	300	15,000	4.0	-	60,000	Cost and spec as per CSS (p3, FG1)	
Whittle Dene SGZ	Concrete Yard Renewal	5100	metre square	50	40	2,000	27.1	-	54,280	Cost and spec as per CSS (p4, RP15)	
Whittle Dene SGZ	Rainwater goods (guttering/downpipes)	5100	metre	50	50	2,500	11.4	-	28,500	Cost and spec as per CSS (p4, RP16)	
Whittle Dene SGZ	12-24m watercourse buffer strip on cultivated land	5100	hectare	50		50	512.0	5	128,000	Cost and spec as per CSS (p2, option SW4)	
Whittle Dene SGZ	Monitoring programme	5100	each	n/a	n/a	1	3,500.0	5	17,500	Based on sampling costs for Pesti-wise plus additional allowance for crypto samples	

Coquet SGZ	Trough	8800	each	30	2	60	110.0	-	6,600	Cost and spec as per CSS (p4, option LV7)	374,895
Coquet SGZ	Trough Pump	8800	each	30	2	60	220.0	-	13,200	Cost and spec as per CSS (p3, LV5)	
Coquet SGZ	Fencing (per meter)	8800	metre	30	300	9,000	4.0	-	36,000	Cost and spec as per CSS (p3, FG1)	
Coquet SGZ	Concrete Yard Renewal	8800	metre square	30	40	1,200	27.1	-	162,840	Cost and spec as per CSS (p4, RP15)	
Coquet SGZ	12-24m watercourse buffer strip on cultivated land	8800	hectare	30	n/a	50	512.0	5	128,000	Cost and spec as per CSS (p2, option SW4)	
Coquet SGZ	Guttering (Clean Water Separation)	8800	metre	30	50	1,500	7.2	-	10,755	Cost and spec as per CSS	
Coquet SGZ	Monitoring programme	8800	each	n/a	n/a	1	3,500.0	5	17,500	Based on sampling costs for Pesti-wise plus additional allowance for crypto samples	
Waveney	Sediment Ponds / Traps	62500	each	unknown	1	50	200.0	-	10,000	Assumes £10/m2 (as per CSS rate, p4 RP7) & 20m2 pond	**270,000**
Waveney	Biofilter and roofed washdown area/ Biobed and uncovered washdown area	62500	each	unknown	1	25	10,000.0	-	250,000	Based on average costs claimed by farmers through Pestiwise	
Waveney	Monitoring programme	62500	each	unknown		1	10,000.0	-	10,000	As per Pestiwise	

Abberton Inflows	Sediment Ponds / Traps	9800		20	1	20	200.0	-	4,000	Assumes £10/m2 (as per CSS rate, p4 RP7) & 20m2 pond	**129,000**
Abberton Inflows	Biofilter and roofed washdown area/ Biobed and uncovered washdown area	9800	each	10	1	10	10,000.0	-	100,000	Based on average costs claimed by farmers through Pestiwise	
Abberton Inflows	Monitoring programme	9800				1	5,000.0	5	25,000	Based on pestiwise costs	
Hanningfield Inflows	Monitoring programme	1327				1	5,000.0	5	25,000	Based on pestiwise costs	**25,000**
Tees (to tie in with wider HLF Tees Swale project	Peat Restoration	200				200	1500	-	300000	Restoration costs of 1500ha (North Pennines AONB estimate)	**330,000**
Tees (to tie in with wider HLF Tees Swale project	Monitoring programme	200				1	30000		30,000	Based on budget allowed in PR14	
Berwick Nitrates - arable area	SOYL N-mapping	1091				1091	8	5	43,640	£8/ha	**411,727**
Berwick Nitrates - arable area	N-inhibitor	1091				545.5	22.8	5	62,187	Didin @ £45.50 per 20l drum (10l/ha)	
Berwick Nitrates -	Cover Crops	1091				273	60	5	81,900	Based on rate paid by Wessex Water	

arable area											
Berwick Nitrates - arable area	Reduced N applications to winter wheat	1091	hectare			55	50	5	13,750	assumed take up on 10% of winter wheat crop	
Berwick Nitrates - whole area	Calibrating spreaders annually	1374	each			20	210	5	21,000		
Berwick Nitrates - whole area	Various land management and capital options based on CSS (TBC)	1374				68.7	500	5	171,750	Based on uptake on 10% of land of measured based on selection of countryside stewardship options e.g. buffer strips, arable reversion etc.	
Berwick Nitrates	Monitoring programme	1374				1	3500	5	17,500	Based on Pesti-wise monitoring costs	
All Catchments	Project Management (AI PM)	n/a	hours			518	70	-	43,512	Based on conversations with Pestiwise PM, JS, and his experience of Pestiwise. Hourly rate £70/hr, 7.5hr days, day a fortnight for first 9 months, day a month for rest of AMP. Plus 20% to allow for new catchments i.e. Berwick and South Tyne	**834,432**

All Catchments	Reactive Catchment Programme - Ad-hoc measures as issues arise	n/a				1	100000	5	500000	Additional Opex budget to allow Catchment Advisors flexibility to react and implement low cost solutions if a water quality issue arises and there is a quick fix available. To be shared across operating area on a case by case basis.	
Coquet and Whittle Dene	Catchment Advisor					1	242170.28		242170		
All Catchments	Admin support	n/a	hours			1950		-	48750	Based on pesti-wise £25/hr	

Grand total	**2,696,334**
On-costs @ 10%	269,633
Grand total plus on-costs	**2,965,968**

Appendix 2 – Table of Risk

Description of identified risk	Chance of risk (high/medium/low)	Impact of risk (high/medium/low)	Planned action to manage or mitigate the risk
Farmers unwilling to engage with us	Low	High	The NWL catchment team have been delivering farmer engagement work for almost a decade and are well experienced in getting farmers 'on board'. In Pesti-wise we achieved over 80% engagement in 4 out of 5 catchments and the 5th catchment, although a struggle at first is now getting good levels of engagement through persistence.
Farmers not willing to adopt the measures we propose/low uptake of measures	Low	High	We have learnt through Pesti-wise that getting the options right is important and will use this experience to help develop our AMP7 schemes. We plan to use recognised grant rates to ensure payment rates meet farmer's expectations and have been questioning farmers on what they would like to see.
The future of farm subsidy post Brexit and potential impacts on farming in general	Medium	Medium	Changes post Brexit could have a huge impact on environmental interventions on farm and clearly we do not want to be funding interventions which farmers could get funding for from elsewhere. As changes do come to light we may need to amend our proposed investment accordingly and this situation will be closely monitored. As we do not have any detail on the future of subsidies we have assumed that we will need to provide support for the specific interventions we want to see as Defra priorities may not align with our own.

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WINEP- WFD INVESTIGATIONS AND MEASURES ENHANCEMENT BUSINESS CASE

WS2 - Wholesale water capital and operating enhancement expenditure by purpose Line 18 (WFD) and 20 (River flows)

APPENDIX 3.2

WINEP WFD INVESTIGATIONS AND MEASURES

Name of claim	PR19 ENHANCEMENT BUSINESS CASE: WINEP – WFD INV and Improving River Flows	
Name and identifier of related claim submitted in May 2018	Not Cost Adjustment Claim	
Business plan table lines w here the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line A18 and A20	
Total value of enhancement for AMP7	£4.646 million comprising: A18: WFD Investigations: £4.591 million A20: Improving River Flows: £0.055 million	
Total opex of enhancement for AMP7	£0.00 million	
Total capex of enhancement for AMP7	£4.646 million	
Depreciation on capex in AMP7 (retail controls only)	[n/a]	
Remaining capex required after AMP7 to complete construction	Not known until WFD investigations have been completed. Capex will only be required if sustainability reductions cause a supply deficit.	
Whole life totex of claim	N/A	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	Material	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		✓
Need for investment/expenditure	Modelling and site investigations to confirm sustainability of abstraction and to fulfil AMP7 WINEP obligations.	
Need for the adjustment (if relevant)	N/A	
Outside management control (if relevant)	n/a	
Best option for customers (if relevant)	To complete the investigations as outlined in this business case.	
Robustness and efficiency of claim's costs	See Section 7: All costs for schemes in this business case were provided and assured by the NW Cost Assurance team. These costs were benchmarked and assured as follows: - 20% Full iMOD cost estimate using business as usual processes; and - 78% Traditional unit rate build up The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018. The cost confidence in each	

	business case as a whole has been assessed using the following methodology: • **Green** - Over 75% achieving Green RAG status • **Amber** – Over 65% achieving Green or over 90% achieving Amber RAG status • **Red** – Not achieving Green or Amber. This review has assessed scheme costs as Amber. NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.
Customer protection (if relevant)	See Section 8: WINEP cost adjustment mechanism
Affordability (if relevant)	See Section 8: The bill impacts will rise to £0.15 a year in 2024/25. This is set within an overall bill drop of more than 12% in AMP7.
Board Assurance (if relevant)	See Section 8: The full board have signed a revised Board Assurance Statement at the full board meeting on the 29th of March 2019 confirming that they have seen and are confident in the enhancement cases.

APPENDIX 3.2

WINEP WFD INVESTIGATIONS AND MEASURES

1. Executive Summary

This enhancement scheme business case covers all named scheme in our part of the Water Industry National Environment Programme (WINEP) with ether a Water Framework Directive Investigation or Improvements to River Flow driver. As the WINEP is compiled by the Environment Agency, the inclusion of the schemes in the WINEP means that it is supported by the Environment Agency.

Completion of these investigations is mandatory and Ofwat and the Environment Agency expects funding requirements to be accounted for in the Company's PR19 Business Plan.

The total cost in AMP7 for WINEP "WFD" and "Improving River Flow" schemes is £4.646m and covers 34 schemes (see Appendix 1 of this document) in our Essex & Suffolk Water and Northumbrian Water operating areas.

2. Context and Scope

This business case relates to Table WS2 (Wholesale water capital enhancement expenditure by purpose) and lines:

18: WINEP / NEP Water Framework Directive Measures
19: WINEP / NEP Investigations
20: Improvements to River Flow

The Water Industry National Environment Programme (WINEP) is a list of environmental requirements produced by the Environment Agency and Natural England that water companies should include in their business plans submitted to Ofwat. It was previously called the National Environment Programme.

The WINEP is an integrated list of requirements for water resources, water quality and fisheries, biodiversity and geomorphology. It consists of investigations, options appraisals and actions to protect (prevent deterioration) and improve the water environment. Actions to protect or improve the environment include both licence changes, also known as sustainability changes, and non-licence change actions, such as river restoration.

By April 2018, there will have been three iterations of the WINEP as follows:

- WINEP1: Issued in March 2017;
- WINEP2: Issued on 29 September 2017; and
- WINEP3: To be issued on 30 March 2018.

A full version of the current WINEP can be viewed here https://data.gov.uk/dataset/a1b25bcb-9d42-4227-9b3a-34782763f0c0/water-industry-national-environment-programme although an updated version is expected at the end of March 2019.

WINEP3 (combined NW and ESW) contains:

- 30 Water Framework Directive (WFD) investigations and options appraisals; and
- Four sustainability change implementation schemes.

This expenditure is classified as enhancement rather than base maintenance because it is included in the Water Industry National Environment Programme (WINEP) and completion of the WINEP will enhance the capacity and quality of services beyond current levels and support our Environmental outcomes.

This enhancement will contribute towards:

i. "We protect and enhance the environment in delivering our services, leading by example"

This is because if NWG fulfils the requirements of the WINEP Water Framework Directive (WFD) investigations and concludes that the abstraction licence is not sustainable, the licensed quantity will be reduced to sustainable levels. This will protect the environment.

ii. "We provide a reliable and sufficient supply of water"

This is because if NWG undertakes the investigations and concludes that the abstraction is sustainable, the deployable output of that source will be preserved. If NWG concludes that the abstraction licence is not sustainable, this will trigger an options appraisal process which will ensure any resulting supply deficit is eliminated through the PR24 process.

3. Customer and Stakeholder Expectation

The Environment Agency's guidance entitled "Sustainable Abstraction" (Environment Agency, 2017c), states that WRMPs should include the requirements set out in the WINEP, which sets out measures needed to protect and improve the environment.

As noted above, there have been three iterations of WINEP:

- WINEP1: Issued in March 2017;
- WINEP2: Issued on 29 September 2017; and
- WINEP3: To be issued on 30 March 2018.

The Environment Agency has applied a traffic light system to WINEP2 to indicate certainty of measures. It expects all green and amber sustainability changes, as defined in WINEP1, to be allowed for in draft WRMPs as adjustments to final plan deployable output.

WINEP 2 was issued after most water companies' supply and demand forecasts had been completed. Therefore, where it was not possible to allow for new WINEP2 green and amber schemes to be included in the draft WRMP, the Environment Agency has asked water companies to consider these schemes and their associated sustainability reductions as a supply demand balance scenario, rather than as a reduction in deployable output in the final plan supply demand balance calculation.

The Water Resources team, through quarterly EA Liaison Meetings with both the EA and Natural England have been involved in the development of WINEP2 and WINEP3.

The expected scope of WFD investigations and solutions is to be included within the PR19 WINEP is set out in the Environment Agency's 'Sustainable Abstraction" guidance' (Environment Agency, June 2017). NWG has ensured, through liaison with local Environment Agency, that our plans meet their expectations.

In summary, in terms of successful delivery in customer benefit terms, will be completion of the agreed WINEP programme as detailed in Appendix 1 of this document. Failing to deliver the WINEP could result precautionary (conservative) sustainability reductions being imposed on our abstraction licenses. If this were to occur, this could cause a supply demand deficit in our Water Resources Management Plan as published on our website. This could result in us unnecessarily investing in an expensive supply scheme to eradicate the supply deficit.

WINEP

Whilst this enhancement scheme is regulatory driven, we have still consulted with our stakeholders including engagement with the Water Forum.

Our Water Forums are supportive of our WINEP proposals which we shared with them in April 2018. Our Water Forum members expect that we will deliver these investigations and solutions promptly.

In summary, successful delivery in customer benefit terms, will be completion of the agreed WINEP programme.

4. Current and Historical Service Delivery and Expenditure

Prior to PR19, the WINEP was known as the National Environment Programme (NEP) which was established at least in AMP2 (1995 to 2000). Since then, we have met all of our obligations. One of the first schemes was the relocation of Redgrave Borehole in Suffolk which was impacting on Redgrave Fen SSSI while more recent schemes in the north east have been to amend reservoir compensation releases.

5. Forward Looking Analysis

The majority of the WFD investigations are in our Blyth and Hartismere Water Resource Zones in Suffolk. Until we complete the investigations, we won't know whether our abstraction licence licensed quantities will be reduced. Losing licensed quantity due to the WINEP investigations is the biggest risk to our current water resources supply demand balance and could cause a supply deficit. This deficit would need to be removed through the PR24 Water Resources Management Plan and Business Planning process. Schemes might include pipelines from other water resource zones or desalination plants. Losing licensed quantity could also compromise our ability to supply national infrastructure projects such as Sizewell C Power Station. We have highlighted this risk to the EA.

The EA recognises that license reductions will be a significant cost to the water industry and to customers and indeed may not be affordable. If this turns out to be the case, Defra will need to consider its surface and groundwater objectives.

6. Option Appraisal

WINEP actions generally fall into one of the following categories:

- Investigation;
- Options Appraisal; and

- Implementation

Investigations are required where the Environment Agency suspects that an abstraction could be having an adverse effect on the environment but where the level of certainty is low. Consequently, investigations are required to raise the level of certainty so that conclusions can be drawn over the sustainability of the abstraction. Where an investigation concludes an abstraction is sustainable, the licence is re-affirmed. Where an investigation concludes an abstraction is un-sustainable, then a sustainability reduction (i.e. a reduction in the annual and / or daily licensed quantities) is quantified and then implemented.

Options appraisals are required where a sustainability reduction causes a supply deficit. The appraisal considers a series of options which will:

- Reduce demand to eliminate the supply deficit;
- Increase supplies to eliminate the supply deficit; and
- Mitigate any impact on the environment to a level whereby the sustainability reduction is no longer required.

The preferred option may comprise of either one measure or a series of supply, demand and mitigation measures.
Implementation of a preferred option is required in the following AMP following investigations and options appraisal.

WINEP3 contains 30 Water Framework Directive (WFD) investigations and options appraisals. In the majority of cases, we have agreed with the Agency that these investigations and options appraisals will be completed in AMP7 with any implementation schemes being delivered in the first two years of AMP8.

WINEP3 also includes four implementation schemes. The largest (£0.98 million) improves the sustainability of our Berwick Fell Sandstone boreholes. Our preferred options was identified in our Options Appraisal report (available on Waternet) which has been approved by the Environment Agency. This report considered many options including the following:

- Do nothing
- Accept full sustainability reduction
- Relocate the Thornton Bog borehole to spread the effect of abstraction
- Aquifer storage and recharge
- Bulk transfer from Kielder Water Resource Zone.

The preferred option (following options appraisal) that ensure a supply surplus is maintained across our 40 year planning period and is the least cost, least environmental impact option, is to replace Thornton Bog borehole 1 with new a borehole at a new location. This will spread the effect of abstraction reducing the overall drawdown in groundwater levels. If this scheme is not delivered, our abstraction licence will be reduced which will eliminate all of our supply surplus (i.e. not scope for growth). The main alternative scheme is a new pipeline bringing in water from the Kielder WRZ. The cost of this is ~£50 million which is not deemed to be cost beneficial.

Given that the WINEP prescribes a mix of investigations, options appraisal and implementation that are mandatory, there is little opportunity to consider alternative options for AMP7 spending. Rather, the emphasis is on exploring options for AMP8 and ensuring that investigations and options appraisal undertaken in AMP7 are robust and undertaken efficiently.

Options available for undertaking WFD investigations are:

i. Sustainability assessments using the Environment Agency's regional model; and
ii. Site investigations which may include the drilling and monitoring of observation boreholes to confirm conceptual hydro-geology as well as water level, flow water quality and ecological monitoring in rivers that could be affected by abstraction.

In the case of the WINEP 2 investigations, the sustainability of all abstractions will be assessed using the EA's regional model. However, there is a risk that these assessments conclude that an abstraction is not sustainable in which case the annual licensed quantity would be reduced. If this were to cause a water resource zone supply deficit, the cost of bringing the WRZ back into supply could be significant. For example, it is generally accepted that its costs £2.5 million to develop 1Ml/d of water. There, NWG proposes undertaking site investigations as well to demonstrate the actual effect of NWG abstraction.

7. Costing and Identification of Preferred Plan / Option

Costing Approach

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach.

All costs for schemes in this business case were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[1]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed costs for schemes in this business case are [£4,646 million Capex and £0 million Opex]. The detailed cost calculations for each line of the WINEP are provided in Appendix 1.

These costs were benchmarked and assured as follows:

- 20% Full iMOD cost estimate using business as usual processes; and
- 78% Traditional unit rate build up

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[2]. The cost confidence in each business case as a whole has been assessed using the following methodology:

[1] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology
[2] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

- **Green** - Over 75% achieving Green RAG status
- **Amber** – Over 65% achieving Green or over 90% achieving Amber RAG status
- **Red** – Not achieving Green or Amber.

This review has assessed scheme costs as Amber. NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

While the need for WFD investigations has been driven by the Environment Agency, the Environment Agency's high level scoping document called a Measures Specification Form was only received in Q1 of 2019. Consequently, the detailed scope of the investigations will not be confirmed until later in 2019. Therefore, the costs of investigations are necessarily estimates informed by previous comparable investigation and / or new cost estimates from either our own Cost Estimation team or directly from contractors. Examples of how investigation and implementation schemes have been developed are provided below.

The costs for the PR19 WINEP WFD investigations have been built up for each line in the WINEP, based on:

- Modelling: Based on recent model costs (model prep, model runs, validation and report)
- Site investigation: All site investigations are different and so a cost estimate using expert judgement based on previous NEP investigations has been prepared as follows:

Task	Unit Cost (£)	Unit	Quantity	Sub-total	Oncost %age	Oncost (£)	Total Inc. Oncosts (£)
Monitoring Borehole Drilling	£26,529	Each	2	£53,058	15%	£7,959	£61,017
Data Loggers with direct read cable	£798	Each	2	£1,596	10%	£160	£1,756
Water Quality Monitoring	471.1	Per month	36	£16,960	10%	£1,696	£18,656
Flow Gauging	550.02	Per month	36	£19,801	10%	£1,980	£21,781
Ecological Survey	2970	per year	5	£14,850	10%	£1,485	£16,335

A mitigation scheme has been included in WINEP to mitigate against the effect of abstraction from NWG's Langham Boreholes on base flow to the River Brett. This mitigation may not prevent the need for a reduction in the annual licensed quantity but should limit the size of the reduction. This mitigation scheme will be implemented jointly with Anglian Water and Affinity Water, all of whom also impact on baseflows to the River Brett. The types of mitigation fall under the headings of flow deflectors, woody debris and back water creation. The number of these mitigation sites that will be required is not known. However, an estimate along with costs is made below:

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WINEP WFD INVESTIGATIONS AND MEASURES

Task	Unit Cost (£)	Unit	Quantity	Sub-total	Total	Oncost %age	Oncost (£)	Total Cost with On Costs (£)
Flow Deflectors	£10,000	Each	3	£30,000	£50,000	10.00%	£5,000.00	£55,000
Back water Creation	£15,000	Each	1	£15,000				
Woody Debris	1000	Per month	5	£5,000				

The largest implementation scheme is the Fell Sandstone / Berwick borehole scheme (£0.99 million). These costs are based on a cost estimate from NWL's Cost Estimation team. A further borehole may be required and so this has been allowed for in NWL's Cost Adjustment Mechanism.

The programme will be delivered through a combination of in-house resources, contractors and consultants. The Water Resources team has hydrologists, hydrogeologists and environmental scientists while the Conservation team has ecologists. Where works falls outside of the team's expertise or we simply need additional resource, contractors and consultants will be used. Consultants will be specifically used for running the EA's regional model. This combined approach has worked very well for delivery of the NEPs in AMP3, 4, 5 and 6. It is also a cost effective way of delivering the work as internal staff costs are significantly lower than those of consultants.

The cost expenditure profile is set according to Environment Agency deadlines for each line of the WINEP WFD Investigations detailed Appendix 1. AMP7 WFD investigations need to conclude by 31 March 2022 in order to feed into the PR24 process. Therefore, the profiling of costs is likely to be as follows:

2020/21: 30%
2021/22: 30%
2022/23: 20%
2023/24: 10%
2024:25: 10%

Perceived risk of the project failing to deliver and proposed mitigation is summarised in Appendix 2. Given our experience of delivering WFD investigations and adaptive management reservoir release schemes in previous AMPs, we are confident in delivering all of the schemes. Therefore, the only risk highlighted is regarding the Fell Sandstone scheme. This risk is not in relation to delivery of the new borehole as allowed for in the WINEP costs – we are confident that this will be delivered. Instead, it relates to whether additional mitigation over and above that allowed for in the WINEP costs is required. The need for additional mitigation was initially covered in the Cost Adjustment Mechanism. However, as the Fell Sandstone is a confirmed scheme, it does not fall within the scope for the cost adjustment mechanism and so has been removed from it at Mott MacDonalds request.

It should be noted that the risk of further mitigation being required is considered very low. If further mitigation was required, the Company would have to find funding for this through its normal business as usual capital investment process.

No WFD driven schemes are categorised as unconfirmed.

No performance commitment is proposed for this business case since it is a regulatory requirement. However, success will be measured by tracker spreadsheets and delivery of the schemes by the agreed regulatory deadlines as set out in Appendix 1 below. Performance will be monitored and discussed at both regional EA Liaison Meetings as well as the NE / NWG Joint Management Group Meeting.

8. Customer Protection

Any variations from the WINEP, not agreed via change protocol, would result in enforcement action being undertaken under the corresponding legislation. A number of areas of the WINEP are currently uncertain, and a cost adjustment mechanism will be used to protect customers if requirements change.

NWL is proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed. We are proposing a cost adjustment mechanism for enhancement costs that will protect customers against late or non-delivery of those enhancement schemes. Full details of our enhancements delivery incentive mechanisms are included in Chapter 4: Measuring and Incentivising Success of our final business plan. More detail specific to the cost adjustment mechanism proposed for WINEP schemes is also provided in Appendix 3.9 of our PR19 Business Plan. The latter sets out a proposed cost adjustment mechanism to be applied in the event of discrepancies in scale between the assumed Water Industry National Environmental Programme (WINEP) at the time of the Final Determination in December 2019 and the confirmed programme in 2021.

The document describes:

i. The requirements and guidelines that drive the need for this approach;
ii. The principles and assumptions applied in the calculation of the proposed unit costs and the proposed adjustment mechanism. This will include consideration of;
    a. What we will do if the scheme is no longer required. This applies to all green and amber schemes; and
    b. What we will do if the amber schemes deliver more or less outputs.
iii. The Governance and Assurance of the proposed mechanism.

WINEP Enhancement - Guidelines and Requirements for Cost Adjustment

A large portion of enhancement expenditure is driven by environmental requirements. These requirements are set out in the third and final release of the Water Industry National Environment Programme (WINEP) known as WINEP3.

The timeline differences between the PR19 planning and the third cycle river basin management planning for WFD introduce an ongoing level of uncertainty. This means that despite the iterative approach some requirements will remain uncertain when we submit our business plans in September 2018, and when Ofwat makes their final determinations in December 2019. The provisional ministerial sign off date for the 2021 river basin management plans is December 2021. There is therefore a need to continue with a ‘managing uncertainty’ approach that evolves based on the lessons learnt from that adopted in PR14.

The EA applied a traffic light system (red, amber, green) during development of the WINEP. The red, amber, green traffic lights system reflects the different levels of certainty (green being most certain) associated with the development of measures, economic appraisal and ministerial decisions.

At NWG, we recognise our role in meeting objectives for rivers and coastal waters, but we aim to ensure that our customers’ money is spent on well justified cost beneficial schemes that will deliver real improvements to water quality and ecology. To achieve this, we have worked very closely with

our local and national EA River Basin Management Service (RBMS) representatives, through smaller technical specialist areas and sharing of knowledge from work undertaken with other external groups and stakeholders, to agree the obligations included in the PR19 WINEP.

In the PR19 Final Methodology Ofwat has identified (Section 9.4.3) that the anticipated (uncertain) programme will be funded, as long as companies propose an appropriate cost adjustment mechanism to account for any potential discrepancy between the scale of the assumed and confirmed programmes. Companies will be required to link expenditure for unconfirmed requirements to a unit cost, which may relate directly to an outcome. Ofwat will use the unit cost to make an adjustment at the end of the control period, based on the volume of work that was eventually confirmed as required and delivered by the company.

Principles and Assumptions
WINEP development – improved level of certainty

The EA has stated it only expects to see cost allowances in company business plans for green and amber measures in WINEP3. NWG has not included red schemes in the plan.
We have established that we will treat **all WINEP ambers** as if they were 'green' i.e. we are committed to deliver all of the amber and green schemes and investigations unless better, more efficient delivery mechanisms can be identified to deliver the same environmental objective by alternative means. Any alternative proposals (such as delivery via catchment partnership projects) would need to be approved by the EA and logged via a formal change protocol procedure.

Cost adjustment mechanism – Unit cost

An appropriate cost adjustment mechanism will be proposed (in accordance with the Ofwat methodology reference section 9.4.3) in order to ensure our customers are not paying for schemes and outcomes that have not been delivered.

It is Ofwats expectation that companies should link expenditure for unconfirmed requirements to a unit cost which must relate to a readily quantifiable measure. This may or may not be a specific performance commitment.

The Water WINEP comprises a range of schemes and investigations. **However, we do not believe that there is a single unit cost that could be applied across the whole of WINEP**.

Water enhancement schemes designated as amber in WINEP3 have lower monetary value than the wastewater amber schemes. These are largely where investigations will be undertaken prior to Options appraisal. This may mean that mitigation measures are no longer required, or that the measure differs from that assumed in the business plan estimate. Table 1 provides comment on the individual lines from WINEP to indicate where cost adjustment may be possible on a line by line basis.

We propose the following scenarios:

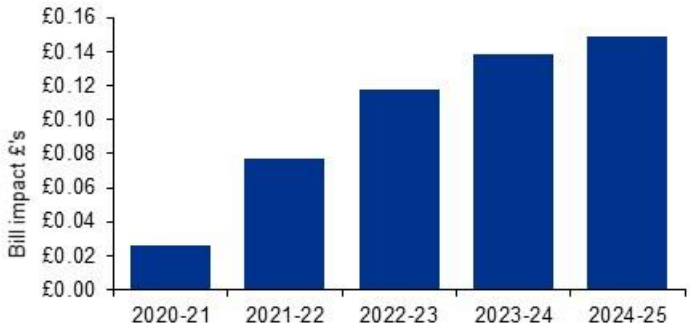
i. Where the scheme is no longer required. This applies to all green and amber schemes. We would propose to simply return the 2020-25 funding at the end of the 2020-25 period in a net present value neutral way. (A full breakdown of costs against each WINEP deliverable is available).
ii. Where the amber schemes deliver more or less outputs. We would propose making an adjustment to funding to reflect the actual change in outputs. This would be at the end of the 2020-25 period.

As the Fell Sandstone scheme is a confirmed scheme, this has been removed from the Cost Adjustment Mechanism.

In all cases, there will be some initial spend prior to the decision not to invest e.g. feasibility study, modelling, or sampling programme. This initial spend would need to be accounted for in the adjustment.

Affordability

The impact of these enhancement investments on customer bills are shown below[3].



Overall the analysis shows that the bill impacts would rise to £0.15 a year in 2024/25.

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted to grow at between 0.8 - 1.2% per annum[4] driving significant improvements to average customer affordability.

We have not engaged directly with customers regarding willingness to pay for the delivery of WINEP3 as it is mandatory. However, customer focus groups, held across NWG supply areas, during 2017 indicated a high level of support in principle for our PR19 environmental objectives and general programme.

In March and April 2018, we conducted two phases of deliberative qualitative research with customers to explore their acceptability for a range of discretionary enhancement schemes. The schemes were presented in the context that in 2020 customers' bills would be reduced by 10% and that the schemes could be funded by making the 10% reduction smaller. When reviewing the

[3] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.

In 2016 we conducted customer research on River Water Quality. The outcome was that customers were strongly supportive of improvements in River Water Quality. Delivery of WINEP is a statutory requirement and hence not dependent on customer support, however our plan is stronger for knowing that customers do support this.

[4] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

results of the engagement, we considered customers' acceptability to be anything over 70%. This was based on CCWater's Threshold of Acceptability research that was carried out for PR14.

The second phase of research was conducted because in the first phase a number of customers stated that they did not know if they accepted the schemes. We discussed this with our Water Forums and agreed that we should carry out additional engagement to understand why this was, and what information we would need to provide to customers to allow them to answer the acceptability question. The results from the acceptability engagement were discussed with our Water Forums, who welcomed the generally very high levels of customer support for the schemes. Members did not agree on a definitive threshold for support in percentage terms, however some views shared were that anything over about 60% would be acceptable.

All our enhancements were included in our overall acceptability research, where our plan was supported by 91% of customers.

The schemes proposed is material to the long-term stability and health of the customer service, and will contribute to a robust future network. This is in the context of an AMP7 plan which customers fully support.

Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remains a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 2030[5] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

Governance and Assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers"[7].

9. Alignment with Stakeholder Needs

The key stakeholders for WFD WINEP investigations are the Environment Agency and Natural England. NWG has ensured, through EA / NE liaison meetings, that our plans meet their expectations. WINEP3 has now been issued by the EA and NWG is expected to incorporate it into its PR19 Business Plan for delivery in AMP7.

[5] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf
[7] See Board Assurance Statement

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WINEP WFD INVESTIGATIONS AND MEASURES

Customer engagement is less relevant for these enhancements as they derive from a statutory programme of work (the WINEP) and are therefore obligatory, regardless of customer opinion. However, customer focus groups, held across NWG supply areas, during 2017 indicated a high level of support in principle for our PR19 environmental objectives and general programme. Our Water Forum members expect that we will deliver these investigations and solutions promptly.

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WINEP WFD INVESTIGATIONS AND MEASURES

Table 1: Water WINEP Schemes Covered by Proposed Cost Adjustment Mechanism

Water Co.	Unique ID	Scheme Name/Name of Investigation/Site Name/License name	Driver Code (Primary)	Measure Type	Completion Date	Level of Certainty? (P= Purple, R=Red, A=Amber, G=Gree	Cost Estimate (£)	Cost Adjustment Mechanism: In Scope (Y/N)	Cost Adjustment Unit Rate	Comment
ESW	7ES200010	Eel measures at Ormesby Broad	EE_IMP	Eel Screen	31/03/2025	Amber	£0	Y	£9,200/scheme	The EA has indicated that it will accepted "soft start" pumps as the solution which will be delivered as part of an existing AMP6 pump upgrade. This scheme should be covered by the cost adjustment mechanism as the EA has still to formally confirm acceptance of the solution and in case the pump upgrade does not go ahead as currently planned. The unit cost will be £19,200/scheme.
ESW	7ES100130	LANGHAM A, B, C & E	WFD_IMP_WRHMWB	Sustainability Change	31/03/2024	Amber	£55,000	Y	£55,000 per scheme	This scheme is amber as the detailed scope has yet to be agreed with the EA. Following discussions with the EA, we have made an allowance for in-river channel measures to mitigate against low flow impact due to PWS abstraction (ESW, AWS, Affinity). This scheme should be covered by the cost adjustment mechanism in case this in-river channel measures are not suitable mitigation measures. The unit cost is £55,000 per scheme.
NW	7NW10005	Barrasford raw water pumping station - Rede to Gunnerton Burn, Barrasford to S Tyne, Watersmeet to Tidal Limit - Eels Regs and MM3	EE_IMP	Eel Screen	22/12/2024	Amber	£1,070,943	Y	£1,070,943 / intake screen	The eel screen cost is an estimates based on the cost of the AMP6 Lumley eel screens. The scheme is amber as EA guidance is that we do not actually have to install the screens until we next upgrade the pumping station. We currently intend to install the screens in AMP7. However, the scheme should be subject to the Cost Adjustment Mechanism in case NWL chooses to delay screen installation until a future upgrade. The unit cost is £1,070,943 / intake screen.
NW	7NW100011	Harthope burn catchwater - Water supply asset - MM1 and MM7	WFD_IMP_WRHMWB	Fish Passage	22/12/2024	Amber	176,554	Y	£176,544/ fish pass	The fish pass structure cost is an estimate based on the cost of the Wellhope Burn fish pass. This is an amber scheme and so should be subject to the Cost Adjustment Mechanism. If the scheme is not required, the unit cost is £176,544/ fish pass
NW	7NW100012	Wear Pipe crossing St Johns Chapel -fish passage MM1	WFD_IMP_WRHMWB	Fish Passage	22/12/2024	Amber	176,554	Y	£176,544/ fish pass	The fish pass structure cost is an estimate based on the cost of the Wellhope Burn fish pass. This is an amber scheme and so should be subject to the Cost Adjustment Mechanism. If the scheme is not required, the unit cost is £176,544/ fish pass
NW	7NW100013	Ireshope - Wham pasture MM1. MM7 Burnhope res supply	WFD_IMP_WRHMWB	Fish Passage	22/12/2024	Amber	176,554	Y	£176,544/ fish pass	The fish pass structure cost is an estimate based on the cost of the Wellhope Burn fish pass. This is an amber scheme and so should be subject to the Cost Adjustment Mechanism. If the scheme is not required, the unit cost is £176,544/ fish pass
NW	7NW100014	Ireshope Burn - Greenwell Crags - MM1, MM7 Burnhope res supply	WFD_IMP_WRHMWB	Fish Passage	22/12/2024	Amber	176,554	Y	£176,544/ fish pass	The fish pass structure cost is an estimate based on the cost of the Wellhope Burn fish pass. This is an amber scheme and so should be subject to the Cost Adjustment Mechanism. If the scheme is not required, the unit cost is £176,544/ fish pass
NW	7NW10006	Pont - channel d/s of sluice - MM6 and MM7	WFD_IMP_WRHMWB	Sustainability Change	22/12/2024	Amber	149,800	Y	Not known	The amount of channel restoration has yet to be defined and will be confirmed / agreed with the EA following an initial AMP7 survey. Consequently, the actual cost could change up or down and so the scheme should be covered by the cost adjustment mechanism. At this stage, it is not possible to confirm a unit cost.
NW	7NW10009	Burnhope Burn catchwater to River Derwent MM1 and MM2 , MM5, MM7	WFD_IMP_WRHMWB	Sustainability Change	22/12/2024	Amber	243,915	Y	£160,503 / fish pass	The scheme comprises an allowance for pre- and post-implementation monitoring plus £160,503K for fish pass construction costs. This is an amber scheme and so should be subject to the Cost Adjustment Mechanism. If the scheme is not required, the unit cost is £160,503 / fish pass
NW	7NW10088	BLACK BURN catchwater, feeds into Burnhope Burn d/s of Catchwater . 100% take. MM5, MM7	WFD_IMP_WRHMWB	Sustainability Change	22/12/2024	Amber	133,412	Y	£50,000/ fish pass	The scheme comprises an allowance for pre- and post-implementation monitoring plus £50K for fish pass construction costs. This is an amber scheme and so should be subject to the Cost Adjustment Mechanism. If the scheme is not required, the unit cost is £50,000/ fish pass
ESW	7ES200009	Investigate options for trap and transport of eel population from Hanningfield Reservoir	EE_INV	Investigation and Options Appraisal	30/03/2022	Green	£12,815	Y	Not known	The outcome from the AMP6 investigation (agreed with the EA) was a trap and transport scheme although WINEP3 is for further investigation. We are awaiting confirmation from the EA. Consequently, until confirmed, this scheme should be subject to the cost adjustment mechanism. At this stage, it is not possible to confirm a unit cost.
NW	7NW100001	Balder - d/s Hury Resvoir dam wall - - continue AMP 6 adaptive management trial putting seasonality to compensation release then implement end of AMP 7 - MM5, MM2, MM7 and MM8	WFD_IMP_WRHMWB	Adaptive Management	22/12/2024	Amber	£83,412	Y	£41,706/survey	This scheme is about changing the flows of reservoir releases. There is no capital cost associated with physically changing the flows. Therefore the scheme cost is environmental monitoring which will continue through out the AMP. The level of certainty in terms of spend is high. However, as the scheme is an amber scheme, for completeness, we propose that it should be subject to the cost adjustment mechanism. In the event more or less surveys are required, we propose a unit cost of £41,706/survey.
NW	7NW100002	Lune - Grassholme Res Dam wall - continue AMP 6 adaptive management trial putting seasonality to compensation release then implement end of AMP 7 - MM5, MM2, MM7 amd MM8	WFD_IMP_WRHMWB	Adaptive Management	22/12/2024	Amber	£83,412	Y	£41,706/survey	This scheme is about changing the flows of reservoir releases. There is no capital cost associated with physically changing the flows. Therefore the scheme cost is environmental monitoring which will continue through out the AMP. The level of certainty in terms of spend is high. However, as the scheme is an amber scheme, for completeness, we propose that it should be subject to the cost adjustment mechanism. In the event more or less surveys are required, we propose a unit cost of £41,706/survey.
NW	7NW100003	Waskerley Res - d/s dam wall - implement outcomes of Adaptive Management trials for end of AMP 7 - MM5, plus MM1, MM2, MM4, MM8	WFD_IMP_WRHMWB	Adaptive Management	22/12/2024	Amber	£83,412	Y	£41,706/survey	This scheme is about changing the flows of reservoir releases. There is no capital cost associated with physically changing the flows. Therefore the scheme cost is environmental monitoring which will continue through out the AMP. The level of certainty in terms of spend is high. However, as the scheme is an amber scheme, for completeness, we propose that it should be subject to the cost adjustment mechanism. In the event more or less surveys are required, we propose a unit cost of £41,706/survey.
NW	7NW100016	River Derwent - implement outcomes of Adaptive Management trials for end of AMP 7 - MM5	WFD_IMP_WRHMWB	Adaptive Management	22/12/2024	Amber	£83,412	Y	£41,706/survey	This scheme is about changing the flows of reservoir releases. There is no capital cost associated with physically changing the flows. Therefore the scheme cost is environmental monitoring which will continue through out the AMP. The level of certainty in terms of spend is high. However, as the scheme is an amber scheme, for completeness, we propose that it should be subject to the cost adjustment mechanism. In the event more or less surveys are required, we propose a unit cost of £41,706/survey.
NW	7NW100017	Smiddy Shaw and Hisehope reservoirs Surface Water Transfer , MM5, MM7 and MM8	WFD_IMP_WRHMWB	Investigation and Options Appraisal	22/12/2024	Amber	£83,412	Y	£41,706/survey	This scheme is an investigation. The level of certainty in terms of spend is high. However, as the scheme is an amber scheme, for completeness, we propose that it should be subject to the cost adjustment mechanism. In the event that more than two surveys are required, we propose a unit cost of £41,706/survey.

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WINEP WFD INVESTIGATIONS AND MEASURES

Appendix 1

Water Resources Investigations

Issue No:	1	Quality Document Type:	PR19 Enhancement Business Case
Amendment No.	0	Ref:	
Date:	21/02/2018	Originator of this document is:	Helen Allister

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WINEP WFD INVESTIGATIONS AND MEASURES

Scheme Name	Driver Code (Primary)	Measure Type	Completion Date (DD/MM/YY)	Linked Groundwater Body Name	Aim of Investigation / Implementation Scheme	No. of model runs	Model Cost (£) (Inc. Oncosts)	Site Investigation Cost (£) (Inc. Oncosts)	Solution Cost (£) (Inc. Oncosts)	Total Cost Estimate (£) (Inc. Oncosts)
Grange and Juby Farms	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Broadland Rivers Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£0	£0	18,480
Eye, Mendlesham and Syleham	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Broadland Rivers Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£358,632	£0	377,112
Broome	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Broadland Rivers Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£119,544	£0	138,024
Bungay	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Broadland Rivers Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£0	£0	18,480
Barsham Bridge and Puddingmoor	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Broadland Rivers Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£0	£0	18,480
Nunnery Farm	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Broadland Rivers Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£0	£0	18,480
Barsham Hall	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Broadland Rivers Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£0	£0	18,480
Shipmeadow (Waveney Chalk Bore)	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Broadland Rivers Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£0	£0	18,480

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Walpole / Rockstone Lane	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Waveney and East Suffolk Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£119,544	£0	138,024
Holton/ Halesworth	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Waveney and East Suffolk Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£119,544	£0	138,024
Alder Carr and Quay Lane	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Waveney and East Suffolk Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£0	£0	18,480
Coldfair Green	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Waveney and East Suffolk Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£119,544	£0	138,024
Leiston	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Waveney and East Suffolk Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£119,544	£0	138,024
Benhall, Parham and Saxmundham	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Waveney and East Suffolk Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£358,632	£0	377,112
Aldeburgh	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Waveney and East Suffolk Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£0	£0	18,480
Langham Bores	WFD_INV_WRFlow	Investigation and Options Appraisal	31/03/2022	North Essex Chalk	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£18,480	£0	£0	18,480
Roman River	WFD_NDINV_WRFlow	Investigation and Options Appraisal	31/3/22		Requires level sensor at weir, eel brushes to weir and maintenance of MMF. Also investigation into the effects of sedimentation upon the condition of Abberton SSSI/SAC should be undertaken.		£50,000	£0	£0	50,000
Blackwater Intake and Langford Mill	WFD_INV_WRFlow	Investigation and Options Appraisal	31/3/22		This licence to be considered as part of the Abberton Scheme. Development of fish bypass channel in previous AMP.		£9,000	£0	£0	9,000

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Linford & Stifford	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	South Essex Thurrock Chalk	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£16,800	£0	£0	16,800
Bedingfield	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Broadland Rivers Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£16,800	£239,088	£0	255,888
Little Glemham	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022	Waveney and East Suffolk Chalk & Crag	To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£16,800	£119,544	£0	136,344
Ball Lane	WFDGW_INV_GWR	Investigation and Options Appraisal	31/03/2022		To assess the sustainability of the groundwater abstraction in the context of the WFD GW unit.	1	£16,800	£0	£0	16,800
Stratford St. Mary	WFD_INV_WRHMWB	Investigation and Options Appraisal	31/03/22	N/A	To review and simplify the Stour licence while maintaining residual flows to estuary without significant effect on overall Essex System DO.		£20,000	£0	£0	20,000
Balder, Grassholm, Derwent (2 schemes), Waskerley	WFD_IMP_WRHMWB	Adaptive Management Investigations	31/03/22	N/A	Adaptive management trials - baseline monitoring, change releases, monitor		£0	£333,648	£0	333,648
North Tyne, River Font, Smiddyshaw and Hisehope, Waskerley Catchwaters	WFD_INV_WRHMWB	Investigation and Options Appraisal	31/03/22	N/A	Adaptive management trials - baseline monitoring, change releases, monitor		£0	£417,060	£0	417,060
Blackburn Catchwater	WFD_IMP_WRHMWB	Investigation, Options Appraisal & Implementation	31/12/2024	N/A	Baseline and post-implementation monitoring, mods on existing structure required.		£0	£133,412	£0	133,412
Burnhope Burn	WFD_IMP_WRHMWB	Investigation, Options Appraisal & Implementation	31/12/2024	N/A	Baseline and post-implementation monitoring, mods on existing structure required.		£0	£243,915	£0	243,915

WINEP WFD INVESTIGATIONS AND MEASURES

Magnesiam Limestone - saline intrusion / coal authority	WFDGW_NDINV_GWR&GWQ	Investigation and Options Appraisal	31/03/2022	Mag Limestone	To further develop the mag limestone model to assess risk from saline intrusion and also minewater		£50,000	£0	£0	50,000
Fell Sandstone	WFDGW_ND_GWR	Implementation	31/12/2024	Fell Sandstone	Further test pumping (once new TWs operational) and construction of replacement boreholes - Thornton and Thornton Bog.		£0	£0	£988,116	988,116
Stoneygate	WFDGW_NDINV_GWQ	Investigation and Options Appraisal	31/03/2022	Mag Limestone	Investigation to confirm source of nitrates - may require drilling of monitoring borehole and some monitoring		£0	50,000	£0	50,000
Coquet Tdial Weir	NERC_INV1	Investigation and Options Appraisal	31/03/2022	Fell Sandstone	Undertake investigations to review existing info and gaps in evidence on opportunities for priority habitat creation, restoration, species recovery or ecosystem services, so as to contribute towards biodiversity priorities and the NERC Act.		£0	£50,000	£0	50,000
Pont	WFD_IMP_WRHMWB	Sustainability Change	31/03/2022	N/A	River morphology enhancements		£0	£0	£149,800	149,800
River Rede (Scour releases)	NERC_INV1	Investigation and Options Appraisal	31/03/2022	N/A	Investigation into impacts of scour valve releases on water quality and associated species and habitats		£0	£60,000	£0	60,000
					Grand Total					4,591,449

Improving River Flows

Task	Unit Cost (£)	Unit	Quantity	Sub-total	Total	Oncost %age	Oncost (£)	Total Cost with On Costs (£)
Flow Deflectors	£10,000	Each	3	£30,000	£50,000	10.00%	£5,000.00	£55,000
Back water Creation	£15,000	Each	1	£15,000				
Woody Debris	1000	Per month	5	£5,000				

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WINEP WFD INVESTIGATIONS AND MEASURES

Issue No:	1	Quality Document Type:	PR19 Enhancement Business Case
Amendment No.	0	Ref:	
Date:	21/02/2018	Originator of this document is:	Helen Allister

Appendix 2 – Table of Risk

Description of identified risk	Chance of risk (high/medium/low)	Impact of risk (high/medium/low)	Planned action to manage or mitigate the risk
Berwick Fell Sandstone Sustainability We are confident of delivery of the confirmed scheme to deliver the new borehole. However, further investigation is required. This may confirm that further mitigation over and above that in the WINEP is required.	Low	Low	This risk assessment is not for delivery of the new borehole as allowed for in the WINEP costs – we are confident that this will be delivered. Instead, it covers additional mitigation over and above that allowed for in the WINEP costs. The need for additional mitigation was initially covered in the Cost Adjustment Mechanism. However, as the Fell Sandstone is a confirmed scheme, it does not fall within the scope for the cost adjustment mechanism and so has been removed from it at Mott MacDonalds request. It should be noted that the risk of further mitigation being required is considered very low. If further mitigation was required, the Company would have to find funding for this through its normal business as usual capital investment process.

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Household Customer Metering Enhancement Business Case

WS2 - Wholesale water capital and operating enhancement expenditure by purpose
Line 21, 22, 55 and 56

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METERING

Name of claim	Household Customer Metering	
Name and identifier of related claim submitted in May 2018	n/a	
Business plan table lines where the totex value of this claim is reported	WS2 lines 21, 22, 55 and 56	
Total value of enhancement for AMP7	£43.2m	
Total opex of enhancement for AMP7	0	
Total capex of enhancement for AMP7	£43.2m	
Depreciation on capex in AMP7 (retail controls only)	n/a	
Remaining capex required after AMP7 to complete construction	n/a	
Whole life totex of claim	n/a	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	Material	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		No
Need for investment/expenditure	To satisfy the legal requirement to fit a water meter for any customer who requests one and to satisfy the EA that we are increasing our meter penetration in line with our WRMPs.	
Need for the adjustment (if relevant)	n/a	
Outside management control (if relevant)	n/a	
Best option for customers (if relevant)	An optant based programme in the north with smart capable meters fitted according to a new location policy. In ESW, we will also deliver smart capable meters in line with our new location policy but our programme will combine optant metering and 'whole area metering' which will improve the efficiency of metering and also protect customer choice.	
Robustness and efficiency of claim's costs	Costs were provided by our Cost Estimation team and externally assured. Our costs are more efficient than the allowance Ofwat made in their metering enhancement feeder model in spite of our proposal to introduce smart metering.	

Customer protection (if relevant)	We are proposing to use a cost adjustment mechanism which will reimburse customers in the event of under-delivery.
Affordability (if relevant)	See page 24
Board Assurance (if relevant)	See page 26

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METERING

Contents

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METERING

Executive summary

Proposal

This business case relates to new household water meter installations classed as enhancements in the periodic review. We also propose to fund part of our household meter replacement programme as enhancement to cover the difference in cost of upgrading existing analogue meters to smart meters.

- We will continue with optant metering across all areas but our forecast numbers have been increased by 25% to allow us to increase meter awareness in response to customer feedback and in support of our goal to reduce water poverty to zero by 2030.
- We will deliver Whole Area Metering in Essex throughout AMP7. This programme replaced metering on change of occupier in 2018/19. We will deliver twice as many meter installations but the cost of the programme will be halved because we will focus on areas where boundary boxes have already been installed at least until 2025.
- From 2020 all new and replacement meters will be smart capable and by 2035 all our meter stock will be smart.
- The additional cost of smart metering will be funded by a change of meter location policy and using Whole Area Metering instead of selective (change of occupier) metering.

Benefits

The proposal will directly deliver benefits that are valued by customers:

- We will significantly improve our service to customers as smart meters will enable us to offer a wider range of tariffs; enable customers to save water and save money; start delivering our digital service ambition with better, more personalised communication; and resolve issues faster. Our new meter location policy will also enable customers to have much quicker meter installation times).
- Metering will contribute to our ambition to achieving zero water poverty by 2030.
- We will be able to achieve more substantial savings to per capita consumption with smart meters (which becomes a regulatory measure with an ODI from 2020).
- Smart meters will assist with efficient leakage management. This benefit will grow through time as we increase the coverage of smart meters across our areas. This will be key to delivering our long term commitments to reduce leakage to approximately half of current levels by 2045.

Cost

- The totex cost of this plan is £65.7m of which we propose £43.2m will be funded as enhancement. This will cover the full cost of new meters and the additional cost of upgrading existing meters to smart meters (rather than replacing like for like).

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Table 1: Summary numbers and costs

	Number of meters	TOTEX (£'m)
New installations (all smart meters)	163,094	35.5
Replacement meters	309,832	30.2
• *Base cost (like for like replacement)*		*22.5*
• *Additional cost of upgrading to smart meters*		*7.7*
Enhancement funding	472,926	43.2
Total plan	**472,926**	**65.7**

- The enhanced funding level is in line with our plans for AMP5 (£44m) and AMP6 (£43m), despite our proposal to introduce smart meters, increase the number of new meters we install and include part of the cost of meter replacement. This will be possible because of the significant efficiencies made by introducing of Whole Area Metering and a new location policy.

Customer acceptability

- This plan has been built around what our customers have told us. It has been developed over the past 18 months with a group of key business stakeholders and informed by multiple customer research projects along the way;
- The plan to introduce smart meters was tested with customers in recent discretionary enhancement research, with the majority of customers willing to pay for smart meters.

Context and scope

The installation of new meters has always been classed as enhancement expenditure as water companies have a statutory obligation to install a water meter free of charge to any customer who requests one (see The Water Industry Act 1991, 1999). Other metering programmes are usually linked to water resource management and are also considered as enhancement.

New meters are installed in all new homes, at a cost to the developer. Therefore, no enhancement funding is required for this and new development meters are not in the scope of this proposal.

Meter replacements are not classed as enhancement. However, our plan to upgrade our meter stock to smart meters will constitute an enhancement. The additional cost of replacing meters with smart meters is included in this enhancement proposal.

In early 2017 NWL's Strategic Planning team initiated a holistic review of our household customer metering policy involving a range of both internal and external stakeholders to help us build our Water Resource Management Plans and PR19 plan. The policy review began with extensive customer research including nine deliberative research sessions held with a representative sample of customers across our three operating areas and an online survey which was completed by almost 1200 customers company-wide. Following on from this, a series of workshops have been held with internal stakeholders to agree how our customers' views should shape our approach to

metering going forward. Below is a high level summary of what has been agreed as fundamental policy decisions. Our plans have been built on these policy decisions.

1. Metering is about customer choice and service

Our customers want to be free to choose whether or not to go on a meter and they want us to do a better job of making them aware of their choice to try a meter and revert back to unmeasured charges if it doesn't work out for them.

We are not proposing compulsory metering in any area and we will discontinue metering on change of occupier. We will improve awareness about the potential benefits of meters. In a separate but related work stream about tariffs we have designed a range of new tariffs to give customers more choice about how they pay for their water and wastewater services. This includes a review of fixed charges which are currently much higher than the industry average. This means that going on a water meter does not deliver much of a financial saving for customers which causes dissatisfaction.

2. The opportunity and benefits of smart metering

Meters could be used to achieve much more. If we invest in upgrading our meter technology, both we and our customers could get a lot more benefit from meters.

We want to upgrade new (and replacement) meters to future proof, 'smart' capable meters from 2019. In the short term this will enable drive by or walk by reading to ensure customers on a meter will always receive bills based on a reading. By 2022 we want to link meters up to a wide area network which will be the next development in the area of smart metering; offering a more affordable solution for data communication than is currently available.

We feel it is the right time to upgrade our meter technology, because:

- **There is a clear push in the direction of digital technologies** and the success of our own 'digital ambition' is dependent on enabling technology and especially smart meters. We have been described as 'an analogue industry in a digital age' by Ofwat's former CEO (and Ofwat's new CEO Rachel Fletcher was a key influence behind smart meters in energy).

- **Smart meters are a key enabler behind several aspects of our plans** to reduce consumption and improve customer service in the area of affordability and addressing water poverty. Smart meters will:
  - Enable us to offer more innovative range of tariffs;
  - Help give customers more control over what they use and pay;
  - Enable quicker resolution of issues such as disputes about meter reading/meter accuracy/bill accuracy.

- **Our customers are broadly in favour of smart metering** and 62%/64% (NW/ESW) said they would be willing to pay for it. The minority of customers who are not in support of smart meters are simply unsure of the purpose. Many customers want to receive the benefits of smart meters but do not necessarily understand the underlying technology which will be required to deliver them.

- **Smart meters will enable faster reductions to consumption and leakage.** Ofwat has singled out these measures in PR19, stating that they expect to see innovation and ambition in PR19 plans. We need to move faster than other companies on these measures and getting ahead on metering technology could be key to achieving that. Nobody else is doing WAN smart metering yet. 24/7 monitoring will enable us to do much more to deliver unrivalled customer service, influence customer behaviour to reduce consumption and tackle leakage through enhanced network monitoring capabilities. There will be greater value in customers having a smart meter whether or not they are on a measured bill.

3. Making metering more efficient

We are proposing a new meter location policy which will favour wall box installations after our first choice of a 'drop in' to an existing external meter chamber. The next option would be to do an internal installation and the last option would be to install a meter externally on the customers' property. Installations in the public highway will no longer be offered due to the increasing costs and delays associated with installing meters here. This location policy will enable us to provide an industry leading level of service on optant installation time, aligning with our customers' expectations that we should install a new meter within 14 days of their request.

Additionally we are introducing Whole Area Metering in Essex in 2018 which will enable us to install meters in a whole area but leave customers free to choose whether they switch to measured billing, based on comparative bills. We will start by targeting areas where we have carried out network renewal and previously installed meter chambers. This will be far more efficient than installing meters one by one and will pave the way to universal metering long term without taking away our customers' choice of how they pay their bill.

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Customer and stakeholder expectation

Customer engagement

We have spoken to customers about metering directly and indirectly through a number of independently led research and co-creation workshops including:

Table 2: Customer research

Research/workshop title*	Date	Number of customers involved
WRMP and metering research	April-June 2017	144 (qualitative deliberative workshops companywide) 687 (quantitative online survey, ESW customers) 8 (vulnerable customer interviews)
WRMP and metering survey in NW (the same survey carried out in ESW in June 2017)	January 2018	500 (quantitative online survey, NW customers)
Tariffs Structures research	January 2018	106 (qualitative, NW and ESW customers)
D-Mex co-creation day with developers	2018	
Behaviour change and funds research	December 2017	9 deliberative workshops with several customers at each. 8 vulnerable customers
Tariffs co-creation workshops	December 2017	32
Discretionary enhancement research 1	March-April 2018	78 (qualitative NW and ESW customers)
Discretionary enhancement research 2	May 2018	115 (qualitative, NW and ESW customers)

Our key findings from this research are summarised below.

1. **Customers expect us to do more to improve awareness about meters**

A particular and incidental finding from our focused metering research in spring 2017 was that customers were largely unaware of the range of benefits meters can bring for customers, the environment and performance management and very vocal about their dissatisfaction that they had not previously been made aware of these things. As part of the planned research questions we did ask customers if they thought we should promote metering to particular groups and our customers told us that we should improve awareness generally across all customer groups so that they could make informed decisions. They were not keen on the idea of meter 'promotion' as this was

perceived as potentially pushy. Our plans are to do exactly as customers suggest and improve awareness generally, being open and honest about the potential drawbacks to having a meter as well as the many benefits.

In general our customers want more communication from us – but many of the examples they cite are connected with meters. These include more meter readings; more frequent billing; visibility of water usage comparative to others' (average/neighbours); reminders to pay their bill/read their meter; and alerts for high/increased usage. Most of these things will only be possible with smart meters and digital engagement although not all customers understand this. These expectations are part of what underpins our proposal to introduce smart metering.

2. **Customers want more choice of ways to pay**

Through talking to our customers on a range of different subjects, we have heard a very clear message that they want choice about how they pay for their water and wastewater services. The majority of our customers do not support the idea of compulsory metering or change of occupier metering and this has already informed our policy decision not to install new meters using either of these approaches in future. Instead, we have devised Whole Area Metering as an alternative approach.

At present, we offer only two choices to customers: a measured tariff and an unmeasured tariff. Few of our customers understand how unmeasured charges work and when informed about this, the majority consider it outdated and unfair. The majority see measured charges as fairer than unmeasured charges but they think all customers should be able to choose which tariff they are on. This is because measured charges tend to penalise families in lower value properties (and therefore probably on lower incomes). Our customers agree that water bills should be affordable for all as water is essential for everyday life. We have seen across multiple research projects that customers are supportive of the concept of meter reversion and have suggested it should be extended to all customers to make it fairer – not just to those who have opted to go on a meter in the previous 24 months.

Our customers have confirmed that a wider range of tariffs would be a good way of providing choice in a fair way. Our customers have endorsed a number of proposed tariffs; most of which will depend on the use of meters which can monitor flows at regular intervals. This is a key driver behind our recommendation to upgrade our meter stock to 'smart' meters.

3. **Customers want insight about their consumption and want us to do more to enable behaviour change**

Our customers want to be able to monitor their own consumption more closely through digital channels. Most customers understand that smart meters will enable this. Smart meters will provide us with better data with which we can provide better insight for our customers and provide a more personalised service and incentivise behaviour change – and our customers have told us we should be doing more to encourage water efficiency. Our customers are not enthusiastic about 'in-home displays' (IHDs) and would instead like to monitor their usage through existing devices, with older customers generally preferring websites and younger customers favouring smart phone applications. Our plans reflect this and we are not proposing to invest in IHDs.

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Customers are generally supportive of the idea of incentives for behaviour change, although only in the form of rewards. They are strongly opposed to the concept of penalties because they are seen as a way of trying to make more money and likely to lead to unfair treatment of some customers.

We expect digital engagement based on smart meter data to provide customer insight and build a stronger relationship with our customers which will allow us to influence their behaviour and encourage their participation in delivering improved performance, and allow them to give us feedback, contribute new ideas, and find out about events and more value add services that we offer.

Wider stakeholder engagement

We have consulted with our Water Forum, CCWater and the Environment Agency throughout the development of our metering plan. We have also given careful consideration to the many recent publications from Defra and Ofwat which are relevant to metering.

Water Forum engagement

At the outset of the household metering policy review a meeting was held with Steve Grebby who sits on our Water Forum and is also a Policy Manager at CCWater. Steve was keen to encourage us to present water metering in a balanced way to customers and not to talk only about the benefits but openly highlight potential drawbacks. We produced an educational film about metering for use in our WRMP research which covered all the uses of meters and the benefits as well as the disbenefits. Steve Grebby and Graham Dale from our Water Forum both attended some of the deliberative research sessions and recognised the balanced way in which we had presented metering to our customers. Several members of the Forum also participated in our strategy workshops and attended recent discretionary enhancement research sessions.

We consulted with a number of stakeholders including CCWater in summer 2017 and they agreed that:

- There is no mandate to introduce compulsory metering into Essex and Suffolk;
- Selective metering of customers on change of occupier will no longer be undertaken;
- We will replace selective metering with Whole Are Metering from 2018. Initially this will be prioritised to filling existing empty chambers and customers will be charged as unmeasured but given equivalent measured bills for a period of 2 years, with the expectation that a significant number will opt in to measured billing;
- To match the impact of installing around 5000 selective meter per annum we have agreed to meter 10,000 drop ins per annum.

We have agreed to keep CCWater involved with further details as the plan evolves, especially about customer communication. In view of customer satisfaction, and given the time taken to meter selectives, our approach was seen as a good way forward.

Our Water Forum have very recently being consulted on the results of our discretionary enhancement research which included discussion of whether to proceed with smart metering. The Forum's view was that 62/64% willingness to pay (NW/ESW) seems reasonably supportive. They

said that we need to be clearer on what we mean by a smart meter, what the benefits are for customers and how we will ensure that everyone who wants a smart meter will be able to get one.

Regulatory Expectations

The Environment Agency (EA) is the strongest advocate of meters in the UK water industry, and has on numerous occasions called for universal metering by a target date and an acceleration of metering across the UK. It regards the existing approach to metering as 'piecemeal' and inefficient and argue that companies should be given powers to install meters compulsorily regardless of whether the area they serve is resource constrained or not. We have responded to these expectations through our decision to introduce Whole Area Metering which addresses their criticism of 'piecemeal' metering and recognises their expectation that we are working towards universal metering in the long term. The EA is also a strong advocate of smart meters and water saving tariffs. We are proposing to introduce smart meters and will be increasing the focus on water efficiency, partly through the introduction of new tariffs.

Ofwat state their position on metering as being about service at a fair price and making sure water supplies continue to be secure for customers in future. They have concerns that there may be many customers in situations of vulnerability without water meters who may be paying too much while they are at risk of financial difficulty. Our plans to improve meter awareness and put customers first in our approach to metering are in line with their position. More recently Ofwat have linked meters closely with providing better service through enhanced monitoring. They believe using customer data more effectively could transform customer service and satisfaction, improve efficiency and resilience; especially benefitting vulnerable customers. Ofwat are also increasingly holding companies responsible for reducing customer consumption and PCC will become a compulsory performance indicator from 2020. They want to see companies treating customers as participants in delivering services and using data to influence customer behaviour. Reducing consumption is frequently signposted as a key example. All of these expectations point to the use of smart metering and our plan to introduce smart meters and develop a digital service is intended to help us respond to these challenges.

Current and historical service delivery and expenditure

The rate at which new meters are being installed in the current period is based on forecasts of the number of optants expected to be seen, and in the case of Essex we have also been installing meters on change of occupier since 2003. Meters have also been installed in new homes since 1991. NWL saw a surge in requests for meters after the right to a free meter was first introduced in 1999 and the number of optants has been maintained at a steady rate since 2001, sometimes boosted by targeted meter promotions.

Below is a summary of our planned installation numbers and expenditure for household meters compared against the numbers we actually delivered from 2010/11 to the present.

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Table 3: Historical delivery

		Planned *(WRMP/business plan commitments)*	**Actual**
2010-15	NW installations	70,000	75,330
	NW expenditure (£'m)	£16.3	£24.7
	ESW installations	91,150	56,616
	ESW expenditure (£'m)	£25.8	£16.5
	NWL installations	**161,150**	**131,946**
	NWL expenditure (£'m)	**£44.0**	**£41.2**
2015-20	NW installations	78,000	47,296
	NW expenditure (£'m)	£24.3	£15.2
	ESW installations	66,375	26,817
	ESW expenditure (£'m)	£18.6	£8.5
	NWL installations	**144,375**	**74,113**
	NWL expenditure (£'m)	**£43.0**	**£23.7**

We did not deliver the planned number of new meter installations in 2010-15. This was in large part due to the impact of the financial crisis on our change of occupier metering programme in Essex, in that the property market was badly affected. In addition, we have found that as meter penetration has increased over the years, many properties which change ownership are already metered. Certain cohorts of property change ownership more frequently than others and this has meant opportunities for us to meter homes on change of occupier have further decreased. We have also seen a steep decline in optant rates in Essex and Suffolk since 2010. As a result we are forecasting low levels of optants through 2020-25 and the majority of our installations in Essex will be made through Whole Area Metering.

We are confident we will be able to meet our planned installation numbers for 2015-20. Delivery is comfortably on track in NW and through initiating meter awareness campaigns in 2018 and 2019 and introducing Whole Area Metering in Essex in 2018 we expect to meet the planned number of installations within the budget by end of March 2020.

Forward looking analysis

- **We have forecast the likely optant rate over 2020-25. We propose to improve meter awareness and install 25% more meters than our forecast shows;**
- **We will deliver a Whole Area Metering programme in Essex, which is our most resource constrained operating area;**
- **We also propose to upgrade all new meters to smart.**

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Much of our investment in new meters is unavoidable because we are required to install a meter for customers who request one by law. Historically we have taken a minimalist approach, delivering predominantly optant led metering programmes. As a result we now have low levels of meter penetration across our supply areas by comparison with other water companies in the UK. We have met the minimum requirements for making customers aware of their right to a free meter and a two year trial period in which they can revert back to unmeasured charges, although our customers have told us we are not doing enough.

It is also possible that smart metering could be enforced on the water industry at some point in future. Defra has recently communicated with us that they are considering the possibility of introducing combined smart utility meters (for energy and water) and whether this should be made compulsory.

As part of our Water Resource Management Plans we forecast supply and demand levels for the next 25 years and beyond. Even where there is a healthy balance between supply and demand, we have to commit to a number of meters that will be installed in each region through the next five year period as well as the reduction to PCC which will be achieved. Our draft plans committed to continued delivery of optant metering and forecast the likely rate of customer requests in each operating area. As forecast optant levels in ESW are now low, we also committed to delivering 10,000 new meter installations each year in Essex through Whole Area Metering.

Option appraisal

Costing of options

All costs for the household customer metering programme were provided and assured by the NW Cost Assurance team based on robust assessment and forecasting using historical spend data. Variations in cost between our operating areas were accounted for by the provision of three separate cost estimation assessment for Northumbria, Essex and Suffolk.

The costs of our plan are more efficient than the allowance Ofwat made in their metering enhancement feeder model in spite of our proposal to introduce smart metering. This is because we have made significant efficiencies by proposing to introduce a new area based metering programme

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[1]. This review has assessed the household customer metering costs as green. That is to say that NWL has followed an appropriate costing methodology and has evidenced that the costs used are robust and consistent with good industry practice. The NWL PR19 Costing methodology is included in full in Appendix 3.2.

New meter installations

We have considered eight overall options for new meter installation with three key variables of meter technology, installation numbers and location.

[1] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

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The additional cost of a smart meter which is capable of connecting with wide area networks is straightforward to estimate. The area of uncertainty in our smart metering costing is around the data handling and communication costs. We have chosen to add a nominal cost per meter for communication, based on quotes received from suppliers. In reality, there are a number of ways we could procure access to a communication network – either paying to use a third party network or installing our own infrastructure. The costs per meter will vary depending on the number of smart meters we connect to a network in one area, with larger numbers of meters in a concentrated areas being the lowest cost and most efficient way to deliver smart metering.

Table 4: New meter installation options

	Analogue meters		Smart meters	
Installation numbers	WRMP numbers	WRMP numbers + 25% more optants	WRMP numbers	WRMP numbers + 25% more optants
Existing location policy	**£31.5m**	**£39.4m**	**£36.9m**	**£46.1m**
Proposed location policy	**£22.9m**	**£28.7m**	**£28.3m**	**£35.4m**

The table above does not show the efficiencies we have already made through Whole Area Metering. If we had continued with change of occupier metering during 2020-25 this would have added another £7.5m to each of the costs above.

Meter replacements

The need to replace meters is still a relatively new 'problem'. In ESW, we began installing meters in large numbers from 1996. By law we were required to install meters free of charge from 2000. A large number of optant requests followed immediately afterwards in both operating areas. Our plan for AMP6 was to replace all meters installed before 2000 which means that the numbers due for replacement in AMP7 will be much larger.

The need for a forward looking approach to meter replacement was recognised across the industry in the late '00s. Up until then companies ran meters to failure. However, it was recognised that meters start under-reading from installation and continue to increasingly under-read through time. WRc completed a study looking at meters from companies across the industry and recommended replacing every 14 years. We completed our own in house study which came to the same conclusion. By year 14 the average meter will be under-reading by 10%.

We introduced a planned meter replacement programme in AMP5 (alongside a reactive meter replacement programme). This programme was set up with the ultimate aim to deliver a meter stock of no more than 15 years of age by the end of AMP6.

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We have considered six different options for meter replacement, as summarised below. The information about our PR14 plan is included for a point of reference.

Table 5: Summary of options for meter replacement

	Options	Number of meter replacements	Cost
PR14	Final plan	174,594	£13.55m
PR19	Option 1 – replace meters reactively on failure	~ 42,000	£4.3m
	Option 2 – upgrade all meter stock installed before 2010 with 'dumb' meters by 2025 (in line with policy & multi-AMP strategy initiated late '00s)	481,858	£36.6m
	Option 3 – upgrade meter all meter stock installed before 2010 with smart meters by 2025	481,858	£48.7m
	Option 4 – upgrade all meter stock with smart meters by 2030 (half of all analogue meter stock in AMP7)	464,748	£45.3m
	Option 5 – Upgrade all meter stock installed before 2020 with 'dumb' meters by 2035 (in line with multi-AMP strategy)	309,832	£22.5m
	Option 6 – Upgrade all meter stock with smart meters by 2035 (option 5 but smart)	309,832	£30.2m

Clearly, the options above show that whatever approach we decide to take to meter replacement, the costs are going to increase considerably from previous years. Option 1 would be the exception although it comes with a number of risks:

- Replacement on failure will continue to increase with inefficient one off replacements. Planned replacement is done by area and would offer the opportunity to upgrade meters to smart meters with an area smart network.
- Customers with older meters are likely to be paying too little. On receiving a new meter they are likely to notice a difference in consumption and their bill.
- Our water balance (calculating what is PCC and what is leakage) will be incorrect. This will 'increase' leakage at a local level and misdirect leak detection time and resources to supposed 'leakage' which is actually consumption.

Options 2 and 3 show that 'catching up' on our meter replacement in AMP7 alone will be extremely costly. We need to spread the cost of meter replacement over a longer period.

As we have an ambitious goal to eradicate water poverty in our regions by 2030 and metering is expected to play a key part in achieving that, it was initially requested that we look at upgrading all our meter stock to smart meters by 2030. However, the cost of doing this would be ~ £45m in AMP7 and again in AMP8. As meter replacement is not classed as enhancement, this would place a heavy burden on base funding.

Extending our replacement programme to 2035 (whether 'dumb' or 'smart') would significantly reduce the cost burden of meter replacements. It also aligns with our policy of replacing meters after 15 years of use – as meters installed now in 2018 would be upgraded in the early 2030s.

In addition, although meter replacement is not classed as enhancement, we consider that the difference in cost between replacing meters like for like and upgrading meters to smart meters are above and beyond normal maintenance costs and should be classed as enhancement.

Benefits assessment

This section considers the benefits from the metering programme for customers and wider stakeholders (i.e. benefits to the environment). The installation of smart capable meters and the move to wider area smart networks will deliver a range of benefits, as follows:

- **Improvements in customer service.** Smart meters will enable us to offer a wider range of tariffs and provide improved customer services. This includes more accurate, timely and personalised billing. It will facilitate the delivery of our digital service ambition, with improvement communication and faster response to customer issues;
- **Fairer billing.** Customers support metering as a fair way of paying for the water service and the option to introduce more tariff propositions provides the potential for further benefits. In addition, it can support our plans to protect financially vulnerable customers and move towards achieving zero water poverty by 2030;
- **Reducing PCC and leakage.** The metering proposals also deliver benefits in terms of reduced consumption and scope to reduce leakage (specifically through targeting supply pipe leakage). These elements of performance are strongly supported by customers. This also leads to environmental benefits in terms of reduced carbon (less electricity consumed in pumping and treatment) and the deferral of alternative resource schemes in the future.

In developing the cost-benefit assessment for the metering programme it is important to reflect the range of benefits that the programme can deliver. At the same time it is also important to take account of potential overlaps with other performance commitments and measures to ensure that the benefits are not being double-counted.

Approach to estimation of benefits

As our proposed metering programme delivers such a wide range of benefits and interacts with some many elements of the business, this presents a challenge in quantifying the scale of the benefits. The fact that smart metering is a facilitating investment that enables other investments and activities to deliver benefits to customers adds to the complexity and raises the question of the allocation of benefits. Finally, there are customer benefits in terms of increased fairness and protecting vulnerable customers that are difficult to derive values for, as they can be sensitive to the context that the respondent is either given or creates themselves[2].

Given these challenges our approach to benefit assessment is to consider a wide range of evidence sources. In particular, we first consider the valuation evidence for specific benefits that arise from

[2] For example, responses can depend on beliefs about the cause of unfairness or vulnerability.

the metering programme. We have then also considered the direct customer evidence in support of the proposed programme.

Scale of customer valuation

At PR19 NWL has undertaken a range of research on specific areas. One core piece of research was an innovative customer valuation research tool developed collaboratively with Explain, Frontier Economics and Supercharge[3]. This tool covered a number of service areas, including leakage and PCC. The valuation results from the research were as follows:

- Leakage – customers valued a reduction in leakage of 1 Ml per day at £335,000 per year;
- PCC – customers valued a reduction in PCC of 1 litre per person per day at £1,205,000 per year.

The values for leakage are similar to those obtained by the industry at PR14. At PR14 four companies included leakage in their Willingness to Pay (WTP) and the median valuation was £231,000 per Ml/d (in today's prices) with a range of £99,000 to £405,000 per Ml/day. Comparative data on PCC valuation is not available from PR14. In terms of applying these benefits to the metering programme there are two issues to consider:

- First, the extent to which these benefits are additional and not captured in PCs and ODIs for leakage and PCC;
- Second, the scale of benefits against these elements that the programme can achieve.

On the first point, it has been important for us to ensure that no double-counting has occurred between the different aspects of the business plan. On leakage Ofwat has prescribed an approach to setting challenging performance commitment levels (PCL) for all companies to achieve. Therefore although the valuation evidence is used to set the ODIs around the performance level they do not drive the PCL itself. In other words the valuation of moving leakage from the current level to the PCL is not reflected elsewhere in the plan and so there is no double-counting to take account of.

For PCC, double-counting could in theory be more of an issue. We conducted different research to determine the PCL and the ODI. For PCC this showed that the amount that customers valued a reduction in PCC was greater than the amount they considered appropriate to include in a financial incentive. Therefore we can include the difference between the values in this assessment and in that way it is clear there is no double-counting between the ODI performance and the case for the enhancement funding.

On the second point there is inevitably some uncertainty about the scale of benefits that the WSM would deliver. But based on the values above (and adjusting the PCC value for double-counting):

- A 1 Ml/d reduction in leakage results in customer benefits over the 5 years of £1.7 million;
- A 1 l/p/d reduction in PCC results in customer benefits over the 5 years of £5.0 million.

Another area of customer benefit arising from the metering programme arises from improved customer service. Smart metering enables us to prevent queries through more accurate billing and

[3] NWL PR19 Research Tool, Striking the right balance between delivering business plan insights and cognitively valid results, January 2018.

to resolve customer service and billing queries more quickly, resulting in higher customer satisfaction. To illustrate the scale of potential customer benefits we have used the Accent report of the comparison of PR14 customer research[4]. The table shows the valuation results for a reduction in customers affected by unsatisfactory customer service and a reduction in the time required to answer one enquiry.

Table 6: Customer benefits from improved service

Aspect of improved service	Customer valuation (uplifted to 2018 prices)
1 customer affected by unsatisfactory customer service	£74.20 (median of 3 surveys)
1 day to answer an enquiry from 1 customer	£1.51 (1 survey)

Ofwat will incentivise good customer service through the new service incentive mechanism C-MeX. The improvements in billing accuracy and communications arising from the metering programme would contribute to an improved C-MeX score. However, in terms of potential double-counting of benefits we note that the C-MeX is a dynamic incentive with the financial upside awarded only to the best performing companies. Most companies have invested in, or are proposing to invest in, metering and automated meter reading programmes. Therefore to achieve any financial upside through the C-MeX we would need to deliver performance over and above that implied by the metering programme. Therefore we do not believe there is any material double-counting of benefits with C-MeX.

The metering programme will facilitate further customer benefits as the penetration of metering increases. These include:

- The introduction of new tariff structures that better meet customer requirements;
- New digital services that further improve overall customer services and satisfaction, giving more data and control to customers;
- Tariff options and services that help to address affordability and vulnerability, helping us to achieve the goal of zero water poverty by 2030.

Estimating the scale of these benefits is challenging but the level of customer support for these aims indicates that the benefits to customers are material.

Customer support for proposed solutions

A recurring theme from the above findings is that customers want us to provide better services; many of which will depend heavily on the use of smart meters. However, our customers do not always understand the link between these improved services and smart meters. Our discretionary enhancement research set out to explain why smart metering would be necessary to providing service improvements that our customers have identified in multiple ways, including through research.

[4] Accent, Comparative Review of Willingness to Pay Results, Final Report, October 2013.

APPENDIX 3.2

METERING

We undertook two phases of acceptability testing for the metering programme, involving nearly 200 customers. They were given detailed information on the programme, its benefits and costs, and asked whether they supported the programme given its impact on bills. The results are shown in the Table below.

In all cases there were more customers voting 'Yes' than 'No', although the overall level of support was lower than for other discretionary programmes. In part this may reflect the multi-faceted nature of the impacts of metering and uncertainty over whether it should already be part of the base service. This would explain the relatively high level recording an 'Unsure' vote. We expect that appetite for digital service will only increase through time because it tends to correlate with age. Given that we are planning for the future we deem it appropriate to put more weight on the views of younger customers and also to take account of the other research evidence in support of tariff innovation and improved customer service.

Table 7: Customer support for funding smart metering as enhancement

		'yes' votes	'unsure' votes	'no' votes
Phase 1	NW	62%	16%	22%
	ESW	64%	29%	7%
Phase 2	NW	43%	17%	40%
	ESW	61%	9%	30%

To express these results in terms of cost and benefit terms we have translated the research results in to benefit-cost ratios. To do this we assume that the 'demand curve' is linear and we consider price elasticities ranging from 0.5 (inelastic) to 2.0 (elastic), we also remove the 'Unsure' respondents from the calculation.

These results are shown in the table below.

Table 8: Benefit-cost ratios for metering programme

	Low	High
Essex & Suffolk – total	1.17	1.68
Northumbrian Water - total	1.09	1.34

The table shows that all of the proposed elements of the programme have support from customers and implied benefit cost ratios of over 1.0. For Northumbrian Water the estimated benefits exceed costs by somewhere between 9% and 34%, while for Essex & Suffolk the range is 17% to 68%.

Summary of benefits evidence

We have considered a range of benefit evidence that supports the proposed metering programme:

- Evidence on the benefits of reduced leakage and PCC. The evidence from our PR19 customer valuation tool indicates that a 1 Ml/d reduction in leakage results in customer benefits over the 5 years of £1.7 million, and a 1 l/p/d reduction in PCC results in customer benefits over the 5 years of £5.0 million.

- Evidence of valuation of improved customer service. Using available evidence on customer valuation of improved customer service, the metering programme could deliver further benefits through more accurate billing and response to queries. In addition there is strong support from customers for new tariff structures, digital communications platforms and the improvements in affordability and vulnerability measures that metering can support;

- Finally, there is customer support for this scheme in the customer research undertaken for PR19. This research has been undertaken on small sample groups but with detailed information about the costs and benefits of the programme. The level of support is lower than for some other discretionary schemes but nonetheless implies a positive benefit-cost position.

Our preferred plan/option

We are proposing to upgrade all our meter stock to smart meters by 2035. This means:

- A total of 472,926 smart meters will introduced in the period 2025-25, with an estimated totex of £65.7m.
- 163,094 of these will be new installations (not including new devt), with a totex estimate of £35.5m. We will increase the optant rate by 25% through meter promotion, installing a total of 113,094 meters. We will install a further 10,000 new meters a year in Essex through Whole Area Metering.
- We will replace one third of our meter stock (inc meters installed up to 2020) by 2025 with smart meters. The totex estimate for this is £30.2m. £7.7m of this will be funded as enhancement; the remaining £22.5m will be funded from base.

The best plan for customers is to enable those who could benefit from being on a meter a better chance of accessing this service. As we are planning to improve meter awareness in response to what our customers told us during research, we are forecasting an additional 25% of optants in the period over and above WRMP levels. This will support our goal to achieve zero water poverty by 2030.

We also consider that the additional spend on smart meters is fully justified given the significant benefits they will bring to customers and improving performance in a number of areas identified above.

We will significantly enhance the efficiency of metering in delivering this plan. Our overall level of planned expenditure will be lower than in the preceding periods 2010-2020 but we will deliver greater benefits.

Optant metering (line 21)

Our optant metering programme for 2020-25 is based on estimates of the likely number of customers who will opt for a meter, which are included in our Water Resource Management Plans (WRMP). The regional forecasts of future optant rates are based on past experience and trends. We have seen a steady rate of optant requests in our northern operating area and expect this to continue while meter penetration is still below 50%. In Essex and Suffolk, the optant rate has been declining over the last 15 years and we expect this to continue.

However, our strategic long term goal of eradicating water poverty will involve changing tariffs and communicating more effectively with customers about meters – something we have not been able to afford in the past as optant levels are already quite high with very little promotion on our part. The figures above assume changes will come into effect in such a way as to stimulate an increase in the number of optants by 100% in our northern operating area and 50% in Essex and Suffolk in 2020; reducing to 50% additional optants in our northern operating area by 2025 and 10% in Essex and Suffolk. These assumptions are reflective of the low meter penetration rate in NW and higher rate of water poverty and/or vulnerability.

Meters introduced by companies (line 22)

There are two elements included within line 24, 'meters introduced by companies'. They are:

- Whole Area Metering; and
- Upgrading existing meters to smart meters on replacement.

Whole Area Metering

We have chosen to move away from metering on change of occupier because our customers want us to prioritise their freedom to choose how they pay for their water and wastewater services. We could simply look to make up the numbers of meter installations by targeted promotions to stimulate the number of optants. However, optant metering is very costly and inefficient as meters are installed individually. We are also unlikely to reach universal metering by relying on optant metering alone.

Instead, by installing meters with optional measured billing, we will open up the opportunity of metering in areas of our choice without it being 'compulsory metering'. There are large areas where we have already installed chambers which can be used to deliver metering much more efficiently and whether the customers choose to switch to measured billing or not will have no impact on revenue. In general, we should be moving away from installing meters in isolation as this is inefficient. The most efficient way to install meters is in large numbers in a whole area, enabling cost savings on travel and administration. In the short term we will focus metering by area in places where we have already installed a large number of meter boundary boxes, allowing us to install meters for a quarter of the cost of metering a home on customer request. We will therefore also look to target areas where customers are most likely to benefit from going on a meter to reduce 'reactive' metering of optants.

We will achieve numerous benefits from switching to metering in whole areas:

- **Financial:** by installing meters in one area, we will be able to make more installations with our available resources than we do by installing meters at individual properties in various locations. We have large areas where boundary boxes are already in place to receive meters and these will be a particular focus of low cost, area based installations;
- **Addressing supply issues:** metering by area enables demand to be reduced in a more concentrated area where this is necessary, and this could be to alleviate capacity issues either in water or wastewater;
- **Reduced consumption: w**here customers do opt in to measured billing we can expect to see a reduction in their consumption which is at least in line with the reductions optants make (5%). By metering homes which are unlikely to opt for a meter, we will be able to identify high consumers where water savings have the potential to be greater if we can

provide effective insight and incentives for behaviour change. Even where customers do not opt in to measured billing, we can expect to see reductions in consumption because the customer will know their water usage is being monitored. This is known as the 'Hawthorn effect' and reduces consumption by 3%. With more meters being installed the overall savings will be more significant than change of occupier metering. High consumers will be easy to identify and can then be offered services such as a water efficiency home audit to help reduce their consumption;

- **Finding leaks:** the impact of metering a whole area would be considerable to understanding and addressing leakage in that area; especially where 'smart' meters are used;
- **Flexibility: i**t is difficult to manage workload when reacting to requests or the timing of when customers move house. The area based approach can be planned, controlled and flexible when necessary.

Under this programme, customers will be provided with comparative billing information, showing them what their bill would be if they switched to a measured tariff, but they will retain the right to choose how they pay for their water for as long as they live at the property. If they opt in to measured billing, they will have 24 months to revert back in the same way that optants do. We expect at least half of customers who are metered through WAM will opt to go on to measured charges. The remainder will still be able to benefit from monitoring their consumption and take steps to reduce it. We will also be able to identify more customer-side leaks proactively and much more quickly, saving damage and waste.

Upgrading meters to smart meters on replacement

Our plan for meter replacements will be mainly funded from base as it constitutes 'maintenance'. However, we intend to upgrade all our meter stock to smart meters by 2035 which will incur additional costs to like for like replacements. It would be inconsistent to propose all new meters should be smart while continuing to replace meters with 'dumb' meters. Our proposal is that the additional cost of replacing meters with smart meters should be funded as an enhancement. This is because it will deliver enhancements to service which will not be directly incentivised through ODIs.

The scale of meter replacement which will be required in the coming period 2020-25 is vast. However, we cannot defer meter replacement indefinitely and we propose to establish a programme which spreads the burden of this cost evenly over a 15 year cycle. Our replacement plan extends to 2035 and takes account of all the meters we expect to install and replace for the remainder of AMP6. Naturally, this programme will only grow in size beyond 2035 so delivering the programme as planned will be necessary to prevent a significant problem developing in future years.

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METERING

Summary of Totex

Optants (line 21)

Table 9: Optant installation numbers & costs

Installation numbers	2020/21	2021/22	2022/23	2023/24	2024/25	Total
NW optants	17,500	17,500	17,500	17,500	17,500	87,500
Essex optants	5,000	4,688	4,375	4,063	3,750	21,875
Suffolk optants	844	813	750	688	625	3,719
NWG optants	23,344	23,001	22,625	22,251	21,875	113,094

Costs	2020/21	2021/22	2022/23	2023/24	2024/25	Total
	£	£	£	£	£	£
NW totex	**4,625,095.77**	**4,674,373.20**	**4,723,650.63**	**4,772,928.07**	**4,822,205.50**	**23,618,253.17**
NW capex	4,575,818.33	4,575,818.33	4,575,818.33	4,575,818.33	4,575,818.33	22,879,091.67
NW opex	49,277.43	98,554.87	147,832.30	197,109.73	246,387.17	739,161.50
E totex	**1,543,592.69**	**1,481,027.01**	**1,417,562.74**	**1,353,199.86**	**1,287,938.38**	**7,083,320.68**
Essex capex	1,529,215.07	1,453,170.38	1,377,125.68	1,301,080.99	1,225,036.30	6,885,628.42
Essex opex	14,377.62	27,856.64	40,437.05	52,118.87	62,902.08	197,692.27
S totex	**307,500.01**	**298,657.37**	**278,331.53**	**257,817.08**	**237,114.01**	**1,379,419.99**
Suffolk capex	304,953.77	293,659.18	271,070.02	248,480.85	225,891.68	1,344,055.50
Suffolk opex	2,546.24	4,998.18	7,261.51	9,336.23	11,222.33	35,364.50
NWG capex	6,409,987.17	6,322,647.89	6,224,014.03	6,125,380.17	6,026,746.31	31,108,775.58
NWG opex	66,201.30	131,409.69	195,530.86	258,564.83	320,511.58	972,218.26
NWG totex	**6,476,188.46**	**6,454,057.58**	**6,419,544.90**	**6,383,945.00**	**6,347,257.90**	**32,080,993.84**

Meters introduced by companies (line 24)

Table 10: Whole Area Metering installation numbers and costs (Essex only)

	2020/21	2021/22	2022/23	2023/24	2024/25	total
Replacement	nr	nr	nr	nr	nr	

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numbers

Installation numbers (Essex only)	10,000	10,000	10,000	10,000	10,000	50,000
Costs	£	£	£	£	£	£
WAM totex	**642,785.42**	**649,425.00**	**656,064.58**	**662,704.17**	**669,343.75**	**3,280,322.92**
WAM capex	636,145.83	636,145.83	636,145.83	636,145.83	636,145.83	3,180,729.17
WAM opex	6,639.58	13,279.17	19,918.75	26,558.33	33,197.92	99,593.75

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Table 11: Upgrading meters to smart meters on replacement – numbers and costs

	2020/21	2021/22	2022/23	2023/24	2024/25	total
Replacement numbers	**nr**	**nr**	**nr**	**nr**	**nr**	
NW replacements	30,984	30,983	30,983	30,983	30,983	**154,916**
E replacements	24,787	24,787	24,787	24,786	24,786	**123,933**
S replacements	6,197	6,197	6,197	6,196	6,196	**30,983**
NWG replacements	**61,968**	**61,967**	**61,967**	**61,965**	**61,965**	**309,832**
Costs (capex only)	**£**	**£**	**£**	**£**	**£**	£
NW smart upgrades	774,580.28	774,580.28	774,580.28	774,580.28	774,580.28	**3,872,901.39**
Essex smart upgrades	619,664.22	619,664.22	619,664.22	619,664.22	619,664.22	**3,098,321.11**
Suffolk smart upgrades	154,916.06	154,916.06	154,916.06	154,916.06	154,916.06	**774,580.28**
NWG smart meter upgrades	**1,549,160.56**	**1,549,160.56**	**1,549,160.56**	**1,549,160.56**	**1,549,160.56**	**7,745,802.78**

Risks, uncertainties and further work

The draft Water Resource Management Plans commit publicly to a specific number of installations. The additions we are proposing to the numbers included in these will need to be explained in our final WRMPs although we do not expect to receive any challenge to this.

The efficiency of Whole Area Metering depends on how easily we can exploit the existence of readily installed meter boundary boxes. Gathering a comprehensive record of the number and, more particularly, the location of empty meter chambers has been more challenging than anticipated and delayed the progress of WAM. However, work is ongoing as we are committed to beginning the WAM programme in 2018. We will therefore be well prepared to deliver our plans by 2020.

Committing to deliver smart metering is ambitious and it will be a significant challenge to deliver it. While other water companies are doing trials with wide area networks we will be the first water company to use them at scale and there will be challenges to overcome which we have not foreseen. However, a meter steering group has already been formed of internal experts who are laying the groundwork for delivering smart metering by 2022. We have already factored an element of risk into our costings and are consulting with industry experts to help us plan as effectively as possible.

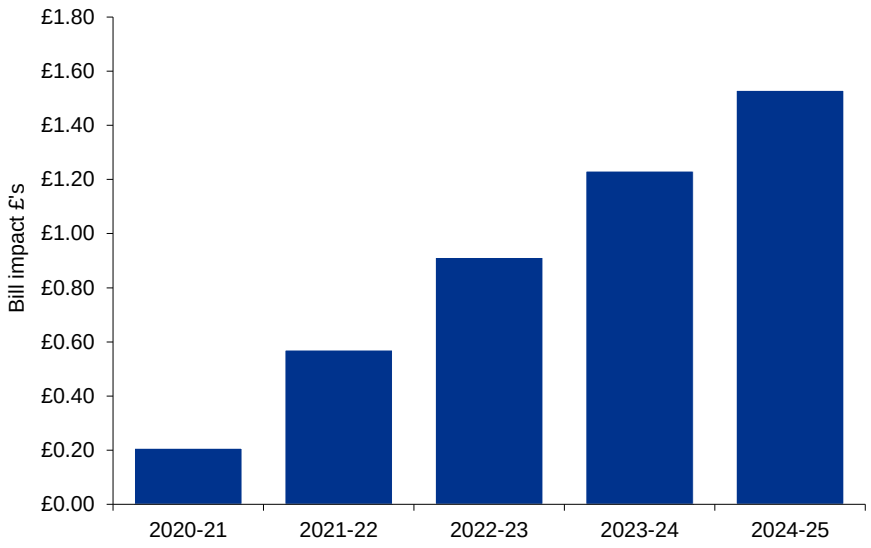
The legacy of our new plan will be a higher meter replacement cost although we anticipate the cost of smart meters should reduce in the near future as demand shifts away from analogue or AMR meters to AMI meters.

Our proposed meter location policy will have its challenges. A large number of our meter installations are currently made in the public highway because this is where most customers prefer to have them. However, this choice of location is becoming unjustifiably expensive. We will develop a customer communication plan around all the changes to our approach to metering and our people will be trained on how to handle conversations with customers. Customers will still have a choice of three meter locations or can be offered an assessed measured charge.

Wall boxes are not yet being used by other water companies and we see this as a huge missed opportunity. Because of this there is a degree of uncertainty about the proportion of homes which can be metered with a wall box. We have carried out an initial test survey on the proportion of properties which can practically be metered in this way and we are conservatively assuming that 40% will be meterable with a wall box in our costings. Our goal will be to meter at least 50% of optants with wall boxes. We need to overcome the basic objection to wall boxes which relates to their appearance and find a supplier who can produce products which are more visually appealing and practical as well.

Affordability

The impact of these enhancement investments on customer bills is shown below[5].



Overall the analysis shows that the bill impacts would be around £0.89 a year. Rising from £0.21 in year 1, to £1.53 in year 5.

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[6] driving significant improvements to average customer affordability.

[5] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.

[6] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

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We shared details of our plans with customers at two phases of discretionary enhancement research with 193 customers. Participants were asked if they would be willing to return a portion of the 10% bill decrease we had committed to giving to fund this and other enhancements. Acceptance levels were as follows:

Table 12: Customer support for funding smart metering as an enhancement

		'yes' votes	'unsure' votes	'no' votes
Phase 1	NW	62%	16%	22%
	ESW	64%	29%	7%
Phase 2	NW	43%	17%	40%
	ESW	61%	9%	30%

The results above show broad support for our plans, with the exception of the results from NW customers in phase 2. Our Water Forum saw the results as showing a reasonable level of customer support.

The overall position in the plan will reduce bills considerably in AMP7 at a time of expected real earnings increases. However, we recognise that affordability will remains a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 2030[7] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

Alignment with stakeholder needs

Regulators and other stakeholders

We believe our plans will meet the expectations of our regulators given that we have paid close attention to their clear views expressed through multiple recent publications. It is expected that Ofwat and the EA will welcome our plans to introduce smart metering, and in particular our ambition to using new technology for more affordable data transmission (wide area networks). The efficiencies we have identified will doubtless also be regarded in a positive light. Ofwat in particular are looking for companies to become more efficient and demonstrate what can be achieved across the industry by setting an example.

What is more important, however, is what we plan to do achieve through metering and with smart technology. Delivering zero water poverty and leading service both inside and outside the water industry are at the top of our agenda for 2020-25. Smart water metering will play a crucial enabling role in delivering our plans in these areas.

Customer protection

We are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not

[7] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

developed or delivery is delayed. To protect our customers we will apply a penalty rate for underperformance against this enhancement. As this enhancement targets a number of specified units as an output, we have based our penalty on a per unit basis. We will incur a penalty to the value of the number of units we achieve below our Performance Commitment (PC). For example, a PC of 10 and an actual performance of 9 would incur a penalty of 1/10th the value of customer funding received.

Any penalty will be calculated as a net present value neutral adjustment as part of the PR24 true up process of the relevant 2019 Final Determination cash flows should the outcome be delivered partially or not at all. The discount rate used will be 3.3% real, the CPIH stripped cost of capital.

Further details of our enhancements delivery incentive mechanisms are included in Chapter 4: Measuring and Incentivising Success of our final business plan.

The unit rates per meter payable in the event of non-delivery are summarised below. (No adjustment would be made in the event of delivering any more than we have planned for.)

Table 13: Unit rates payable for non-delivery

	Number of meters	Unit rate payable for non-delivery
New installations	163,094	£182.31
Replacements	309,832	£75.89

Board assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers"."[8].

[8] See Board Assurance Statement

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Wastewater Water Industry National Environment Programme (WINEP) Business Case

WWS2 - Wholesale wastewater capital and operating enhancement expenditure by purpose Lines 6, 7, 9, 10, 11, 12, 13, 16, 18, 19, 20

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WASTEWATER WINEP

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WASTEWATER WINEP

Executive summary

This business case is for the Wastewater Water Industry National Environment Programme (WINEP) enhancement plan. Enhancement expenditure provides an identifiable, measurable and permanent step change in overall level of service to existing customers above the standard previously provided. These enhancements are detailed in the Ofwat Table WWS2 Wholesale wastewater capital and operating expenditure by purpose and are summarised in the following table together with the Totex breakdown (£M). This indicates the relevant Ofwat table lines and cross references with the appropriate environmental objective, Directive and EA WINEP drivers:

Directive	EA Drivers	Ofwat Table WWS2 Line references	Description	Totex £M
Urban Wastewater Treatment Directive (UWWTD) and Bathing Water Directive	UMON1,2,3,4, BWMON, UIMP4, UIMP5, UIMP6 and BWND	Lines 6,7,9,10 and 11	Treatment capacity to deal with Increased Flow to full treatment (inc. Storm tank storage). Flow and spill frequency measurement. Increased network storage capacity to prevent deterioration to Bathing and river water quality.	£56.7M
WFD Nutrients	WFDND, WFDIMPg,m,p	Lines 18,19, 20	Treatment to remove phosphorus and / or ammonia in order to meet WFD river water quality standards with the aim of meeting Good status	£99.6M
WFD Chemicals	WFDIMP, ND and NDLS	Lines 12	Removal and prevent deterioration of chemicals	£7.5M
WFD Chemicals	WFDINVCHEM1-14	Line 13	Chemicals Investigations as part of National CIP3 Programme	£1.9M
Investigations	UINV2, HDINV, BWNDINV, BWINV4	Line 16	Bathing waters investigations, raising ambition to excellent, plus specific investigation measures.	£8.2M
Total Wastewater WINEP				£173.9M

Completion of these enhancements are mandatory as regulatory commitments. Ofwat and the EA expects funding requirements to be accounted for in the Company's PR19 Business Plan to account for WINEP obligations. They will enhance the capacity and quality of services beyond current levels and support our Environmental outcomes. The EA's environmental outcome identified as the measure of benefit in WINEP3 (as measured by the EA's key performance indicator (KPI)), is 'length of waterbody enhanced in kilometres (km)'. The total km river length improved by the wastewater drivers covered by this business case is 186 km.

We know many of our customers use amenity areas to access the water environment (rivers, becks and streams, lakes and reservoirs, coasts and beaches). This can make them healthier and happier. We know that our customers are generally satisfied with current standards of bathing water quality, but would like more facilities and cleaner beaches. We also know that they have different ways of judging water quality at rivers and beaches to regulators and stakeholders and that their priorities for improvement do not always align with regulatory targets. We have to take this into consideration when ensuring that what we deliver as a WINEP enhancement is fully justified and cost beneficial.

The business case demonstrates how the WINEP enhancement schemes have been developed and agreed with the EA, and the level of support and engagement received by customers and Water Forum representatives. The business supports inclusion of **all** of the certain WINEP3 enhancement obligations (amber and green certainty categories) and will make allowance for their inclusion within the plan.

The key elements of the business case can be summarized as follows:

Name of claim	Wastewater WINEP (Water Industry National Environment Programme)
Name and identifier of related claim submitted in May 2018	N/A
Business plan table lines w here the totex value of this claim is reported	WWS2 Lines 6,7,9,10,11,12,13,16,18,19,20
Total value of enhancement for AMP7	£173.9M
Total opex of enhancement for AMP7	£0.0M
Total capex of enhancement for AMP7	£173.9M
Depreciation on capex in AMP7 (retail controls only)	[n/a]
Remaining capex required after AMP7 to complete construction	[Expected to complete scheme by date specified in WINEP – all AMP7 completion.
Whole life totex of claim	N/A
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No

Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	Material	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		No
Need for investment/expenditure	Completion of these enhancements are mandatory as regulatory commitments. Ofwat and the EA expects funding requirements to be accounted for in the Company's PR19 Business Plan to account for WINEP obligations. The need for specific expenditure against each EA driver (driven by UK Regulations and EU Directives) are detailed within this business case.	
Need for the adjustment (if relevant)	n/a	
Outside management control (if relevant)	n/a	
Best option for customers (if relevant)	Optioneering has been dependent on the level of certainty and prescriptive detail behind each driver. The best solution has been proposed for the level of detail and certainty known at the time of submission. We are proposing a cost adjustment mechanisms that will protect customers against late or non-delivery of enhancement schemes.	
Robustness and efficiency of claim's costs	NWL has assessed the costs through a structured and robust approach, involving benchmarking of cost estimates against alternatives. The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018.	
Customer protection (if relevant)	An appropriate cost adjustment mechanism is proposed and outlined within this document. Further detail is also presented in Appendix 3.9 of the business plan.	
Affordability (if relevant)	Overall the analysis shows that the bill impacts would be rising from £0.25 a year (year 1) to £5.33 a year (year 5). This is set within an overall bill drop of more than 12% (wastewater) in AMP7, including all enhancement investments, one of the largest across the sector.	
Board Assurance (if relevant)	The details of all our enhancement cases have been discussed with our PR19 Board Sub-Committee and full Board both prior to plan	

	submission and following IAP. During these discussions the board sub-committee have challenged the details of our enhancement proposals in a number of ways which are reflected in our final enhancement cases.

Context and Scope

This business case is for the Wastewater Water Industry National Environment Programme (WINEP) enhancement plan. Enhancement expenditure provides an identifiable, measurable and permanent step change in overall level of service to existing customers above the standard previously provided. Completion of the WINEP will enhance the capacity and quality of services beyond current levels and support our Environmental outcomes.

The Water Industry National Environment Programme (WINEP), formerly known as the National Environment Programme (NEP), is a national investment programme for all water only and water and wastewater companies. It includes investigations, monitoring, options appraisals and schemes to drive improvements and prevent deterioration and protect the water environment. These commitments form part of each water company's Asset Management Plan (AMP) and form a set of regulatory obligations which must be delivered.

The WINEP is a key part of the overall programme of measures to meet the requirements of the Environment Agency (EA)'s Water Industry Strategic Environmental Requirements (WISER) document. This includes objectives to meet Water Framework Directive (WFD) 'Good' status in our rivers by 2027 and prevent deterioration in status, together with other international regulatory drivers including the Urban Waste Water Treatment (UWWT) and Habitats Directives.

At NWL, we recognise our role in meeting water quality objectives for rivers and coastal waters, but we aim to ensure that our customers' money is spent on well justified cost beneficial schemes that will deliver real improvements to water quality and ecology. To achieve this, we have worked very closely with our local and national EA River Basin Management Service (RBMS) representatives, through smaller technical specialist areas and sharing of knowledge from work undertaken with other external groups and stakeholders, to agree the obligations included in the PR19 WINEP and ensure all of the requirements identified in the WISER document are covered.

In addition to WISER, the EA has provided a comprehensive series of guidance documents; PR19 Driver Guidances and Guiding Principles[1]. These were shared with water companies and Natural England in order to assist in the collaborative development of WINEP.

The EA has adopted an iterative approach to development of the Water Industry National Environment Programme (WINEP) for PR19. There have been three releases:

- WINEP1 in March 2017 focused largely on water resources actions to inform draft Water Resource Management Plans and included only some wastewater schemes;

[1] PR19 Driver Guidances and Guiding Principles – received via EA Account Manager – River Basin Management Service

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- WINEP2 in September 2017 provided the latest position on the environmental measures to include in PR19 plans;

- WINEP 3 published on 29th March 2018 was the final update and includes a comprehensive list of schemes to be included in company business plans.

The WINEP is published in spreadsheet format, with each line being a commitment to be undertaken. The level of certainty for each line is classified as green (certain evidence and cost beneficial, must be undertaken), amber (certain evidence and cost beneficial, requires further approval), red (uncertain evidence and/or non-cost beneficial) or purple (intended to provide a direction of travel for potential future work areas that may inform business plans beyond PR19). The certainty of schemes changed between each iteration of the WINEP as the EA gathered additional evidence to support inclusion.

WINEP does include schemes which will not have to be undertaken in AMP7 (red category of certainty scheme names have been included as a separate tab in WINEP3). The EA expect to see cost allowances in company business plans for all green and amber measures in WINEP3. NW and ESW has decided that we will treat ambers as if they were green in that we expect to deliver all of the amber and green schemes and investigations unless better, more efficient delivery mechanisms can be identified. Any alternative proposals (such as catchment partnership projects) would need to be approved by the EA and logged via a formal change protocol procedure. An appropriate cost adjustment mechanism will be proposed (in accordance with the Ofwat methodology reference section 9.4.3) in order to ensure our customers are not paying for schemes and outcomes that have not been delivered.

This business case covers the wastewater elements of WINEP only. As we do not manage wastewater in our ESW operating area, the commitments referred to here are only relevant to our NW operating area.
These enhancements are detailed in the Ofwat PR19 Table 'WWS2 Wholesale wastewater capital and operating expenditure by purpose', and are summarised in the Table 1 below. This indicates the relevant Ofwat table lines and cross references with the appropriate environmental objective, Directive and EA WINEP drivers:

Table 1 PR19 Wastewater WINEP Enhancements - Ofwat Table WWS2 lines cross-referenced with EA WINEP Objective (Directives and Drivers) – Note: References to source in Section 7.

Directive	EA Drivers	Ofwat Table WWS2 Line references	Description
Urban Wastewater Treatment Directive (UWWTD) and Bathing Water Directive	UMON1,2,3,4, BWMON, UIMP4, UIMP5, UIMP6 and BWND	Lines 6,7,9,10 and 11	Treatment capacity to deal with Increased Flow to full treatment (inc. Storm tank storage). Flow and spill frequency measurement. Increased network storage capacity to prevent deterioration to Bathing and river water quality.
WFD Nutrients (Sanitary	WFDND,	Lines18,19,20	Treatment to remove phosphorus and / or

Directive	EA Drivers	Ofwat Table WWS2 Line references	Description
parameters)	WFDIMPg,m,p		ammonia in order to meet WFD river water quality standards with the aim of meeting Good status
WFD Chemicals	WFDIMP, ND and NDLS	Lines 12	Removal and prevent deterioration of chemicals
WFD Chemicals	WFDINVCHEM1-14	Line 13	Chemicals Investigations as part of National CIP3 Programme
Investigations	UINV2, HDINV, BWNDINV, BWINV4	Line 16	Bathing waters investigations, raising ambition to excellent, plus specific investigation measures.

Sections 2, 3, 4, 5 and 8 of this document are applicable to all areas of the wastewater WINEP.

Sections 6 and 7 are broken down into sections specific to the Directives listed in Table 1 above.

- Urban Wastewater Treatment Directive (UWWTD) and Bathing Water Directive
- WFD Nutrients (Sanitary parameters)
- WFD Chemicals – Improvement
- WFD Chemicals - Investigations
- WINEP Investigations – Supporting information for PR24 planning

Customer and Stakeholder expectations

We have undertaken specific research and workshops events to better understand our customers' support to improving river water and bathing water quality.

Delivery of WINEP is a statutory requirement and hence not dependent on customer support, however our plan is stronger for knowing that customers do support this.

The following timeline illustrates how we have engaged our customers, key stakeholders and our Water Forum members during development of and to gauge support of the WINEP enhancement programme.

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Customer expectations

From our PR19 customer research and our tracking surveys we understand that:

- Our customers expect that we will be responsible and effective custodians of the environment and trust that we will make the right environmental decisions;
- Sewage treatment and disposal services are not a 'top of mind' concern for customers;
- Our customers feel the quality of our rivers needs improvement;
- Our customers value the environment and believe that we should be working in partnership to protect and enhance it.

As part of our customer research for PR19, we asked customers to review service areas across the business (eight for NW and six for ESW), and adjust slider positions representing investment in them for different levels of performance. Support for improvements in the accessible water environment came second, after pollution (which also impacts on the environment).

We tested our strategic themes for PR19 with our customers at our Innovation Festival in July 2017. Customers were very supportive of the strategic themes, were surprised by the amount of 'work' that goes into cleaning their waste and were encouraged by our partnership approach to preventing pollution.

Our customer research into river water quality expectation based on two local deliberative events in 2016 concluded there was an overall balance of support for investment to improve river water quality, except from those who saw no personal gain (non-river users). Customers do not want to be the only ones 'footing the bill' and want us to focus more on prevention to reduce costly intervention. Overall there was more support for investment if the benefits to local society are fully understood.

The available research for bathing waters suggests that improving bathing water quality at our beaches is a 'medium priority' to customers. When prompted, there is a desire for bathing water to be of the highest quality, with between 61% of non-users and 76% of beach users agreeing that they'd like the region's beaches to be the cleanest in England. However, in our 2015 Bathing Water research, only a minority (24%) of customers were willing to pay more on their bill to improve the

quality of sea water at the (less than Excellent) beaches they regularly used, with 24% agreeing they would be willing to pay more to make sure sea water at all 32 bathing beaches in the North East are classified as Excellent.

We know many of our customers use amenity areas to access the water environment (rivers, becks and streams, lakes and reservoirs, coasts and beaches). This can make them healthier and happier. We know that our customers are generally satisfied with current standards of bathing water quality, but would like more facilities and cleaner beaches. We also know that they have different ways of judging water quality at rivers and beaches to regulators and stakeholders and that their priorities for improvement do not align well with all regulatory targets.

Stakeholder expectations

In addition to the EA as a key regulator and local partner, we also work in partnership with a wide range of other stakeholders within our catchments.

Our core business in abstracting water from reservoirs, rivers and groundwater, treating and supplying water and then treating wastewater and returning it to rivers and the sea, means that we play a significant role in the environment. However, there are many other organisations that have responsibilities towards the environment and work in this area. As NWL, we have over 25 years of experience of successful partnership working in the environment, and our work with environmental partners is very important to us.

We are very active participants of the five Catchment Partnerships in our NW operating area, supported by Defra's Catchment Based Approach (CaBA) which was launched in 2013. Together we are working to protect and enhance the water environment and improve WFD water bodies and their catchments.

In 2017, we ran a series of Thinking Ahead workshops with our environmental partners, engaging over 80 environmental organisations within our regions at both catchment and regional level. We know from this engagement that our partners expect us to:

- Build stronger local engagement with existing partnerships, communities and land managers to deliver improvements for common benefit;
- Continue to support the Catchment Based Approach and to strengthen our partnership working, recognising the successes and opportunities this can bring;
- Use our core business plan investment against regulatory obligations in the WINEP to support catchment investment through partnerships to deliver multiple benefits which will improve the water environment (i.e. not just single issue focused);
- Play a leading role in developing regional partnership ambitions for the water environment which will help link the activities and aspirations of different partnerships.

Water Forums (Customer Challenge Group (CCG))

We provide regular updates to the Customer Challenge Group (CCG) on the progress of WINEP development as part of our 'Regulatory Update'. These are documented and saved in the Water Forum Sharepoint area. We have also provided a number of working group sessions specifically for the 'Environment network' members of the CCG. These include the following sessions:

- February 2017 – Presentation of the customer research on bathing waters and river water quality.
- December 2017 – Catchment discussions with Water Forum members.
- April 2018 – 3 working sessions including presentation of the company's proposed enhancement schemes, including statutory enhancements such as the WINEP.
- May 2018 – Water Forum environment network – discussion on the overall environment theme including overview of WINEP and our wider environment ambitions.

Feedback from the Forum at the April Enhancement sub-group (17th April 2018) was generally supportive of the size of the WINEP:

Members asked John Giles (EA) if the EA considered the programme to be good, bad. They were surprised it is not bigger than it was, considering the size of other Companies' programmes. JG said the smaller submission was good, it reflected on asset base. The EA had worked very closely with the company to produce the WINEP programme; there were not many things missing; it was about right; the message that this was statutory was important as well. The Company said there were other reasons for the lighter submission. The rivers in the north were generally good; also the bulk of population was on the coast - this meant there are not many big discharges are made upstream. Other companies, which discharge upstream, had larger investments to make.

Feedback did include a request from the Water forum to emphasise benefits to the customers of the increase in Wastewater WINEP programme from that required in PR14. It was suggested that this could be undertaken jointly with the EA to explain the costs and benefits. The EA confirmed that the measure of benefit they use is km of enhanced river. This is included in WINEP as the measure of benefit. We have also included our own separate wider environment measure which is 'length of accessible water environment improved for the benefit of our customers and communities' (km), which is over and above our regulatory obligations.

Current and historical service delivery and expenditure

Environmental Performance Assessment (EPA)

The Environmental Performance Assessment (EPA) was introduced by the EA in 2011 as a tool for comparing performance against environmental obligations between water companies across years. It therefore provides a useful tool to demonstrate our historical performance against delivering environmental improvement schemes (NEP).

We aspire to be a 4* company under EPA within AMP7. This reflects our ethical stance, and our commitment to be responsible and do the right thing. EPA includes measures for discharge compliance for STWs and Water Treatment Works, pollution, and bathing water compliance. We intend to maintain or improve our environmental performance in all these areas and improve our performance overall within AMP7.

For the year April 2015 to March 2016 (published July 2017), all companies have reported 100% delivery of their planned work on water quality improvement schemes.

The EPA is changing for reporting on progress between April 2016 and March 2017 and beyond, to include schemes associated with water resources and fisheries, biodiversity and geomorphology within companies' Asset Management Programmes (AMP).

The following diagram shows a history of EPA results (source: EPA Published July 2017[2]):

[2]Water and Sewerage companies performance 2016 – published July 2017

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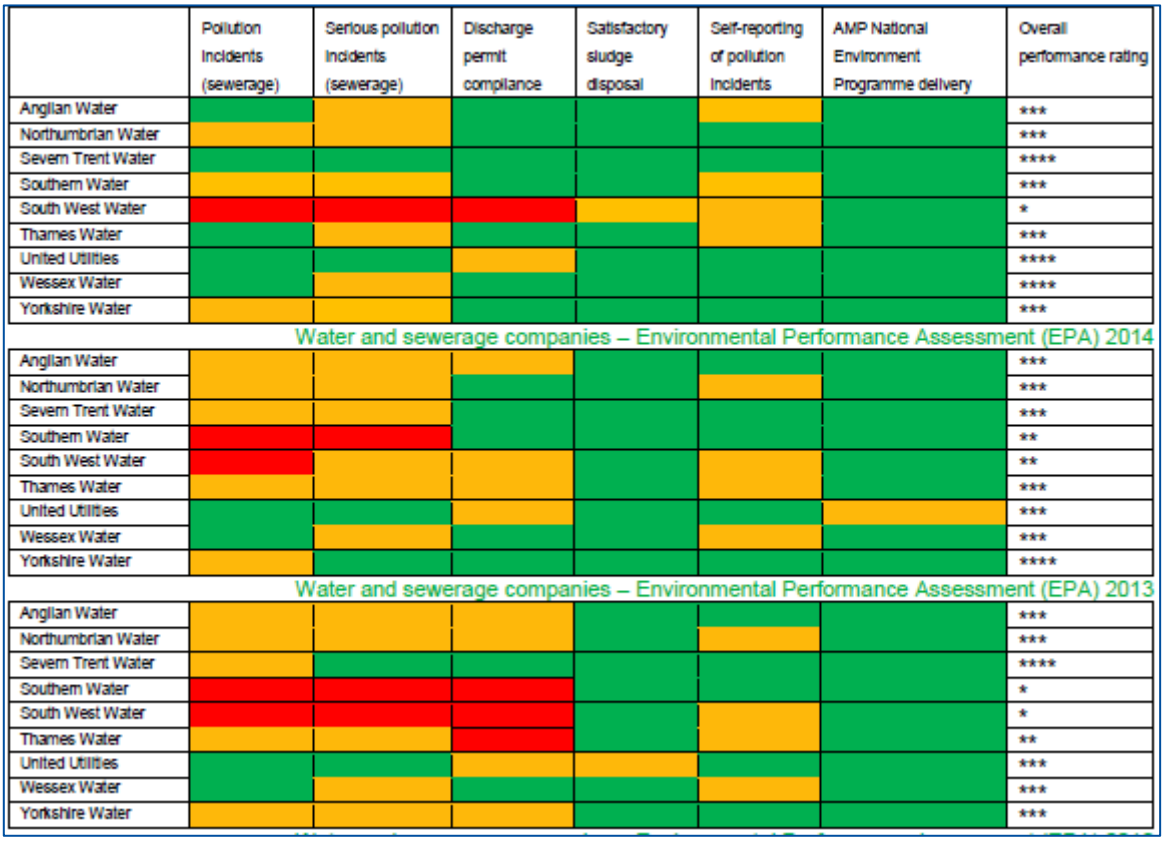

	Pollution incidents (sewerage)	Serious pollution incidents (sewerage)	Discharge permit compliance	Satisfactory sludge disposal	Self-reporting of pollution incidents	AMP National Environment Programme delivery	Overall performance rating
Anglian Water							***
Northumbrian Water							***
Severn Trent Water							****
Southern Water							***
South West Water							*
Thames Water							***
United Utilities							****
Wessex Water							****
Yorkshire Water							***

Water and sewerage companies – Environmental Performance Assessment (EPA) 2014

Anglian Water							***
Northumbrian Water							***
Severn Trent Water							***
Southern Water							**
South West Water							**
Thames Water							***
United Utilities							***
Wessex Water							***
Yorkshire Water							****

Water and sewerage companies – Environmental Performance Assessment (EPA) 2013

Anglian Water							***
Northumbrian Water							***
Severn Trent Water							****
Southern Water							*
South West Water							*
Thames Water							**
United Utilities							***
Wessex Water							***
Yorkshire Water							***

Past delivery of environmental obligations in NEP and WINEP

In 2014 Ofwat set the prices that water companies could charge their customers between 2015 and 2020. As part of that price review the EA developed a programme of environmental improvements, the National Environment Programme (NEP), which water companies needed to make over that period to ensure that they meet legal environmental standards related to water.

The NEP includes schemes, investigations and monitoring to improve and protect both water quality and water resources.

In identifying waste water quality improvements for AMP6 supported by the National Environment Programme (NEP) we adopted a similar approach to that adopted in PR19 planning. We worked closely with the EA to ensure that the regulatory requirements identified in the NEP, were both justified and cost-effective.

In AMP6, we are investing £61m in wastewater schemes in the National Environment Programme (former name for the WINEP). This includes investment to meet UWWTD objectives (P removal), plus Phosphorus and ammonia removal to prevent deterioration, or improve the WFD status, together with Chemicals, WFD and Bathing Water Investigations.

AMP6 includes significant investment in phosphorus (P) removal schemes from our sewage treatment works (STWs), which has been the key element of environmental investment for several AMP periods and contributed to improvements in concentrations of phosphorus in river water

quality. The following table demonstrates the increase in phosphorus load removed over the last 3 AMP periods.

	Pre AMP5	AMP5	AMP6	AMP7
P load removed (kg/day) *	318	101	147	162
Number of schemes	10	5	8	29
Average P removal per scheme (kg)		20	18	5.6
Cumulative P load removed (kg/day)	318	419	566	729

* Assumes 5 mg/l in the influent

We have satisfied our obligations to meet all of our AMP6 NEP obligations to date. This includes sign off of obligations up to March 2018. We have some obligations remaining with completion dates up to the end of the AMP (March 2020). We regularly meet with the EA to discuss progress against these obligations and keep them updated on progress against the delivery dates. We have not identified any issues against completing all of the NEP obligations in accordance with expectations. This will contribute to the EPA score and our objective to become a 4*company.

The environmental outcome identified in the AMP6 NEP as a measure of the benefit of satisfying the NEP obligations is 'km river length improved'.

The following improvements are being reported (Ofwat PR19 tables) based on the km length improved quoted for wastewater schemes in NEP Phase 5 Version 1 29 January 2016:

2015-16	2016-17	2017-18	2018-19	2019-20
38km improved	0	77 km improved	0	1.3 km improved

This measure of benefit has been further clarified for PR19 through the introduction of the EA's key performance indicator (KPI) of length of waterbody enhanced:

'Whilst good ecological status is the ultimate aim of the work that we all deliver, the lag time and complexity inherent to the formal classification system mean that ecological status has not always reflected the great work being undertaken by stakeholders in the water environment. To complement classification data, we have created a new measure focussing on the length of water body enhanced in kilometres.'[3]

[3] EA's external briefing note: '161026 km enhanced external brief 1'

Forward looking analysis

Future planning for WINEP is focused on meeting regulatory obligations under the EU/UK Directives and Regulations (UWWTD, WFD, Habitats, Bathing Waters etc.). These obligations will enhance the capacity and quality of services beyond current levels and will go above and beyond maintaining our current impact on river water quality. We have worked closely with the Environment Agency (EA) to identify these enhancement activities which will be supported by the WINEP. A key aim is to ensure that our customers' money is spent on well justified schemes that will deliver real improvements to water quality and ecology.

Improvement schemes identified in the WINEP will result in the introduction of permit changes to reflect the improvements required to river water quality. Compliance with these revised permits is therefore subsequently encapsulated within our discharge compliance Measure of Success, and will also impact on our target to become a 4* company under EPA within AMP7. The benefits will also contribute to the EA's key performance indicator (KPI) measure to quantify the actual improvements made (length of waterbody (km) enhanced).

It has been important to ensure we identify the right balance between meeting our regulatory obligations (to avoid the risk of UK Infraction), delivering meaningful improvements to the biology of our rivers, whilst also reflecting the improvements that matter to our customers and stakeholders.

We have a long term obligation to address our contribution to achieving 'good' status in our rivers by 2027 under The Water Framework Directive (WFD). In meeting this obligation, we will aim to work in partnership with internal and external stakeholders to attain the necessary sustainable improvements in river water quality, supporting a catchment-based approach to managing the water environment.

We have been undertaking extensive Investigations this AMP (AMP6) to understand our Environmental (WINEP) obligations for the next AMP (AMP7). For example, trialling technologies (in a National Programme) this AMP to understand what is technically achievable to meet tighter phosphorus standards, what treatment technologies are available and whether there are more innovative and sustainable solutions to meeting phosphorus good status in our rivers. These investigations have also helped to clarify our responsibilities with regard to chemical removal.

Under WISER guidance, water company obligations in AMP7 for WFD should be delivered under a 'fairshare' approach, where water companies remove only their portion of P and ammonia to address a reason for 'not achieving good status' (RNAG). In order for our customers to see the benefit of this investment, other responsible sectors must also play their part in reducing P concentrations in waterbodies. This presents a particular concern around agricultural diffuse pollution, the major secondary contributor to RNAGs for P and ammonia, and is a recognised risk to meeting the required river water quality improvements.

We are in a good position in relation to WFD assessments for our NW rivers and for bathing waters. Further investment in AMP7 will move us closer to delivering our fair share to meeting WFD good status targets, and improve our bathing waters towards excellent.

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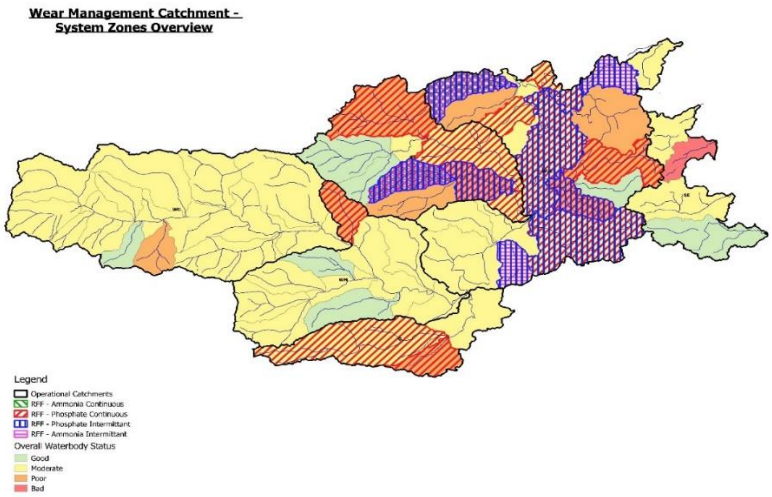
Forward looking analysis - Early work (Pre issue of PR19 WINEP and EA Driver Guidance documents)

Based on our PR14 NEP methodology, we continued to work with the EA, using the tools developed during AMP5. Our Environmental performance tool (EPT) is a GIS based tool that trends river water quality. This is used as an asset management tool to inform our asset planning team, as part of risk based prioritisation, on the impact of our assets on the downstream river quality status. It also helps us as a longer term planning tool to consider how we can aim to meet WFD good status by 2027.

At catchment level:

Using catchment maps we were able to identify waterbodies where NWL are identified by the EA as the RNAG (ref. map below) and whether this was due to continuous or intermittent source. We were then able to identify shortlist at catchment level, where assets within a waterbody are clearly having an impact on downstream water quality and move to an operational catchment review.



At Operational catchment level:

Using operational catchment level maps (indicating river water quality at reach level – see Map of the Browney catchment below) we were able to review the impact of STWs (working from top of catchment to bottom), and identify a short list of sites where further improvements should be modelled.

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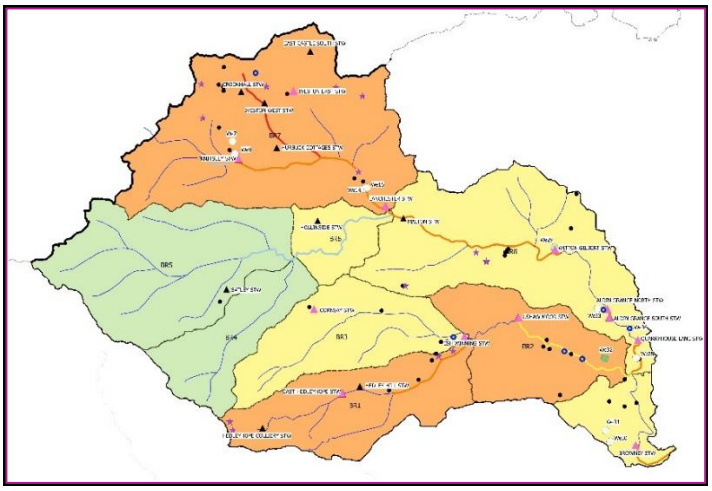

In addition to mapping river water quality in our area, we have also developed internal capabilities in the use of modelling tools including the Source Apportionment GIS tool (SAGIS) developed by the EA and supported by the Water Industry, and the EA's Optimiser tool, both of which can be used to 'scenario test' the impact of improvements on the downstream river water quality. These modelling tools have been used in conjunction with our local EA in the development of short list locations where improvements to the treatment capability of an STW could have a significant benefit on the downstream river water quality with respect to WFD status.

Identification of schemes for WFD drivers has been dependent on the certainty of biological evidence. Schemes have only been included where it is either **very certain** or **quite certain** that there is a confirmed link between the water company's activity, normally an STW discharge, and a failure to meet the required standards in the receiving water (and for nutrient failures, sufficient certainty of eutrophication). The EA provided us with their assessment of the level of certainty of biological evidence.[4]

The development of EA Strategies have been dependent on the output of AMP6 investigations including development of the strategy on chemicals and the outputs from Chemical Investigations Programme (CIP2).

Many decisions have depended on ongoing debate within Investigations Steering Groups (e.g. Chemicals Investigations Programme (CIP2)), and water industry (Water UK) or SWQWPG Task and Finish (T&F) Groups including for example:

- 21st Century drainage Spill frequency reduction T&F group;
- Chemicals T&F Group;
- Flows T&F Group;
- Phosphorus Permitting T&F Group.

Technical discussion with local EA has generally been split into the following sub-groups and is still ongoing:

- Water Quality;
- Water Resources;
- Fisheries, Biodiversity and Geomorphology (FBG).

[4] EA's Copy of first cut P sites for PR19

Notes of these discussions and agreed outputs have been recorded and held in Livelink. These are referenced in the individual Methodologies.

Catchment Partnerships

We are active participants of the catchment partnerships in our operating area. We support the partnerships and together we are working to protect and improve the water bodies in our area and their catchments

.

We will take an integrated approach to delivering the WINEP, considering catchment solutions where appropriate, and deliver multiple benefits to the environment wherever possible. This will allow us to address our portion of the Water Framework Directive (WFD) 'challenge' and implement improvements in response to other international regulatory drivers including the Urban Waste Water Treatment and Habitats Directives, and contribute to the delivery of national objectives including the Biodiversity 2020 strategy and the NERC Act 2006.

Taking a catchment approach to the WINEP will allow us to demonstrate leadership in the area of water quality and quantity to other sectors and regions. It will also allow us to deliver a significant level of improvement to WFD waterbodies, as measured by the Environment Agency 'kilometres enhanced' metric. This aligns with but is a totally separate from our wider environment measure which is 'length of accessible water environment improved for the benefit of our customers and communities' (km). The latter is over and above our regulatory obligations.

We are currently developing a process to consider opportunities to adopt a catchment based approach as an alternative or in support of our own investment, in order to deliver greater environmental benefits.

Cost Benefit Analysis

The EA undertook catchment economic appraisal for all water body objectives in the 2015 river basin management plans (which covered the period 2015-2021). These were considered legally binding, and no further economic appraisal was required to justify PR19 measures designed to move towards achieving these objectives.

In some cases it was considered appropriate to amend these catchment level appraisals where better information is now available, in order to ensure PR19 funding is used to achieve the best outcomes. Better information may include new or changed information, for example, a new measure could been identified or an alternative measure proposed to one that was previously assessed in an appraisal. Other changes could include updated cost information or more certainty about the benefits of a scheme, all of which may make a case for amending an appraisal. The EA published a guidance document 'Economic appraisal for Water Industry National Environment Programme (WINEP) schemes: guiding principles'[5], which was designed to be applied to potential WINEP schemes expected to bring about an improvement in the status of water bodies. Investigations and schemes to prevent deterioration or achieve protected area objectives are not subject to economic appraisal.

[5] EA guidance document 'Economic appraisal for Water Industry National Environment Programme (WINEP) schemes: guiding principles.

Costs were provided (CAPEX and annual OPEX) by NWL for the measures associated with the WFD drivers by the end of October 2017. This was used by the EA to run CBA at a catchment level[6]. A number of iterations were run with variable results depending on the benefits assumptions[7]. NWL did not propose any alternative to this CBA output. Although site specific CBA would be more appropriate than catchment level, we have not challenged the methodology used and are supportive of the proposed schemes.

The environmental outcome identified in the AMP7 WINEP as a measure of the benefit of satisfying the obligations is 'km river length improved'.

The following improvements are being reported (Ofwat PR19 tables) based on the km length improved quoted for wastewater schemes in WINEP3 published 28/3/2018:

	2020-21	2021-22	2022-23	2023-24	2024-2025	Total
km river length improved	0	0	13	142	32	186

Managing Uncertainty / Cost adjustment

The timeline differences between the PR19 planning and the third cycle river basin management planning for WFD introduce an ongoing level of uncertainty.

The final determination date for PR19 is December 2019 and the provisional ministerial sign off date for the 2021 river basin management plans is December 2021. There is therefore a need to continue with the managing uncertainty approach adopted in PR14 to help manage these timeline differences and to evolve the approach based on the lessons learned.

The EA applied a traffic light system (red, amber, green) during development of the WINEP. The red, amber, green traffic lights system reflects the different levels of certainty associated with the development of measures, economic appraisal and ministerial decisions.

In the PR19 Final Methodology Ofwat has identified (Section 9.4.3) that the anticipated (uncertain / amber) programme will be funded, as long as companies propose an appropriate cost adjustment mechanism to account for any potential discrepancy between the scale of the assumed and confirmed programmes. We have proposed a cost adjustment mechanism in order to ensure our customers are not paying for schemes and outcomes that have not been delivered. We expect Ofwat will use this to make an adjustment at the end of the control period (reference separate Appendix[8]).

Delivery of WINEP obligations will be logged by the EA using a 'Tracking' spreadsheet. This will be used to confirm sign off of delivered obligations, and to confirm that the outputs are satisfied or that

[6] The EA CBA methodology and training sessions

[7] The EA CBA Outputs – provided by local EA

[8] Ref. Document 'WINEP Enhancement cost adjustment mechanism – Appendix 3.9'

change protocol is accepted if the output is changed. It will be used for annual reporting purposes as part of the Environmental Performance Assessment (EPA). Delayed or non-delivery of WINEP schemes will be managed via this mechanism. If the change cannot be agreed with the EA it would be recorded as a failure to comply with the obligation, and would subsequently impact on our EPA scoring. It may also lead to permit non-compliance which may contribute to a penalty against our discharge compliance performance commitment (PC).

The WINEP3 for PR19 is significantly larger than the NEP for PR14. This increase is due to the tightening of Phosphorus consents (reduction in the technically feasible concentration), and the approach to address intermittent spills (both from STWs through addressing FFT and storm tank capacity, and CSOs).

Customer protection

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed. We are proposing a cost adjustment mechanism for enhancement costs that will protect customers against late or non-delivery of those enhancement schemes. If delivery is late, or does not occur at all, a penalty (or return of funding) will be calculated based on the NPV of the difference in cash flows compared to on time delivery. Full details of our enhancements delivery incentive mechanisms are included in Chapter 4: Measuring and Incentivising Success of our final business plan. More detail specific to the cost adjustment mechanism proposed for WINEP schemes is also provided in Appendix 3.9.

Options appraisal

Overview

Optioneering to identify preferred solutions for each WINEP line and driver has been undertaken. This has been at a relatively high level in some instances due to time constraints and in fitting with either the level of information or options available. Operation teams have been involved in optioneering where possible to identify site specific requirements. Slightly differing approaches were adopted for the different driver groups depending on monetary value. These have been detailed in individual Methodologies, but are discussed in brief in this section under the following sub-headings:

- Urban Wastewater Treatment Directive (UWWTD) and Bathing Water Directive;
- WFD Nutrients (Sanitary parameters);
- WFD Chemicals – Improvement;
- WFD Chemicals – Investigations;
- WINEP Investigations – Supporting information for PR24 planning.

Risk Management

Risks and assumptions made during optioneering and costing are appropriate for the current stage of development and level of information available from the EA on the output required to satisfy the regulatory objectives. The EA are required to provide ‘Measures specifications’ for outcomes that do not include a change in permit. These are only partially completed and are not due for completion until late 2018. Clarification of an output may also be dependent on the output of an investigation not yet completed. Optioneering has therefore been undertaken on the information available. Work

will continue with the EA to clarify the scope where uncertainty remains in order to manage any associated risk.

We have proposed a cost adjustment mechanism in order to ensure our customers are not paying for schemes and outcomes that have not been delivered due to any remaining uncertainty as a result of lack of clarity in the output required, or late ministerial decisions. Detail of the mechanism is included in a separate Appendix[9].

Opportunities may exist to adopt alternative mitigation measures involving better, more efficient delivery mechanisms that deliver the same environmental objective. Any alternative proposals (such as delivery via catchment partnership projects) would need to be approved by the EA and logged via a formal change protocol procedure. This is regarded as opportunity rather than risk, and will be managed as such.

Urban Waste Water Treatment Directive (UWWTD) and Bathing Water Directive

Including drivers: UMON1, UMON2, UMON3, UMON4, BWMON, UIMP4, UIMP5, UIMP6 and BWND

(WWS2 Line reference: Lines 6,7,9,10 and 11)

The impact of each of these drivers and subsequent identification of schemes and solutions have been guided via discussion at, and output from:

- Water UK Flow T&F Group (UIMP5, UIMP6, UMON1,2,3 and 4).
- Water UK Intermittents T&F Group (UMON1,2 and 3 and BWMON).
- Completion of EDM tracking sheet and Flow drivers tables and implications to expected investment needs in AMP7 and beyond.

There has been limited need for extensive optioneering under these drivers. Flow monitoring and EDM installation will be based on continuation of existing (AMP6) programmes, adopting lessons learnt etc..

Line 6 - This includes the following WINEP drivers: U_MON1, U_MON2 and BW_MON and U_MON3.

Includes event duration monitoring of storm discharges identified (under the Risk Based Approach to the Monitoring of Storm Discharges).

Line 7 - U MON4 driver - Install MCERTS flow monitoring as close to the overflow as practicable to record FFT at WwTW where the existing DWF MCERTS flow monitoring, or other installed flow monitoring, cannot be readily used to confirm the permitted FFT setting is being complied with when the overflow to storm tanks operates. Assumed eight different costing categories depending on site conditions etc.

Line 9 - U IMP5 – Schemes to increase Full flow to treatment. The WwTW FFT must be increased to up to 3PG+IMAX+3E but no less than maximum daily peak flow. Twenty nine sites were identified

[9] Ref. Document 'WINEP Enhancement cost adjustment mechanism'

in WINEP2. Late guidance issued via the EA as output from the Task and Finish Group (15-12-2017) clarified this interpretation and resulted in a reassessment of criteria and a reduction to sixteen sites in WINEP3. Identification of the sites is detailed in the methodology for this work. Optioneering involved identification of site specific capacity limitations (pinch points), and the need for additional process units to deal with the additional capacity.

Line 10 – UIMP6 - Storm tank capacity must be increased to 68 litres per head or to 2 hrs at maximum flow through the tanks. WINEP2 listed 106 sites. This was reviewed (reference detailed methodology) using up to date data. Cost estimations were developed for additional storm tank capacity at 8 number works where a shortfall was identified. This included: Pittington, Greatham, Melsonby, Lynemouth, Whittingham, Bellingham, Cassop, Hawthorn. This was reduced (Hawthorn removed) to 7 sites in WINEP3.

Line 11 - U IMP4 and BWND - Storage schemes required in the network to reduce spill frequency at CSO's. This includes spill frequency improvement schemes - not yet identified but estimated as output from SOAF (Driver U INV4). We haven't undertaken any SOAF investigations to arrive at the most cost beneficial solution, so the number of schemes actually required may be more or less than this estimate (based on five schemes). The schemes could also be significantly different (solution could be for example to remove surface water rather than for storage alone).

The EA requested completion of the 'NWL PR19 Flow Supplementary Tracker spreadsheet' (returned to the EA on 21-12-2017). NW also issued an accompanying letter which highlighted our concerns around the high cost and low benefits associated with UIMP5 at that time. This included recommendation for a review of the approach and adoption of a proposed stepped approach. Subsequent guidance form the EA resulted in a significant reduction in the required scope (reduction from 29 sites to 16 from WINEP2 to 3).

WFD Nutrients (Sanitary parameters)

Including Drivers: WFD IMPg (good), WFD IMPm (moderate), WFD Imp p (poor), WFD ND (No deterioration), WFD INV (Investigation)
(WWS2 Line reference: 18,19 and 20)

The impact of each of these drivers and subsequent identification of schemes and solutions have been guided via discussion at, and output from:

- Chemicals Investigations Programme (CIP2) Steering Groups (most specifically relating to the phosphorus technology trials);
- CIP2 Outputs and Conclusions;
- Water UK P T&F Group.

The preferred solution for P removal uses the conclusions of the AMP6 national programme to investigate technical feasibility of meeting tighter P standards. This includes chemical dosing (assuming ferric) in all instances, and where tighter standards are required (less than 1 mg/l down to the technically feasible concentration of 0.25 mg/l), the addition of a tertiary solids removal process.

Optioneering involved identification of site specific capacity limitations (pinch points), and the need for additional process units to deal with the additional treatment requirements. An optioneering and costing tool was developed with our cost estimation team on the basis of selecting the following site specific needs, associated directly with knock on effects of meeting the tighter P or ammonia standards:

- Front/back end chemical dosing;
- Alkalinity dosing;
- On-line monitoring;
- Auto desludge requirements;
- Additional sludge storage requirements;
- Additional primary tanks;
- Additional final tanks;
- Tertiary pumping facilities;
- Tertiary solids removal;
- Tertiary Ammonia removal;
- Additional biological filter;
- Paving/Roads etc.

This tool was used to try to identify site specific needs for the purpose of costing for the EA's October deadline.

Further more detailed assessment has been undertaken (November / December 2017) where possible to challenge the site specific costing principle and identify any significant omissions or overlaps with other drivers, including capturing overlaps with growth.

Although we have an aspiration for delivering P removal schemes through catchment solutions, we have not undertaken any option appraisal of potential opportunities at this stage in the plan. This is regarded as an opportunity to improve efficiency and environmental benefit rather than risk, and will be managed as such.

Line 18 – Nutrients – P at activated sludge STWs - WFD IMPg,m or p - Nutrients P removal at activated sludge STWs ; Browney STW
P removal already in place (to meet 2 mg/l). Assume enhanced monitoring and control to meet a 1 mg/l consent.

Line 19 – Nutrients (P removal at filter bed STWs) - WFD IMPg, m or p - Nutrients P removal at filter bed STWs - Phosphorus removal to various concentrations between 0.25 and 1 mg/l (assumed preferred technology of chemical dosing plus tertiary solids removal to meet tighter standards).

Line 20 – Reduction of sanitary parameters - WFD IMP g=good, m=moderate and p=poor - Additional nitrification capacity (assumed addition of NSAF and DBF) at three STW's to either prevent deterioration or meet a tighter consent.
Ammonia at : Sedgeletch
WFD ND Ammonia at : Hutton Rudby and Pity Me
Additional nitrification capacity (assumed addition of NSAF and DBF) at three STW to either prevent deterioration or meet tighter consent to reduce impact.

For our WFD schemes, we will work within CaBA to invest in and manage the water environment with our Catchment Partnerships and engage with other sectors in order for improvements in WFD status to be achieved so that benefits can be delivered for our customers. We will take an integrated approach to delivering the WINEP, considering catchment and sustainable solutions where appropriate, and delivering multiple benefits to the environment wherever possible.

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We initially identified 10 priority catchments to target for catchment approaches. This was later reduced to 8 catchments influenced by the areas in which our partners would like to see improvements delivered, or where we anticipate we can achieve greater improvements by taking a catchment approach and working with the Catchment Partnerships. In developing our plan, we have worked closely with our key partners to understand the potential for catchment approaches, and are supporting and initiating the development of local delivery partnerships in our priority catchments in anticipation of our WINEP investment and fairshare challenge for AMP7. [10]

WFD Chemicals Improvements

Including Drivers: WFD IMP CHEM, WFD ND CHEM, WFD NDLS CHEM
(WWS2 Line reference: 12)

The impact of each of these drivers and subsequent identification of schemes and solutions have been guided via discussion at:

- Chemicals Investigations Programme (CIP2) Steering Groups (specifically the Options Appraisal group);
- CIP2 Outputs and Conclusions;
- CIP2 Options Appraisal reports and costing exercise to meet provisional permit levels provided by the EA;
- Output of EA Economic Appraisal for Chemicals and subsequent Defra guidance;
- Water UK Chemicals T&F Group.

Site specific options appraisals were undertaken as part of the CIP2 deliverables for all sites meeting an agreed set of criteria. Completion of these reports formed part of the overall AMP6 NEP obligations and were submitted to the EA and to the overall UKWIR CIP2 final reporting[11].

Removal schemes and costs are based on the technology trials undertaken as part of CIP2. Costs were developed via CIP2 outputs (using Atkins cost models). These were then validated by our cost estimation team (although limited due to the fact the technologies are in some cases new to the Water Industry).

The schemes may be replaced with monitoring and catchment investigations rather than permits and the requirement to invest to meet the permits if alternative source identification and control can be identified.

Reliability of the technology and removal rates has been questioned and will continue to be debated as part of CIP3 ongoing investigations.

Costs have been provided to the EA for chemical removal schemes where levels in the effluent exceed the permit levels that would be required to meet EQS in the river. These were used in CBA assessment specific to chemicals by the EA.

The following points were included as caveats with regards the cost information provided to the EA on the basis of CIP2 trial outputs:

[10] Catchment and partnership thinking – Catchment management for phosphorus

[11] UKWIR NWL Site Specific Options appraisal reports

- It is not always clear from the Atkins cost models what is and isn't included in the cost estimation assumptions. This means there is a risk of missing items off, or double counting. There will therefore be a high level of uncertainty associated with the costs (+/- 50% or more?);
- There is a high level of uncertainty associated with the technologies, which also sometimes only result in very low levels of success. For example, we could spend a lot of money to achieve an average <10% improvement in one substance (for example Zinc at Aycliffe). In some instances, multiple trials using the same technology have resulted in very different % removal – for example NSAF and DBF has achieved minus 14% removal to plus 19% removal of Zinc. This would mean there is actually a risk of spending large sums of money to make it worse.

- We have gained huge amounts of progress in the trials but there is still high level of concern around the true understanding of what is happening during the treatment, and in the reliability / repeatability of the results. This was discussed at the technology trials workshop. We are a long way from achieving performance guarantees from our suppliers;
- The design basis to guarantee compliance on a 95%ile basis is largely unknown for these substances. We generally design to achieve an average of 50% of the permit in order to meet 95%ile compliance for sanitary parameters. This design basis is yet to be assured for these chemicals. An assumption has been made that this may be closer to 10% for metals;
- Our preferred technology is often NSAF and DBF – this is the process combination that was trialled for all chemicals. Data is not available to indicate removal success of the DBF on its own. Costs are likely to be an overestimate based on the assumption that both technologies are required for metal removal.

WFD Chemicals Investigations

Including Drivers: WFD INV CHEM1-14, WFD MON CHEM
(WWS2 Line reference: 13)

The impact of each of these drivers and subsequent identification of schemes and solutions have been guided via discussion at:

- Chemicals Investigations Programme (CIP2) Steering Groups;
- CIP2 Outputs and Conclusions;
- Water UK Chemicals T&F Group.

High level scoping of the chemical investigations programme has been undertaken as part of a Water UK Task and Finish group on chemicals, and will include a wide range of investigations including into microplastics and anti-microbial resistant bacteria (AMR), sludge, trend monitoring and optimisation of existing treatment solutions. These continue to be debated at the main CIP UKWIR Steering group which is now developing a detailed scope of the elements of the next phase of CIP3.

WINEP Investigations

Including Drivers: BWNDINV, UINV, WFDINV, HDINV and UINV2
(WWS2 Line reference: 16)

The impact of each of these drivers and subsequent identification of schemes and solutions have been guided via discussion at:

- Water UK Flow T&F Group (UINV2)
- Water UK Intermittents T&F Group (UINV).
- Completion of EDM tracking sheet and Flow drivers tables and implications to expected investment needs in AMP7 and beyond.

Investigations have been scoped and costed through discussion with the EA and through the outcome of the T&F groups. There has been limited opportunity for optioneering in these instances.

BW_NDINV (Investigations for waters failing their Baseline class)

Bathing Waters Investigations to prevent deterioration, including marine impact modelling (MIM) at:
Marsden including:
- MARSDEN CSO COAST ROAD (A183) REDWELL LANE STY041
- SOUTH SHIELDS SPS REDWELL LANE

Redcar Granville including:
- NEWCOMEN TERRACE 51 CSO
- GRANVILLE TERRACE CSO

U_INV (UWWTR spill frequency reduction investigation and Cost Benefit appraisal) We have 127 high spilling CSOs on the PR19 EDM Supplementary Tracker.

HD INV - The scope is still unclear regarding the detail required for the Seal Sands Tees catchment partnership support.

WFDINV – The scope is still unclear for the Big Waters investigations.

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

All costs for Wastewater WINEP were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[12]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed costs for Wastewater WINEP are £173.9M Capex and £0.0M Opex.

These costs were benchmarked and assured using a combination as follows: 8% Full iMOD estimate; 88% PR19 Costing Tool, and 4% Traditional unit rate.

The cost assurance process and associated costs generated for the wastewater enhancement schemes have been subject to third party assurance provided by Mott Macdonald in July 2018[13].

[12] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes-NWL PR19 costing methodology

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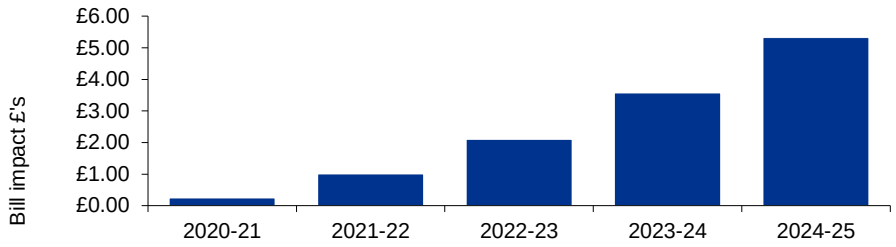
This review has assessed Wastewater WINEP costs as 99% Green, that is NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

Affordability

The impact of these enhancement investments on customer bills are shown below[14].

Figure 1: Bill impacts from wastewater WINEP enhancement scheme



Overall the analysis shows that the bill impacts would be rising from £0.25 (year 1) to £5.33 (year 5) a year.

This is set within an overall bill drop of more than 14% (wastewater) in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[15] driving significant improvements to average customer affordability.

The scheme proposed is material to the long-term stability and health of the customer service, and will contribute to a robust future network. This is in the context of an AMP7 plan which customers fully support.

Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remains a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty

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[13] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

[14] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.

[15] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

by 2030[16] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

Our preferred plan

Detail of AMP7 WINEP Commitments

WINEP3 was published March 28th 2018[17].

We have broken down the WINEP requirements for wastewater services into five areas relating to key environmental objectives / drivers:

- Urban Wastewater Treatment Directive (UWWTD) and Bathing Water Directive;
- WFD Nutrients (Sanitary parameters);
- WFD Chemicals – Improvement;
- WFD Chemicals – Investigations;
- WINEP Investigations – Supporting information for PR24 planning.

These are described in the following sections together with provision of the breakdown of totex expenditure allocated to each line within Ofwat's table WWS2 Wholesale wastewater capital and operating expenditure[1819].

Urban Waste Water Treatment Directive (UWWTD) and Bathing Water Directive

We will invest £56.7M totex to meet our obligations to manage wastewater and reduce unwanted discharges under UWWTD drivers and prevent deterioration of bathing waters under the Bathing Waters Directive. This will allow us to provide increased capacity for storm water storage and treatment of flows at our STWs. It will also ensure we have robust measurement technologies and methodologies in place to manage flows at our STWs and within our network, including on our combined sewer overflows (CSOs). We will also address frequently spilling CSOs through the national Storm Overflow Assessment Framework (SOAF) including provision of increased storage in networks to prevent deterioration of Bathing waters (BWND storage schemes at Marsden, Redcar Granville and Tynemouth Cullercoates).

Including drivers: UMON1, UMON2, UMON3, BWMON (Line 6) UMON4 (Line 7), UIMP5 (Line 9), UIMP6 (Line 10), UIMP4 and BWND (Line 11).

[16] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

[17] WINEP 3 Publication

[18] Wastewater Enhancement tables – summary data.xls (summary table used to populate WWS2)

[19] WINEP Cost spreadsheets – basis for costing information provided for cost assurance

APPENDIX 3.2
WASTEWATER WINEP

	Capex	2020/21	2021/22	2022/23	2023/24	2024/25	Total
Line ref.	Enhancement expenditure by purpose – capital	£m	£m	£m	£m	£m	£m
6	WINEP / NEP ~ Event Duration Monitoring at intermittent discharges	0.32	0.22	0.22	0.22	0.22	1.22
7	WINEP / NEP ~ Flow monitoring at sewage treatment works	0.94	0.94	0.94	0.94	0.94	4.70
9	WINEP / NEP ~ Schemes to increase flow to full treatment	0.00	0.00	8.03	9.84	19.40	37.29
10	WINEP / NEP ~ Storage schemes at STWs to increase storm tank capacity	0.00	0.00	0.09	0.26	0.60	0.95
11	WINEP / NEP ~ Storage schemes in the network to reduce spill frequency at CSOs, etc	4.34	4.34	1.30	1.30	1.30	12.58
	Opex	2020/21	2021/22	2022/23	2023/24	2024/25	Total
A	Enhancement expenditure by purpose – capital	£m	£m	£m	£m	£m	£m
6	WINEP / NEP ~ Event Duration Monitoring at intermittent discharges	0.00	0.00	0.00	0.00	0.00	0.00
7	WINEP / NEP ~ Flow monitoring at sewage treatment works	0.00	0.00	0.00	0.00	0.00	0.00
9	WINEP / NEP ~ Schemes to increase flow to full treatment	0.00	0.00	0.00	0.00	0.00	0.00
10	WINEP / NEP ~ Storage schemes at STWs to increase storm tank capacity	0.00	0.00	0.00	0.00	0.00	0.00
11	WINEP / NEP ~ Storage schemes in the network to reduce spill frequency at CSOs, etc	0.00	0.00	0.00	0.00	0.00	0.00
	Totex	2020/21	2021/22	2022/23	2023/24	2024/25	Total
A	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m
6	WINEP / NEP ~ Event Duration Monitoring at intermittent discharges	0.32	0.22	0.22	0.22	0.22	1.22
7	WINEP / NEP ~ Flow monitoring at sewage treatment works	0.94	0.94	0.94	0.94	0.94	4.70
9	WINEP / NEP ~ Schemes to increase flow to full treatment	0.00	0.00	8.03	9.84	19.41	37.29
10	WINEP / NEP ~ Storage schemes at STWs to increase storm tank capacity	0.00	0.00	0.09	0.26	0.60	0.95
11	WINEP / NEP ~ Storage schemes in the network to reduce spill frequency at CSOs, etc	4.34	4.34	1.30	1.30	1.30	12.58

Water Framework Directive (WFD) - Nutrients

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We will invest £99.6M in WFD nutrient removal (ammonia and phosphate) in our NW operating area to include:

- Phosphate (P) removal from 27 STWs and ammonia removal from three STWs

Including drivers: WFDIMPg, m and p (Line 18 – P removal at activated sludge, Line 19 – P removal at filter beds, Line 20 – Reduction of sanitary parameters)

	Capex	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**Total**
A	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m
18	WINEP / NEP ~ Nutrients (P removal at activated sludge STWs)	0.28	0.10	0.10	0.10	0.10	0.68
19	WINEP / NEP ~ Nutrients (P removal at filter bed STWs)	1.00	12.80	18.86	32.03	25.50	90.18
20	WINEP / NEP ~ Reduction of sanitary parameters	0.13	1.21	1.69	2.72	3.00	8.75
	Opex	2020/21	2021/22	2022/23	2023/24	2024/25	Total
A	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m
18	WINEP / NEP ~ Nutrients (P removal at activated sludge STWs)	0.00	0.00	0.00	0.00	0.00	0.00
19	WINEP / NEP ~ Nutrients (P removal at filter bed STWs)	0.00	0.00	0.00	0.00	0.00	0.00
20	WINEP / NEP ~ Reduction of sanitary parameters	0.00	0.00	0.00	0.00	0.00	0.00
	Totex	2020/21	2021/22	2022/23	2023/24	2024/25	Total
A	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m
18	WINEP / NEP ~ Nutrients (P removal at activated sludge STWs)	0.28	0.10	0.10	0.10	0.10	0.68
19	WINEP / NEP ~ Nutrients (P removal at filter bed STWs)	1.00	12.80	18.86	32.03	25.50	90.18
20	WINEP / NEP ~ Reduction of sanitary parameters	0.13	1.21	1.69	2.72	3.00	8.75

WFD Chemicals Improvement

The EA will implement new permits for substances highlighted in previous chemical investigation programmes contributing to environmental quality standard failures in rivers downstream of STWs. These permits will include substances such as Nickel, Zinc, and Aluminium. These are either no deterioration permits, or, at one STW, improvements based on river needs.

We will invest £7.5M totex on ensuring minimum risk of failure against these new permits. We will seek to investigate potential sources of these substances to understand whether removal at source can mitigate the risk to compliance rather than installing additional high energy treatment solutions.

Including drivers: WFD IMP CHEM, WFD ND CHEM, WFD NDLS CHEM – (Line 12)

	Capex	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**Total**
A	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m
12	WINEP / NEP ~ Chemicals removal schemes	1.51	1.51	1.51	1.51	1.51	7.53
	Opex	2020/21	2021/22	2022/23	2023/24	2024/25	Total
A	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m
12	WINEP / NEP ~ Chemicals removal schemes	0.00	0.00	0.00	0.00	0.00	0.00
	Totex	2020/21	2021/22	2022/23	2023/24	2024/25	Total
A	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m
12	WINEP / NEP ~ Chemicals removal schemes	1.51	1.51	1.51	1.51	1.51	7.53

WFD Chemicals Investigations

We will continue to contribute along with other water and sewerage companies to the national Chemicals Investigation Programme (CIP) which will continue to run in AMP7 after two phases in AMP5 (£25m total) and AMP6 (£140m total).

High level scoping of the chemical investigations programme has been undertaken as part of a Water UK Task and Finish group on chemicals, and will include a wide range of investigations including into microplastics and anti-microbial resistant bacteria (AMR), sludge, trend monitoring and optimisation of existing treatment solutions.

We will invest £1.9M totex (assumed to be capex) to ensure we are able to fulfil obligations identified as part of the ongoing CIP3 investigations.

Including drivers: WFD INV CHEM1-14, WFD MON CHEM - (Line 13)

	Capex	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**Total**
A	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m
13	WINEP / NEP ~ Chemicals monitoring / investigations / options appraisals	1.00	0.90	0.00	0.00	0.00	1.90
	Opex	2020/21	2021/22	2022/23	2023/24	2024/25	Total
A	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m

13	WINEP / NEP ~ Chemicals monitoring / investigations / options appraisals	0.00	0.00	0.00	0.00	0.00	0.00
	Totex	2020/21	2021/22	2022/23	2023/24	2024/25	Total
A	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m
13	WINEP / NEP ~ Chemicals monitoring / investigations / options appraisals	1.00	0.90	0.00	0.00	0.00	1.90

WINEP Investigations

We will invest £8.2M in a number of Investigations that will provide support to the nature and extent of investment required in AMP8 (PR24).

We will undertake investigations at Tynemouth Cullercoats, Marsden and Redcar Granville to ensure no deterioration occurs in seawater water quality and to understand the actions we can take to reduce our environmental impact further. If these investigations identify significant opportunities for better management of our wastewater assets, we will undertake improvement schemes at Marsden and Redcar Granville.

The Government have proposed that the water industry are more ambitious about improving and making Good and Excellent bathing waters more robust. Our final WINEP contains ten bathing waters for catchment-wide ambition investigations that are currently amber in terms of certainty. We await the Ministers decision on these investigations before including them in our PR19 business plan. The ambition investigations are at Redcar Gotham, Redcar Granville, Redcar Lifeboat Station, Redcar Stray, Saltburn, Seaham Hall, Seaton Carew Centre, Seaton Carew North, Spittal and Tynemouth Cullercoats.

Including drivers: BWNDINV, UINV4, WFDINV, HDINV and UINV2
(Line 16)

	Capex	2020/21	2021/22	2022/23	2023/24	2024/25	Total
A	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m
16	WINEP / NEP ~ Investigations	3.29	4.78	0.10	0.00	0.00	8.17
	Opex	2020/21	2021/22	2022/23	2023/24	2024/25	Total
A	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m
16	WINEP / NEP ~ Investigations	0.00	0.00	0.00	0.00	0.00	0.00
	Totex	2020/21	2021/22	2022/23	2023/24	2024/25	Total
A	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m
16	WINEP / NEP ~ Investigations	3.29	4.78	0.10	0.00	0.00	8.17

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WASTEWATER WINEP

Delivery of the WINEP through an integrated catchment approach for wider benefits

Our Audacious Goal relating to the water environment for AMP7 is *"We will have zero pollutions as a result of our assets or operations, helping us* ***achieve the best rivers and beaches in the country****".*

Our investment in the WINEP will contribute towards this goal to have the best rivers and beaches. We will build on our excellent Catchment Partnership foundations to take an integrated approach to delivering the WINEP, considering catchment solutions where appropriate, and delivering multiple benefits to the environment wherever possible. This will allow us to address our portion of the WFD challenge, to work with others to drive corresponding improvements, to implement joint investment schemes where possible to address multiple drivers, and to contribute to the delivery of national objectives including those set out in Defra's 25 year plan, the Biodiversity 2020 strategy and the NERC Act 2006.

Taking a catchment approach to the WINEP will allow us to demonstrate leadership in the area of water quality and quantity to other sectors and regions. It will also allow us to deliver a significant level of improvement to WFD waterbodies, as measured by the Environment Agency 'kilometres enhanced' metric.

We will continue to work with the EA in everyday activities and in AMP planning to look ahead, deliver added benefits through catchment partnership working, and ensure that we consider future quality requirements when delivering business as usual activities. Through this, we take account of potential future environmental impacts and pressures when implementing major maintenance or growth schemes.

Wholesale Totex

Ofwat require Wholesale totex for PR19 to be split between base and enhancement totex. This is split as follows:

ENHANCEMENTS: These are expected to enhance the capacity and quality of services beyond current levels. Generally, these need to be linked to an external driver (new legislation, new obligations, increased demand):

- WINEP
- Supply Demand Schemes (Growth, New Development, Metering)
- Resilience
- Security (SEMD)

BASE: Ongoing opex and capital maintenance, known as base totex (or botex). This includes cost increases in base totex not specific to the water industry (e.g. pensions / energy costs / materials costs). Also, it includes any increased costs of 'doing the same'.

WINEP enhancement costs have been summarised by EA driver and as per the Ofwat Enhancement Tables.

Any overlaps with other enhancement drivers has been highlighted and removed.

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Costing information has been summarised and provided to our cost estimation team for final cost assurance.

The breakdown of the totex enhancements (capex and opex) has been summarised in the Table: ‘The wastewater enhancement tables – Summary data’.

The following Table is a summary of the Wastewater WINEP Drivers, and the delivery profile proposed in WINEP. It should be noted that we may need to agree (via change protocol with the EA) to deliver schemes within AMP7, but to a modified profile in order to enable the most efficient delivery of the overall capital plan. This would only be proposed if agreed by the EA, and where there was no detriment to the environment.

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WASTEWATER WINEP

WINEP 2 Summary			WINEP2 - September 2017		WINEP3 - March 2018		Delivery profile				
Directive / Regulation	**Drivers (Grouped)**	**Brief Description**	**No. of WINEP lines**	**Level of certainty (as per WINEP2)**	**No. of WINEP lines**	**Level of certainty (as per WINEP2)**	**2021**	**2022**	**2023**	**2024**	**2025**
UWWTR	U IMP5	Increase to FFT	29	Red	16	4 Green and 12 Amber			4	5	7
	U IMP6	Increase to Storm Tank capacity	106	Red	7	2 Green and 5 Amber			1	3	3
	U INV	Spill frequency reduction – Investigation and Cost Benefit appraisal	129	Green	122	Green					
	U INV										
	U INV						22	25	21	23	24
	U IMP4	Spill frequency improvement - not yet identified but estiamted as output form SOAF	None		5	Green	2	3			
	U MON3	EDM on flow to storm	157	Green	153	Green	82	18	22	19	12
	U MON1	EDM on flow to storm			4	Green	4				
	U MON2	EDM on flow to storm			54	Green	54				
	UINV2	New driver created where not ienough information available to action UMON4			83	Green		83			
	U MON4 & U INV2	(UMON4 and UINV2) Mcerted flow monitoring of FFT (front end of works)	157	Red	70	Green		17		25	28
WFD Chemicals	WFD IMP CHEM	Hustledownx3, Windlestonex2, Tranche2 and Tranche3&4	7	Red and Purple for Tranche 3 &4	2	Amber				2	
	WFD INV CHEM1	Risk based extension to CIP plus monitoring on Team at East Tanfield	2	Red and Green	5	Green		5			
	WFD INV CHEM2	TraC	1	Red	1	Green		1			
	WFD INV CHEM3	AMR	1	Red	1	Green		1			
	WFD INV CHEM4	Innovative pathway control	1	Red	0						
	WFD INV CHEM5	Microplastics	1	Red	1	Green		1			
	WFD INV CHEM6	Catchment Investigtion	1	Red	3	Green		3			
	WFD INV CHEM7	Sludge	1	Red	1	Green		1			
	WFD INV CHEM8	Programme Management	1	Green	1	Green		1			
	WFD INV CHEM9	Effluent monitoring for substance reduction	1	Red	0						
	WFD INV CHEM10	AMP7 Chemicals Investigations: Effluent monitoring for substance reduction and environmental monitoring for compliance with EQS	1	Red	1	Green		1			
	WFD INV CHEM11	Optimisation of new technologies			4	Green		1			
	WFD INV CHEM12	Mechanism of chemical removal (national programme)			1	Green		1			
	WFD INV CHEM13	Investigate source of Zn	0		1	Green		1			
	WFD INV CHEM14	Monitoring emerging substances	0		3	Green		3			
	WFD MON CHEM	Trend monitoring	1	Red	5	Green					5
	WFD ND Chemicals	WFD No det chemicals	3	1 Red 2 Purple	1	Green					1
	WFD NDLS Chemicals	WFD Load Standstill	10	9xRed and 1 Purple Tranche 3	5	Green		5			
WFD Sanitary Paramaters	WFD IMP g	WFD Improvement schemes to Good	36	33 Red, 3 green	13	Amber				13	
	WFD IMP m	WFD Improvement schemes to Moderate	2	Red	12	Amber				12	
	WFDIMP p	WFD Improvement schemes to Poor	0		2	Amber				2	
	WFD ND	WFD No deterioration (growth within consent that impacts status) P (20 lines), NH3 (9 lines) - chemicals included above WINEP3 reduced 12 sites (only 2 with no det only)	29	30 Red, 2 Purple	12	Green					12
	WFD INV	Phosphorus Investigations (not clear on this yet) - Includes Hawthorn Dean and Big Waters (Blyth) WINEP3 Big Waters only	2	Amber and Red	1	Green				1	
Bathing waters	BW ND INV	Investigation (Marsden and Redcar Granville)	2	Amber and Red	3	Green	3				
	BWMON	EDM on storm - impacting on BW	0		6	Green	6				
	BWINV4	Investigate potential to Excellent - New driver raising ambition	0		10	Amber	10				
	BW ND	Intermittent discharge (Redcar Granville)	1	Red	2	Green		2			
Fisheries, Biodiversity and Geomorphology	INNS ND	Biosecurity and Company strategy	1	Green	2	Green					2
	INNS INV	Crayfish and INNS transfer	3	Green	3	Green		3			
	INNS MON	Companywide	1	Purple	1	Green		1			
	HD IMP	Wooler	1	Green	1	Green				1	
	HDINV	Cat cleugh and Kielder - Pearl mussels			1	Green		1			
	NERC IMP1				2	Green				2	
	NERC INV1	R. Rede scour			1	Green		1			
	Pearl mussels		1	Not completed	0						
Water Quality - Others	DrWPA INV	Till Fell Sandstone - Nitrates in Groundwater	1	Amber	1	Green		1			
	DrWPA ND	Catchment measures	6	4 Green and 2 red	4	Green				4	
	HD INV	SSSI INV - Seal Sands (Tees catchment partnership)	6	Red	1	Seal Sands Green				1	
	MCZ INV	Aln and Coquet	2	Red	0						
	NERC INV1		1	Green	0						
	NERC IMP1	South Tyneside holistic water management			1	Green				1	
	SSSI INV		1	Red	0						
	SSSI ND		1	Red	0						
	WFDGW NDINVGW Q	Stonygate Nitrate	1	Red	1	Green		1			
Water Resources	EE IMP	Eel Screen	1	Amber	1	Amber				1	
	WFD IMP WRHMWB	4 Fish passages and 6 Sustainable change	10	Amber	12	Amber				12	
	WFD INV WRHMWB	Investigations and Options Appraisal	6	Green	4	Green		4			
	WFD ND INV WR Flow	Investigations and Options Appraisal	1	Green	0						
	WFD GW ND GWR	Sustainability change - Fell Sansdtone	1	Green	1	Green				1	
	WFD GW ND INV GWR&GW Q	Investigations and Options Appraisal	1	Red	1	Green		1			
	NERC INV1	Coquest estuary tidal weir	0		1	Green		1			

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Alignment with stakeholder needs

The WINEP is a key part of the overall programme of measures to meet the requirements of the Environment Agency (EA)'s Water Industry Strategic Environmental Requirements (WISER) document. Our schemes in the WINEP have been agreed with the EA and therefore fully align with their needs as a stakeholder.

WINEP involves a number of key schemes in priority areas for our Catchment Partnerships. We intend to use our WINEP investment to deliver wider environment improvements through catchment and innovative approaches. Partnership delivery is a cornerstone of our RP19 plan for the environment.

The business case demonstrates how the WINEP enhancement schemes have been developed and agreed with the EA, and the level of support and engagement received by customers and water forum representatives. The business supports inclusion of **all** of the WINEP3 enhancement obligations (green **and** amber certainty categories) and will make allowance for their inclusion within the plan.

Board assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers.

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WASTEWATER GROWTH ENHANCEMENT BUSINESS CASE

WWS2 - Wholesale wastewater capital and operating enhancement expenditure by purpose Lines 1, 25, 26 and 32

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Contents

1 Executive Summary

The following table summarises the Resilience enhancement proposal.

Name of claim	Wastewater Growth	
Name and identifier of related claim submitted in May 2018	N/A	
Business plan table lines w here the totex value of this claim is reported	WWS2 Lines 1,25,26 and 32	
Total value of enhancement for AMP7	£112.609 m	
Total opex of enhancement for AMP7	£0.000m	
Total capex of enhancement for AMP7	£112.609m	
Depreciation on capex in AMP7 (retail controls only)	[n/a]	
Remaining capex required after AMP7 to complete construction	n/a	
Whole life totex of claim	N/A	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	Material	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		No
Need for investment/expenditure	Regulatory driver under Section 94a and Section 101a of the Water Industry Act	
Need for the adjustment (if relevant)	n/a	
Outside management control (if relevant)	n/a	
Best option for customers (if relevant)	Optioneering has been dependent on the level of certainty and each growth driver. The best solution has been proposed for the level of detail and certainty known at the time of submission. We are proposing a cost adjustment mechanisms that will protect customers against late or non-delivery of enhancement schemes.	
Robustness and efficiency of claim's costs	NWL has assessed the costs through a structured and robust approach, involving benchmarking of cost estimates against alternatives. The cost assurance process and associated costs generated for the water	

	enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018.
Customer protection (if relevant)	A customer protection mechanism is proposed and is outlined within this document.
Affordability (if relevant)	Overall the analysis shows that the bill impacts would be rising from £0.15 a year (year 1) to £3.60 a year (year 5). This is set within an overall bill drop of more than 12% (wastewater) in AMP7, including all enhancement investments, one of the largest across the sector.
Board Assurance (if relevant)	The details of all our enhancement cases have been discussed with our PR19 Board Sub-Committee and full Board both prior to plan submission and following IAP. During these discussions the board sub-committee have challenged the details of our enhancement proposals in a number of ways which are reflected in our final enhancement cases.

2 Drivers

This paper sets out the processes and approaches that have been used to ensure there is an adequate provision of wastewater services to be able to accommodate projected growth within the Northumbrian Water operating area. This will ensure that we are able to fulfil our statutory duties outlined in the Water Industry Act 1991. The total expenditure committed is £112.609m and will ensure that we are able to meet the needs of our Local Planning Authorities and developer customers without increasing flood risk or adversely affecting the environmental performance of our wastewater treatment works.

WWSLines	Expenditure line	Capex (£m)	Opex(£m)	Totex (£m)
Line 1	First time sewerage (s101A)	1.000	0	1.000
Line 25	New development and growth	8.600	0	8.600
Line 26	Growth at sewage treatment works (excluding sludge treatment)	94.359	0	94.359
Line 32	Infrastructure Network Reinforcement	8.650	0	8.650
	TOTAL	112.609	0	112.609

	Capex (£m)	20/21	21/22	22/23	23/24	24/25	Total
Line	Enhancement expenditure by purpose - capital	£m	£m	£m	£m	£m	£m
1	First time sewerage (s101A)	0.000	0.250	0.250	0.250	0.250	1.000
25	New development and growth	1.720	1.720	1.720	1.720	1.720	8.600
26	Growth at sewage treatment works (excluding sludge treatment)	4.105	1.950	11.712	51.857	24.735	94.359
32	Infrastructure Network Reinforcement Charges	1.730	1.730	1.730	1.730	1.730	8.650
		7.555	5.650	15.412	55.557	28.435	112.609

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3 Context and Scope

This business case relates to calls from Government for utility companies to ensure that suitable infrastructure is in place to support new developments in a timely and cost-effective manner[1]. Housing availability is a prominent feature of Government policy:

- National Planning Policy Framework – "aims to simplify planning policy with a view to promoting economic and housing growth"
- Fixing our broken housing market - "we need to ensure that homes are built quickly once planning permissions are granted. We will invest in making the planning system more open and accessible, improve the co-ordination of public investment in infrastructure, support timely connections to utilities, and tackle unnecessary delays" (Foreword by Prime Minister)
- Phillip Hammond's budget pledge in November 2017 - "300,000 houses per year"

Ensuring that there is sufficient supply of wastewater infrastructure across the Northumbrian Water operating area to satisfy projected growth in demand enables us to respond to Government priorities, helping to resolve issues of housing affordability by providing the infrastructure necessary to reduce barriers to housing development and catalyse economic growth[2].

All of the schemes proposed under the Growth line are associated with expenditure that relates to the provision of new development and growth in sewerage services, including the provision of local network assets to provide new customers with no net deterioration of existing levels of service and investment to meet changes in demand from new and existing customers at sewage treatment works. These schemes ensure we are able to fulfil our statutory duties that are defined in the Water Industry Act 1991, and apply to the sewerage network, sewage treatment works (STWs), pumping stations and new sewerage facilities for the application of including our statutory duties under Section 101a of the Water Industry Act 1991.

Relevant regulation includes Section 94(1) of the Water Industry Act 1991, which refers to our general duty to provide a sewerage system and states that:

(1) It shall be the duty of every sewerage undertaker:
(a) to provide, improve and extend such a system of public sewers… and so to cleanse and maintain those sewers… as to ensure that the area is and continues to be effectually drained; and
(b) to make provision for the emptying of those sewers… for effectually dealing, by means of sewage disposal works

In addition, Section 101a of the Water Industry Act 1991 places a statutory obligation on sewerage undertakers to provide a pubic sewer if an existing domestic sewerage system which is not connected to the public sewer (directly or indirectly) is adversely affecting the environment or amenity, where provision of a public sewer is the most appropriate solution. Anyone with an interest in premises (amounting to more than one building) is eligible to ask Northumbrian Water to consider the provision of a public sewer using an application process. An initial assessment is carried out to determine whether the application meets statutory conditions identified above.

There are three elements of wastewater growth that this business case seeks to address:

- Ensuring that we respond to the statutory requirement to provide public sewerage in line with Section 101a of the Water Industry Act 1991 - supporting the values included in line 1 of the WWS2 Ofwat tables

- Ensuring that there is adequate provision of STWs to accommodate growth, supporting the values included in line 26 of the WWS2 Ofwat tables.

- Ensuring that there is adequate provision within the network to accommodate growth – through our sewer requisition and sewer adoption mechanism, supporting the values included in line 25 of the WWS2 Ofwat tables.

- Ensuring that there is adequate provision for our network reinforcement as a result of growth and that can be offset our infrastructure charges, supporting the values in line 32 of the WWS2 Ofwat tables.

The enhancement proposals are under section 94 and section 101 and as per Ofwat's definition that supply and demand is classed as an enhancement and therefore is not base. The proposals will mainly look at the provision of new assets on the Network to accommodate growth and also will look at expansion of treatment works and SPS purely to accept predicted growth. The likelihood that the investment will address current maintenance is negligible.

4 Customer and stakeholder expectation

We provided regular updates to the Customer Challenge Group (CCG) on the progress of the Growth methodology and proposals. These are documented and saved in the Water Forum Sharepoint area.

There are principally three customer and stakeholder segments we need to consider when discussing expectations around wastewater network and treatment growth.

The first is the region's Local Planning Authorities (LPAs). Having supplied us with a complete line of sight of future development over a period of many years through the local plan making process, it is their expectation that we are able to secure sufficient growth funding to support unrestricted growth.

Our developer customers have very similar expectations to those of the LPAs regarding the ability of our infrastructure to support growth. The plan making and planning application processes can be extremely lengthy and take several years from site acquisition to planning approval. Once the relevant permissions are secured, developers do not want to be delayed due to inadequacies within our wastewater networks and treatment works.

We are in constant dialogue with our developer customers in a number of forums:

- Regular face to face meetings with Land, Planning and Technical Directors of all of the major house builders within our region;
- Quarterly attendance at the North East Home Builders Federation Technical meeting; and
- Involvement in national joint industry Defra task and finish groups on water and sewerage infrastructure issues affecting development.

In addition to this, in 2015 we hosted a Developer Day which focused on our approach to the delivery of wastewater infrastructure. The event was attended by developers, consultants and partners from Local Authorities to share their views on the provision of wastewater infrastructure. This event was attended by 125 delegates and the delegates confirmed that our approach met their expectations.

Following the event, our proactive consultation with customers and stakeholders received plaudits from Steve Wielebski from the Home Builders Federation, who said:

"*The positive and helpful attitude towards developers within NWL is very much in evidence and combined with United Utilities, we are a fifth of the way forward towards demonstrating what 'good' can look like*".

In the past year, we have also engaged with our developer customers regarding setting our New Charges for 2018. This involved:

- Face to face charges consultation at workshops or in many cases at the Developers' offices
- An online charges survey
- Survey results and feedback document
- A series of feedback sessions setting out our new charging arrangements and how we would invest proactively to support development

The final segment with an interest in wastewater network and treatment are our domestic customers. This is the most difficult group to engage with proactively regarding development as there is generally little support for new housing development in their area. Quite often this can lead to objections to planning applications and claims that the wastewater flows from the development site will increase flood risk and/or cause the treatment works to fall outside of its environmental consent. We take time to meet with various action groups to explain that our approach to growth is designed in such a way to ensure that neither of these things are allowed to happen. We have also received feedback that suggests customers do not generally support paying for infrastructure which benefits developers.

5 Current and Historical Service delivery and expenditure

In AMP6, £19 million was originally planned for investment in growth at our sewage treatment works. As a consequence of increased housing delivery, we have responded and will actually outturn at £28 million.

In terms of proactive network growth within our sewerage networks, there has been limited investment during the first three years of AMP6. However, following Ofwat's publication of new charging rules which led to new charging arrangements for 2018, there is far greater clarity on the timing and funding of sewerage network reinforcement. Companies have had to move away from a standard industry infrastructure charge and instead have had to calculate their own company-specific infrastructure charge based upon their own growth data.

This will enable companies to proactively invest in sewerage network reinforcement to align with developers' timescales and allow development to progress without delay. The new infrastructure charges have been calculated for the period 2018/2023 and the levels of investment during the final two years of AMP7 are anticipated to be similar.

Effectively these infrastructure charges should net off against required investment for sewerage network and pumping station reinforcement and Ofwat will ask companies to report on actual expenditure. Where actual investment is higher or lower, it is expected that future infrastructure charges will be adjusted accordingly, although Ofwat's preference is that they should remain as stable as possible to give greater stability and cost certainty to developers.

Properties connected through the completion of Section 101a schemes

Very few properties in our operating area are connected through the completion of a Section 101a first time sewerage scheme. One of the main reasons for this is that few of the population within our operating area are not already connected to the public sewerage network.

Table 1.1 is extracted from the 1994 Department of the Environment review of rural water supply and sewerage. Although changes in housing stock may have influenced the precise figures since then, it is still considered as a reasonable representative. It demonstrates that, when compared to other sewerage undertakers, Northumbrian Water has a very low percentage of population not connected to the public sewerage network.

Sewerage Company	Population	Population not connected	% of population not connected
Anglian	5,296,800	439,600	8.30
Dwr Cymru	3,118,300	218,300	7.00
North West	6,842,600	212,100	3.10
Northumbrian	2,612,600	41,800	1.60
Seven Trent	8,320,700	199,700	2.40
South West	1,482.800	222,400	15.00
Southern	4,005,700	196,300	4.90
Thames	11,629,500	255,800	2.20
Wessex	2,425,300	169,800	7.00
Yorkshire	4,545,600	168,200	3.70
All	50,279,900	2,124,000	4.22

Table 1.1 Population not connected to the public sewerage network

Historically we have completed S101a projects at:

- Waren Mill
- Leven Bank
- Dalton

6 Forward looking analysis

6.1 Sewage treatment works

The following section sets out the methodology used to assess future requirements for STWs and arrive at a preferred option.

The process initially began with a list of all the STWs with numeric consents which were put into an Excel spreadsheet called STW Overview[3]. For each site, data was added to include the STW's corresponding LPA area and the 'present headroom' data (m^3/d, population and houses), which was extracted from the development tracking list maintained by the Wastewater Compliance team.

1) Initial filtering

In order to prioritise sites and therefore shorten the list, a review of the current AMP6 investment plan was conducted. Any works which had an ongoing AMP6 project that would deliver a growth solution were automatically excluded from further assessment. The following factors were then used to identify STWs that required further investigation:

- The STW was identified as a deferral from AMP6; or
- The STW was identified as a potential AMP7 scheme at PR14; or
- A CP0 was has been raised due to capacity concerns since PR14; or
- Other issues arising.

After this initial identification, 20 specific candidate works warranted further investigation. In addition, there are many more rural works with descriptive consents. From time to time these can approach the population threshold that would require an application for a numeric consent. Two

such candidate works have been identified as being close to this threshold and have undergone a growth assessment.

6.2 Growth assessment

Growth assessments were made for each candidate works in two tiers:

a) A high projection, based upon LPA projections. For each individual STW, annual and cumulative values for growth between 2018 and 2031 were provided by the LPA.
b) A lower, more representative value of growth within catchments.

This lower growth figure in (b) above is based upon our experience of actual housing delivery versus the housing projections promoted within their local plans. Typically we estimate that actual delivery rates equate to only 70% of the LPA figures.

Further independent research from national planning consultants Lichfields was presented at a North East Royal Town Planning Institute seminar and recommended a figure on no greater than 34 housing units per annum for an individual developer on each site.

After the first tier assessment, each candidate works fell into one of the following categories:

- If headroom was not reached by 2031, no lower figure was required and the site did not need any further investigation; or
- If the headroom was reached at any point between 2018 and 2031, it was passed forward for second tier review.

Second tier review involved further examination of the cause of the site capacity issue. The candidate works that were assessed to have real growth-related capacity issues were then placed into one of the following categories based on the capacity risk:

- A site which had significant forecasts for growth and capacity would be immediately compromised (recommended as AMP 7 Release 1 Scheme);
- A site which had significant forecasts for growth and capacity would be compromised during AMP 7 (recommended as AMP 7 Release 2/3 Scheme);
- A site which had significant growth but capacity can facilitate predicted levels of development and therefore will need reviewing as part of PR24;
- Growth significant but no capacity issues before 2031.

Any new candidate sites identified will undergo the same growth analysis described within this methodology.

It is very unlikely that actual housing delivery will exceed our assumptions but there are two principal risks associated with significant under-delivery. The first is that the LPAs fail to have their Local Plan adopted, bringing delays to delivery. During AMP6, three of our major metropolitan councils had their plans adopted and housing delivery is vibrant. Our two unitary County Council authorities within Northumberland and Durham both withdrew their Local Plans between 2015 and 2017 to address concerns regarding green belt deletions. However, both are now back on track and we have sufficient confidence, from discussions we have held with them, that those areas of high growth we have assumed will remain within their new Local Plans.

The absence of a Local Plan has not hindered housing delivery as the presumption in favour of sustainable housing in the absence of a 5 year deliverable housing supply contained within the National Planning Policy Framework means that developers can, and indeed have, continued to submit planning applications to meet housing demand. A prime example of this is within the Morpeth catchment where, despite the absence of an adopted Local Plan, Bellway, Persimmon, Taylor Wimpey, Linden Homes and Story Homes have all started to deliver housing at sites ranging between 55 and 400 new homes.

The other risk is of a significant global economic crisis similar to that experienced in 2008. All developers in our region are seeking to increase their business plan targets for housing delivery at present and we have assumed that the risk, whilst feasible, is currently low.

Should this risk emerge during AMP7 and housing delivery slow as it did during the last crisis, we would assume that delivery would only slow to 50% of the developers' original targets. If this were to cause us to require a reduction in investment needs then developers would see a reduction in Infrastructure Charges linked to reduced sewerage network reinforcement.

6.3 Costing Methodology

SCOPE of Costing methodology

The purpose of this section is to describe the approach used by Northumbrian Water Group (NWG) to estimate the enhancement cost, for both CAPEX and TOTEX, associated with the PR19 business plan submission.

NWG have taken four primary approaches to costing as described below:-

1. Full iMOD cost estimate using business as usual processes
2. PR19 Costing Tool created from iMOD base estimates
3. Traditional unit rate build up estimates
4. Assessment and forecasting of historical spend

The most appropriate costing method has been chosen for each area, however, where possible either a full iMOD estimate or iMOD based tool has been favoured as it best reflects NWG's business as usual cost estimating processes.

iMOD

iMOD is a Client focussed Engineering Scoping and Cost Estimating software system, developed for Northumbrian Water, bringing project scope definition, whole life costing and tender evaluation together in one integrated system.

iMOD comprises a suite of 50 engineering scoping models and a cost database, which with a minimum of input criteria that is readily known at project inception, can provide a detailed CAPEX, OPEX and whole life costing for a range of business issues.

Supplier tender submissions can be entered directly into the system to allow tenders to be automatically checked against the iMOD asset based cost database, enabling tender evaluation to be carried out with a limited resource requirement as well as providing an enhanced confidence in a project's affordability. On completion outturn costs are captured in the system as part of the agreed project closeout procedure.

The purpose of iMOD is to form the cornerstone of our Capital Delivery Model. Allowing us to embed a should-cost culture as the entry point to working collaboratively with our delivery partners. It also supports Northumbrian Water's strategic outcome to ensure that our finances are sound, stable and achieve a fair balance between customers and investors.

iMOD CAPEX Cost Estimating

The iMOD system uses a Process and Component costing hierarchy. The relevant processes are selected for each estimate, with the engineering scoping model run for each process. This produces a quantified Work Breakdown Structure (WBS), with detailed attribute tags, with costs applied via the iMOD cost database. The process models are then supplemented with individual components and/or unit rates to complete the estimate as appropriate.

Contract overheads are then applied from a selection of 19 sub-categories that are chosen based on site specifics or work type specific considerations. Each sub-category consist of historical data cost curve and is generated using the value of the measured works. Project overheads are then applied to the combined value of the measured works and the contract overheads, based on a selection of 21 sub-categories.

All cost estimated have been produced using APG specific cost curves for Process, Component, Contract and Project Overheads. APG areas area as follows:-

- Water Treatment
- Water Networks
- Wastewater Treatment
- Wastewater Network

iMOD OPEX Cost Estimating

The iMOD engineering scoping models produce detailed OPEX cost calculations for Power, Operational labour, Chemical & Materials and Waste disposal. E.g. when running a Pumping Station model the KW pump rating and daily/monthly/annual run time would all be automatically calculated and costed via the OPEX unit cost table. The OPEX unit cost table has been updated from actual cost data provided by Management Accounts team.

PR19 COSTING TOOLS

PR19 costing tools have been created specifically for the Water Treatment and Waste Water Treatment enhancement costing for both CAPEX and OPEX.

The costing tools consist of tables where the user can input individual site data, giving site specific yardsticks (i.e PE or MLD) and can then select which processes will be required to fulfil the enhancement output needed. The tool will then calculate the CAPEX and OPEX costs for the specific site.

The costs are generated from a series of PR19 specifically generated cost curves, which are based on estimated points. These estimated points have been produced using the iMOD system previously described, using NWG's business as usual estimating processes.

UNIT COST BUILD UP

Traditional unit cost build up have been carried out for enhancement areas where either iMOD system does not have coverage or is not appropriate. In this approach traditional bills of quantities have been produced and costed using unit cost rates. Unit cost rates have been sourced from the following:-

1. Actual historical costs
2. Framework rates
3. Industry Data (SPONS etc)
4. Quotes

The above list order represents the order of preference that has been applied to the selection of rates used for costing.

Contract and Project Overheads have been applied using the same methodology as previously described.

OPEX costs for have not been calculated for the enhancement areas where unit costs have been used as it has been assumed that there would be no significant increase in OPEX costs in the areas applied.

HISTORICAL SPEND

For issues not covered by the previous costing methodologies, a historical spend approach has been used. Assessments of historical spending for programmes of work or unit costs have been completed and applied to forecasts of the activities proposed in PR19.

7 Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

All costs for Growth Candidates were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[4]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

[4] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 costing methodology

The assumed costs are tabulated below.

WWSLines	Expenditure line	Totex (£m)	Costing methodology
Line 1	First time sewerage (s101A)	1.000	**Historical Spend**
Line 25	New development and growth	8.600	**Historical Spend**
Line 26	Growth at sewage treatment works (excluding sludge treatment)	94.359	**iMOD CAPEX Cost Estimating**
Line 32	Infrastructure Network Reinforcement	8.650	**Historical Spend**
	TOTAL	112.609	Refer to Cost Assurance Process

These costs were benchmarked and assured using costing methods described above.

The cost assurance process and associated costs generated for the wastewater enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[5]. This review has assessed all of the Growth costs predominantly as Green that is NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

8 Optioneering

Data and calculations

The first tier of the Stage 2 growth assessment used the LPAs projections to represent higher values of growth sourced from Local Authority plans. It is assumed that completions do not exceed these figures when development timeframes are taken into consideration.

The second tier of the Stage 2 growth assessment utilised a five year average annual completion figure to represent the lower, more representative value of current growth within the catchments sourced from our internal data systems which provided figures relating to completed development.

The methods used to assess the completed development included sourcing data from the Dev Sheet II. For each STW, development since 2012 was collated to create a five year average which was inclusive of varying levels of development. This also involved using GIS to assess the rate of development on larger sites. Additionally, if the average figure calculated was close to the headroom figure, further GIS investigations were used to anticipate the land availability for future development[6] to assess if the location surrounding the STW has the capacity to continue growth at the rate of the five year average of annual completions.

The final part of the growth assessment involved reviewing each site that demonstrated capacity issues to assess the cause of the problem to see whether the site capacity issues were related to growth factors, or if the site had unusually excessive step changes in measured flows which may not be linked to growth, such as MCERT flow meter problems or the illicit connection of ground water.

Assumptions

[5] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

It is assumed for the purposes of this business case that any STWs on the wastewater compliance list which already exceed their consented flows and thus show negative headroom will automatically be put forward under another driver.

The review was conducted with the assumption that the economy would remain broadly stable and there would be neither massive increases in housing growth nor catastrophic downturns, similar to credit crunch between 2008 and 2012.

The assessment is based solely upon increased flows and that any changes on consent as a consequence of 'ratcheting' will be considered by others under the 'no deterioration' driver.

It is assumed that for employment land, only normal domestic flows are anticipated as there is currently no visibility of future large water users or industries requiring trade effluent discharge consents.

Section 101a

As this activity is driven by an application process, it is difficult to estimate the number of Section 101a schemes which will need to be delivered during AMP7.

The process used to estimate the number of Section 101a schemes is therefore reliant on historic information. It is assumed that the number and nature of Section 101a applications that we receive during AMP7 will be similar to those received during AMP6. Consequently, the project costs are likely to be around £1 million for the whole AMP period.

New Development and Growth

As this activity is driven by an application process, it is difficult to estimate the number in AMP7.
The process used to estimate the number sewer requisition and adoption is therefore reliant on historic information. It is assumed that the number and nature of requisitions and adoption applications that we receive during AMP7 will be similar to those received during AMP6. Consequently, the project costs are likely to be around £8.600 million for the whole AMP period.

Infrastructure Network Reinforcement

As this activity is driven by an application process, it is difficult to estimate the number in AMP7.

The process used to estimate the number network reinforcement as result of growth is therefore reliant on historic information. It is assumed that the number and nature of network reinforcement projects that we receive during AMP7 will be similar to those received during AMP6. Consequently, the project costs are likely to be around £8.650 million for the whole AMP period.

9 Option Appraisal

An options approach has not been considered as part of this business case. The proposed preferred option in terms of network enhancements for sewage treatment works, pumping stations and first time sewerage were all evidence based on the process detailed in Section 5 for forward looking analysis and those enhancements required are detailed as part of the preferred option in Section 7.

We did not consider a "Do Nothing" option as it would fail in several key areas:

- We would be unable to support housing delivery in line with central government expectations;

- We would fail to provide infrastructure upgrades for our developer customers and risk delaying housing delivery; or
- We could allow connection and place our downstream customers at greater risk of flooding and/or cause deterioration in our treatment works' performance and the quality of the receiving watercourse.

Our optioneering is based upon robust data agreed with our developer customers and LPAs which has been reviewed and readjusted taking into account historic and current housing delivery and an assessment of certainty of future delivery based upon catchment-specific intelligence.

Solutions have been identified using a risk-based, best value/least cost approach from analysis of previously delivered similar projects. Innovative transfer/rationalisation options were considered for each of the wastewater treatment candidates, however, each is in a discrete catchment which is extremely remote from adjacent catchments.

10 Our preferred plan/option

WWSLines	Expenditure line	Totex (£m)	Costing methodology
Line 1	First time sewerage (s101A)	1.000	**Historical Spend**
Line 25	New development and growth	8.600	**Historical Spend**
Line 26	Growth at sewage treatment works (excluding sludge treatment)	94.359	**iMOD CAPEX Cost Estimating**
Line 32	Infrastructure Network Reinforcement	8.650	**Historical Spend**
	TOTAL	**112.609**	Refer to Cost Assurance Process

10.1 First Time Sewerage (s101a)

The table below sets out the estimated for the identified candidate for First Time Sewerage.

WWSLines	Expenditure line	Totex (£m)
Line 1	First time sewerage (s101A)	
	Castle Hills	0.648
	Hagg Bank	0.202
	Hartford	0.150
	TOTAL	**1.000**

Castle Hills Farm Cottages, Berwick upon Tweed
An application was submitted in 2015 under Section 101a of the Water Industry Act 1991 for provision of a public sewer for premises at Castle Hills Farm Cottages, Berwick upon Tweed, where existing drainage arrangements are causing environmental and amenity problems. Initial investigations have identified that the applicants are drained by a private sewer which outfalls directly to the River Tweed. It has been agreed that this application does comply with the required criteria for such an application, and that we will investigate and provide the most cost effective solution to this application. The solution could be a sewerage pumping station and rising main or a small package STW.

Railway Cottages, Hagg Bank, Wylam
An application was submitted in September 2017 under Section 101a of the Water Industry Act 1991 for provision of a public sewer for premises at Railway Cottages, Wylam, Northumberland. The foul flows at these five properties are treated via a private septic tank to the rear with an overflow direct into the River Tyne. The septic tank and the overflow pipework are starting to fail which is causing an amenity and environmental issue. Although there is still a need to carry out a detailed assessment as part of the process, it is likely that we are going to accept the Section 101a application and a business request (CP0) will be raised.

10.2 New Development and Growth (WWS2 Line 25) – Sewer Adoption and Sewer Requisition

The table below sets out the estimated for the identified candidates where known for the Sewer Adoption and Sewer Requisition candidates.

WWSLines	Expenditure line	Based on	Totex (£m)
Line 25	Sewer Adoption	Historical Spend	3.600
	Sewer Requisition	Historical Spend	5.000
	TOTAL		**8.600**

10.3 Growth at sewage treatment works (excluding sludge treatment) – WWS2 Line26

The table below sets out the costs for all of the STW projects which are required under the preferred option.

Table 1: Sewage treatment works – growth costs

	Current PE	Headroom (props)	Predicted growth 2031 (props)	Props growth beyond headroom	Additional PE growth	Cost estimate
Carlton & Redmarshall STW	2669	139	234	95	228	£552,860
Morpeth STW	16764	601	1470	869	2086	£940,552
Rothbury STW	2102	-13	140	153	367	£651,480
Shilbottle STW	1736	37	100	63	151	£663,716
Longhirst STW						£590,831
Sub- TOTAL						£3,399,439
Howdon STW*						£90,960,000
TOTAL						**£94,359,439**
TOTAL						**£94.359m**

*Please see separate Howdon Business Case

10.4 Network Reinforcement Schemes

WWSLines	Expenditure line	Based on	Totex (£m)
Line 32	Network Reinforcement	Historical Spend	8.650
	TOTAL		**8.650**

11 Alignment with stakeholder needs

We believe that the final plan will meet the needs of our LPA stakeholders and our developer customers in that it targets areas of proposed high growth where we have certainty that housing delivery has commenced and is at a sustainable level. It will also ensure that we are able to allay the concerns of our domestic customers regarding increased flood risk and a deterioration in the quality of our rivers as a consequence of discharges from new development sites.

The final plans have not been discussed as part of our overall customer engagement strategy as the plan impacts upon our developers and LPAs rather than our domestic customers. We are in continuous engagement with our LPAs in the development of their Local Plans and have shared data to align their needs with our programme. Over the past year we have held a series of local workshops and been involved at a national level with Defra, Ofwat and the Home Builders Federation to understand the needs of our developer customers.

We are required to accommodate growth whilst also maintaining levels of service. In particular, our PCS relating to interruptions, flooding and pollution are likely to be impacted if we do not invest sufficiently to accommodate growth.

12 Customer protection

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed.

Unit Rate

To protect our customers we will apply a penalty rate for underperformance against this enhancement. As this enhancement targets a number of specified units as an output, we have based our penalty on a per unit basis. We will incur a penalty to the value of the number of units we achieve below our Performance Commitment (PC). For example, a PC of 10 and an actual performance of 9 would incur a penalty of 1/10th the value of customer funding received.

Any penalty will be calculated as a net present value neutral adjustment as part of the PR24 true up process of the relevant 2019 Final Determination cash flows should the outcome be delivered partially or not at all. The discount rate used will be 3.3% real, the CPIH stripped cost of capital.

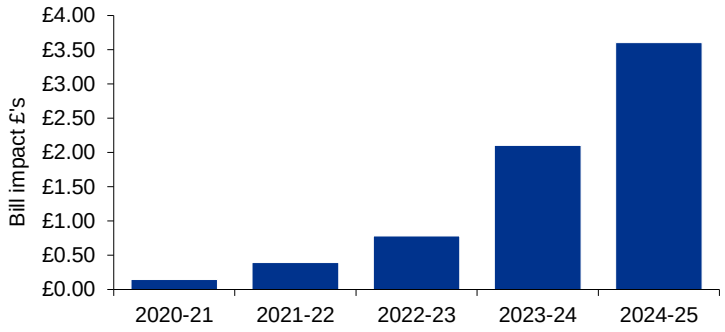
Time Rate

To protect our customers we will apply a penalty rate for underperformance against this enhancement. As this enhancement targets a specific output by a date in the future, we have based our penalty on a per day late of delivery basis. This uses the same principle as our Performance Commitment for R-F1 Delivering a consolidated customer information and billing system, penalty rate 2 at PR14.

Any penalty will be calculated as a net present value neutral adjustment as part of the PR24 true up process of the relevant 2019 Final Determination cash flows should the outcome be delivered late, partially or not at all. The discount rate used will be 3.3% real, the CPIH stripped cost of capital.

13 Affordability

The impact of these enhancement investments on customer bills are shown below[7].



Overall the analysis shows that the bill impacts would be around £1.40 a year and generally increasing over the 5 years.

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[8] driving significant improvements to average customer affordability.

The growth candidates proposed is material to the long-term stability and health of the customer service, and will contribute to a robust future network. This is in the context of an AMP7 plan which customers fully support.
Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remains a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 2030[9] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

14 Board assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the

[7] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.
[8] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast
[9] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers.

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WASTEWATER HOWDON ENHANCEMENT BUSINESS CASE

WWS2 - Wholesale wastewater capital and operating enhancement expenditure by purpose Line 26 and 27

APPENDIX 3.2

WASTEWATER HOWDON

Contents

1 Executive Summary

Name of claim	Howdon STW Expansion	
Name and identifier of related claim submitted in May 2018	[n/a]	
Business plan table lines w here the totex value of this claim is reported	WWS2 Line 26 - £90.960(Growth) and WWS2Line 26- £14.730(Resilience Too Critical to Fail)	
Total value of enhancement for AMP7	£105.690m	
Total opex of enhancement for AMP7	£0.000m	
Total capex of enhancement for AMP7	£105.690m	
Depreciation on capex in AMP7 (retail controls only)	[n/a]	
Remaining capex required after AMP7 to complete construction	[Expected to complete scheme by XX]	
Whole life totex of claim	[n/a]	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	Material	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		No
Need for investment/expenditure	The facility is nearing DWF capacity once future growth and climate change impacts are considered and therefore presents a risk of regulatory compliance failure and associated environmental impacts. Howdon STW plays a crucial role in enabling the future development of North East plc and limitations to its treatment capacity could impact the long term economic and commercial development of Tyneside and therefore the wider region. Howdon PEPS is a very large pumping station transferring flows from the primary treatment process to the site of the secondary treatment process. This asset is identified as one too critical to fail and as such a resilience project has been integrated with the expansion plans.	

Need for the adjustment (if relevant)	n/a
Outside management control (if relevant)	n/a
Best option for customers (if relevant)	Building of new assets which will complement existing treatment processes on site at Howdon to accommodate future growth and also to build in redundancy when required to safeguard from loss of service now and into the future.
Robustness and efficiency of claim's costs	NWL has assessed the costs through a structured and robust approach, involving benchmarking of cost estimates against alternatives. The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018.
Customer protection (if relevant)	A customer protection mechanism is proposed and is outlined within this document.
Affordability (if relevant)	Overall the analysis shows that the bill impacts would be rising from £0.06 a year (year 1) to £3.40 a year (year 5). This is set within an overall bill drop of more than 12% (wastewater) in AMP7, including all enhancement investments, one of the largest across the sector.
Board Assurance (if relevant)	The details of all our enhancement cases have been discussed with our PR19 Board Sub-Committee and full Board both prior to plan submission and following IAP. During these discussions the board sub-committee have challenged the details of our enhancement proposals in a number of ways which are reflected in our final enhancement cases.

Howdon STW, located on the north bank of the River Tyne is the largest wastewater treatment facility on the East Coast between Edinburgh and Humberside. It serves the population of the Tyneside conurbation with a population equivalent of 926,539. (See Figure 1)

The facility is nearing DWF capacity once future growth and climate change impacts are considered and therefore presents a risk of regulatory compliance failure and associated environmental impacts. Howdon STW plays a crucial role in enabling the future development of North East plc and limitations to its treatment capacity could impact the long term economic and commercial development of Tyneside and therefore the wider region.

This proposed investment, **Howdon STW Expansion** therefore addresses these risks and provides the capacity required as per our growth projections but also to improve the resilience of the facility ensuring NWG has the ability to operate and effectively maintain these assets without impact on current and future customers but also to the environment now and into the future. (See Figure 2)

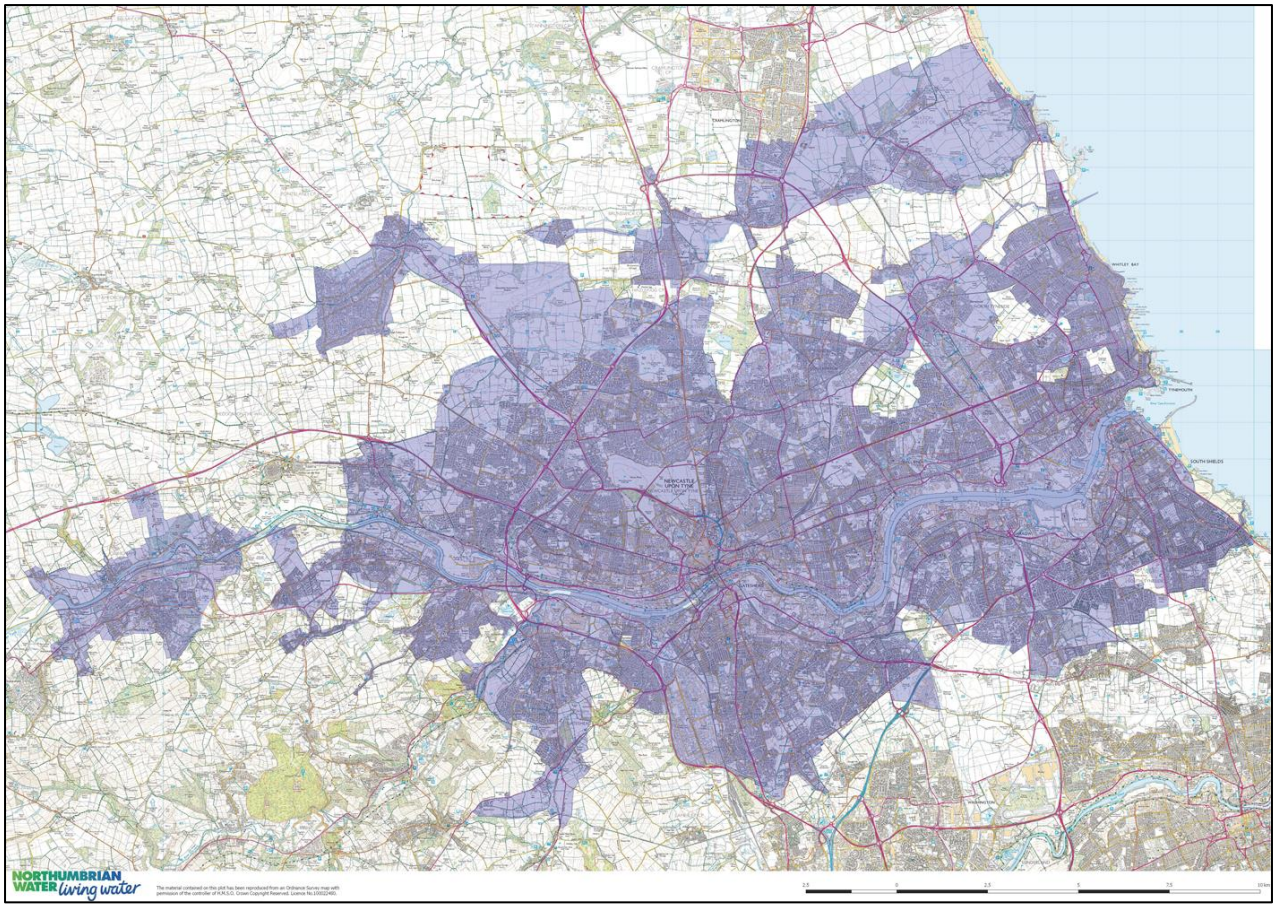


Figure 1. Drainage Area(s) into Howdon STW

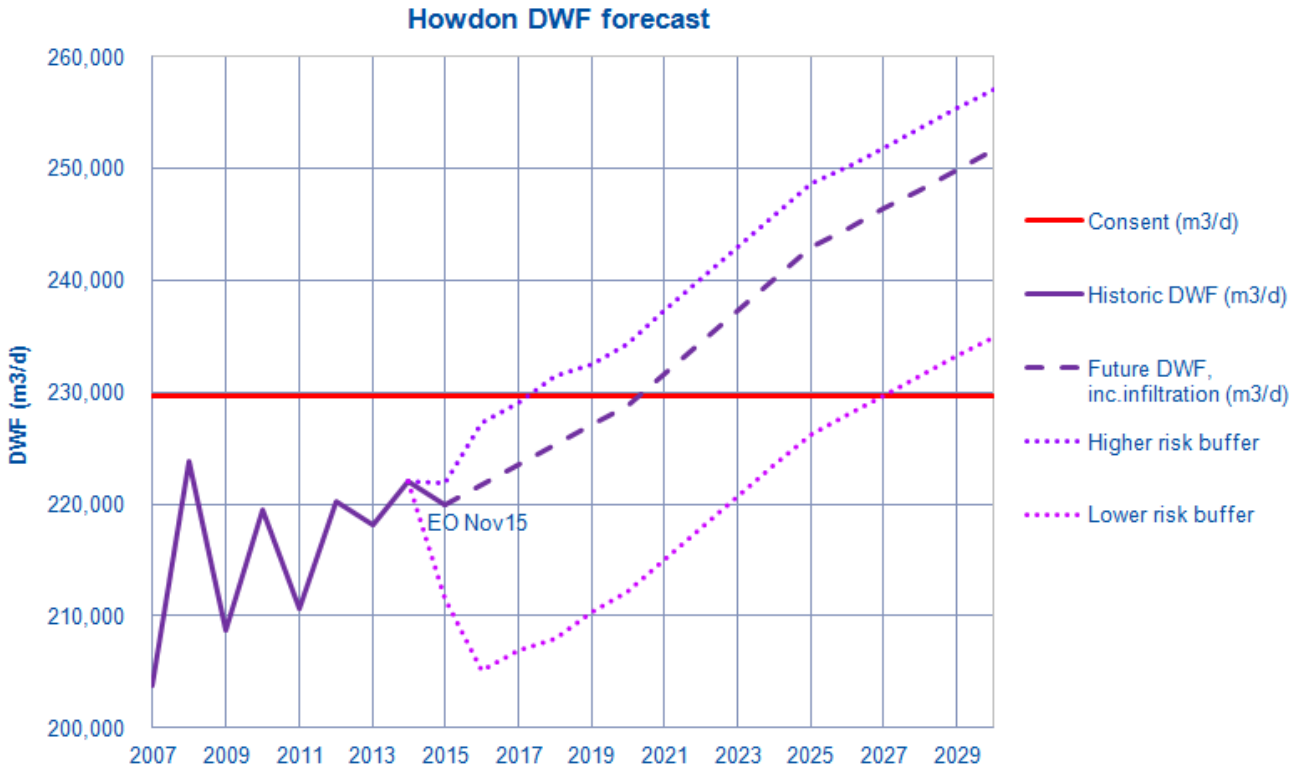


Figure 2. Growth projections and capacity at Howdon STW

2 Context and Scope

This Enhanced Wastewater Resilience Business Case supports the values included in Lines 26 and 27 of the WWS2 Wholesale Wastewater Capital and Operating Expenditure by Purpose Ofwat table.

The proposed scheme will contribute to our 'We deliver water and sewerage services that meet the needs of current and future generations in a changing world' service outcome. Howdon STW Expansion is considered to be enhanced expenditure as the benefit will be to increase the capacity or quality of service beyond current levels. The expenditure is driven primarily by statutory obligations and strategic prioritisation established by customers and stakeholders. The regulator guidelines and best practices which have driven these business plan is:
Our duty under Section 94(1) and (2) of the Water Industry Act 1991
Resilience in the Round (Ofwat)
National Infrastructure Assessment
DEFRA's strategic priorities statement which makes clear the need for long-term wastewater planning;
Ofwat expects wastewater companies to demonstrate that they are adopting the principles and recommended best practice set out in the Drainage Strategy Framework[1] and expect companies to take a risk-based approach to wastewater planning, and go beyond the drainage strategy framework;
National Flood Resilience Review Sep 16[2] carried out by the government highlights that there is need for utilities to improve mechanisms for cooperation and information sharing, identification of interdependencies between different sectors in an emergency and making the link between different industry sectors and the relevance local resilience forums and central government.

And also Government Policies such as:

- Sustainable Communities: Building for the Future 2003 - "Recognition of 30 years of under-delivery of housing by all governments"
- Housing Green Paper 2007 - "3 million homes by 2020"
- National Planning Policy Framework – "aims to simplify planning policy with a view to promoting economic and housing growth"
- Conservative Party - "200,000 houses per year by 2017"
- Labour Party - "200,000 houses per year by 2020 and predicting a 1.3 million national housing shortfall"
- North East Chamber of Commerce 2014 report "Solving the Housing Conundrum" - "the North East's housing market has under-performed for the past decade and last year built only half of the number of homes needed"

Ofwat recommends that companies should aspire to improve serviceability by moving from a reactive maintenance approach towards a more proactive approach.

In addition, NWG is aware that environmental changes will change the current landscape. Moreover, climate change will increase rainfall events and storminess, which will likely exacerbate run off rates and cause peaks and incapacity issues leading to flooding and pollution, and also cause changes in land use and growth projections further exacerbating and stressing existing treatment infrastructure.

[1] https://www.ofwat.gov.uk/wp-content/uploads/2015/12/rpt_com201305drainagestrategy1.pdf
[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/551137/national-flood-resilience-review.pdf

Through our proposal, Howdon STW expansion will contribute to the following outcomes:

- Customer - Our sewerage service deals with sewage and heavy rainfall effectively.
- Customer - We are resilient and provide clean drinking water and effective sewerage services; now, and for future generations.
- Competitiveness - We are a leading, efficient and innovative company that is always ready for change.
- Environment- We help to improve the quality of rivers and coastal waters for the benefit of people, the environment and wildlife.
- Communities - We work in partnership with companies and organisations to achieve the goals that are most important to our customers.
- Communities - We are proud to support our communities by giving time and resources to their important causes.

All of the expenditure associated with Howdon STW Expansion will deliver a permanent increase or step change in the current level of service to a new "base" level and/or the provision to new customers of the current service level. This is particularly relevant to our statutory duty under Section 94 of the Water Industry Act and strategic prioritisation to be referred to as providing resilience due to the importance of Howdon STW being an integral part of the North East of England's infrastructure.

The expenditure reflects investment in addressing issues that are important to our current and future customers. They relate to the provision of continuous wastewater service and looks into minimising the disruptions which have negative impacts on wider society through the impact on the environment, on the economy and on the communities. The investment also looks at providing current resilient services today but most importantly into the future. When looking into the future, challenges posed by climate change, population growth putting pressures on the surface water drainage. The investment will explore new and innovative solutions co-created with customers and partners. The investment does not only seek to mitigate the impacts of these challenges but also look at how services respond and recover to these hazards. It will also offer an opportunity to incorporate sustainable solutions into the design and the need to consider greener alternatives.

2.1 Overall Customer

Several sprints were held to engage with internal members to identify current and future needs for enhancing wastewater resilience.

The NWG Innovation Festive and Regional 'Thinking Ahead' Workshop enabled customers to discuss what it means to have an efficient TOTEX, and their expectations of NWG is in terms of customer service, continuous improvement and education. In addition, a water forum was held in 2018, where customers who attended the events were:

- Customers affected by flooding or other resilience scale events
- Customers at risk from flooding
- Young people
- Vulnerable customers and those in the NWG risk register
- Customers with recent contact with NWG

Through these engagements the main outcomes were that customers:

- Expect NWG to be prepared for unexpected events and responsive when they occur;
- Expect NWG to be planning and implement preventative measures when needed; Expect an adequate level of investment is made in infrastructure and use new technologies to try to stop issues arising in the first place;

- Expect NWG to be working in partnership with customers and stakeholders as a key part of developing their resilience strategy going forward;
- Expect NWG to publish their plans to provide reassurance to members of the public that they are managing these risks to service adequately.

We presented the Howdon proposals at Water Forum and at the discretionary customer engagement sessions. Comments from the different stakeholder engagement groups have helped us shape our final proposal and has taken into consideration customer expectations.

Additionally, it was concluded that customers and stakeholders prioritise the provision of a sewerage service that deals effectively with sewage and heavy rainfall. Following these engagements, schemes have been identified which respond to the customers and stakeholder's priorities and concerns. Moreover, it has influenced NWG's proactive approach to tackling the various issues. The main purpose of these schemes is to find and deal with issues before they impact customers or the environment thereby reducing the risk of uncontrolled discharges from assets which could result in flooding or pollution.

2.2 Growth Stakeholders

At a national level we have clear expectations from central government with regard to the provision of infrastructure to support development.

In the foreword to "Better Connected" published in December 2014, Brandon Lewis the Minister for Housing and Planning said:

> *"To build the homes we need and deliver the local growth and jobs to go with them, we must have a smooth and collaborative process to make sure the right utility infrastructure is in place to enable developments to connect in a timely and cost effective manner.*
>
> *We want to help create a shared understanding between utility companies and developers about utilities connections. We want to enable growth by ensuring utilities are in the right location, at the right time and at the right cost.*
>
> *To make this a reality, developers, utilities companies and regulators must all work together to continuously reduce the complexities, uncertainties and the length of time faced when connecting to utilities. This document is a starting point. It has been produced jointly between departments and the regulators responsible for electricity, gas, the water sector (water and sewerage companies) and telecoms."*

This message was reinforced by the Prime Minister in her foreword to "Fixing our broken housing market" where she stated:

> *"We need to ensure that homes are built quickly once planning permissions are granted. We will invest in making the planning system more open and accessible, improve the co-ordination of public investment in infrastructure, support timely connections to utilities, and tackle unnecessary delays. We're giving councils and developers the tools they need to build more swiftly."*

With regard to the provision of infrastructure as a policy priority at a national level, our Wastewater Director led the Infrastructure Policy Group, where major strategic infrastructure issues are discussed with stakeholders including Ofwat, Defra and the Cabinet Office. We have utilised this

opportunity to understand the expectations of these stakeholders at a national level and to shape our investment plans.

In addition to this two of our senior managers were members of the Defra Task and Finish groups set up to consult with the development sector and to implement the new developer services charging arrangements. Our Developer Services Manager sat on the Pre-Development Group, and our Regulation Manager on the Charges Steering Group.

Engaging with our developer customers specifically, we supported a Water UK 'Developer Day' workshop, where we encouraged Technical Directors from four of our major developer customers to attend and provide a balanced view of priorities alongside those of their trade body. We also carried out a Developer Led workshop to engage with our developer customers.

As part of the new charging arrangements, we were required by the Ofwat rules to develop new charges by engaging with our developer customers. We arranged a series of consultation events, as well as on on-line survey which allowed us to develop cost-reflective infrastructure charges which incentivised sustainable water management.

3 Growth Customers - Developers

We focused our customer consultation towards repeat developer customers that use our services when developing their sites and all organisations that have contacted us in recent years as part of their provision of services to developers i.e. Self-Lay Providers (SLP) and New Appointments and Variations (NAV).

We published information on our website to help customers understand how the changes could affect them and signposted other useful information on Ofwat's website and WaterUK's website.
We met with a number of SLPs and developers.
SLPs and developers were invited to complete an online questionnaire.
We held face to face meetings with NAVs.
To date, 72 customers have participated in our questionnaire.
Since July 2017 we have met with over 30 customers across our Northumbrian and our Essex & Suffolk regions. The majority of customer meetings were on a one to one basis, with other customers participating in group sessions at events that we either hosted or attended in each region.

We are also fully engaged with the local planning authorities across the region and share data with each other to inform and develop the evidenced based documents which inform the development of their local plans. This gives us the best possible data upon which to make informed decisions upon the timing and scale of infrastructure needs across the region.

Those Local Plan evidence based documents include:

- Strategic Housing Land Availability Assessments
- Water Cycle Studies
- Strategic Flood Risk Assessments
- Infrastructure Delivery Plans

3.1 Local Context

The Howdon STW Expansion will consider growth within 6 Local Planning Authorities (LPAs) as shown in the diagram below. Our strong relationship with these LPAs and their requirements to enable growth have shaped our proposal.

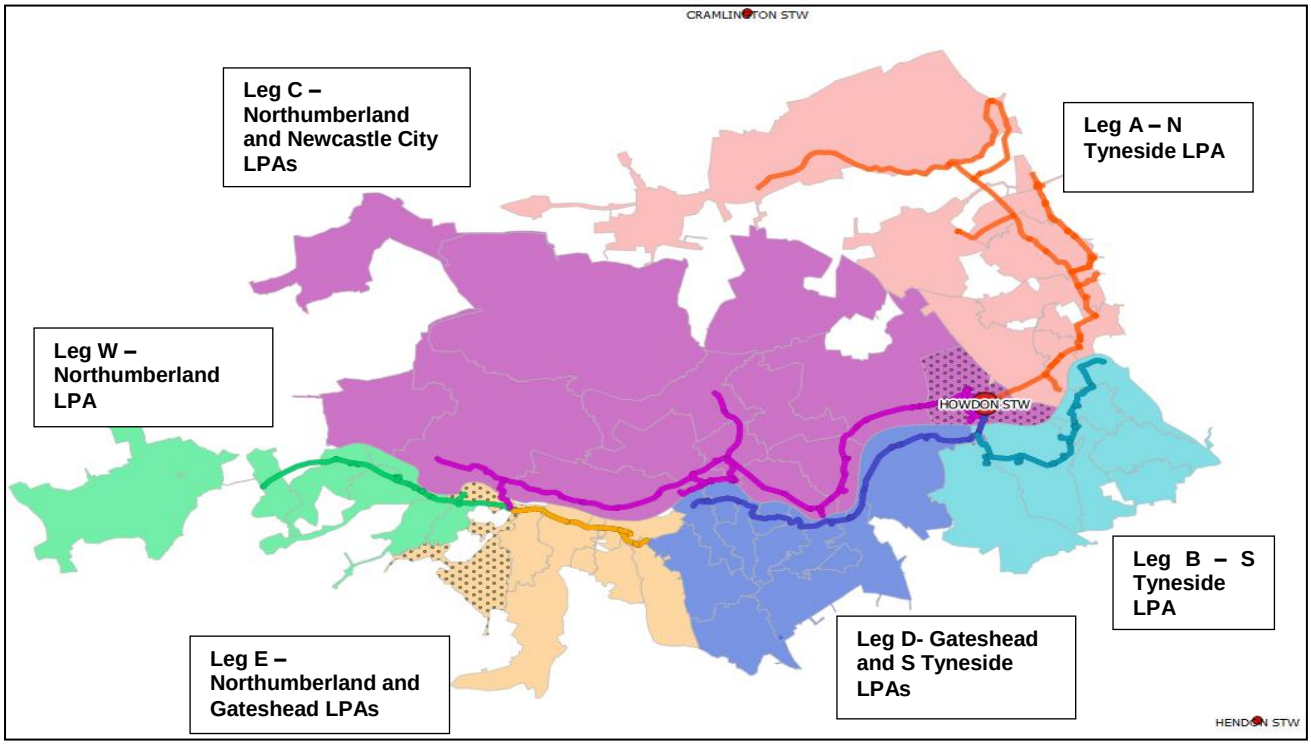


Figure 3. 6 Interceptor Legs into Howdon STW and their relevant LPAs

On site at Howdon, we benefit from a strong relationship with the local community adjacent to the treatment works. We regularly attend their Local Group.

4 Too critical too fail

In addition to the risks and drivers highlighted, the following facilities at Howdon STW have been identified as Too Critical to Fail Assets;

- Howdon South Bank Pumping Station.
- Primary Effluent Pumping Station (PEPS).
- The Return Activated Sludge (RAS) and Surplus Activated Sludge (SAS).

Failure of service at these critical locations would result in unsustainable over pumping regimes before a loss of service (within hours) leading to a significant environmental impact.

Howdon PEPS is a very large pumping station transferring flows from the primary treatment process to the site of the secondary treatment process. This asset is identified as one too critical to fail and as such a resilience project has been integrated with the expansion plans.

The upgrades to these assets and associated expenditure have therefore been included within our resilience business case as too critical to fail (refer to the separate business case for details).

5 Current and Historical Service delivery and expenditure

Over the last 10 years, we have invested circa £61m of investment at Howdon STW of which has predominantly been to address day to day running, upgrades and maintenance.

Howdon has never been expanded to accommodate Growth since it has been built.

Howdon is one of the two locations essential to Northumbrian Water's industry leading Bio Resources Operation processing both indigenous sludge and sludge produced from Durham, Tyne and Wear and Northumberland. Northumbrian Water has invested significant amounts of Capex to provide Advance anaerobic digestion (AAD) with both Combined Heat and Power (CHP) and Gas injection to the Grid capability, the wastewater plant is essential to treat the dewatering liquors from the sludge processes and the whole site benefits from the renewable energy produced from the AAD process.

6 Forward looking analysis

There are a number of uncertainties such as the population projections, existing condition of the infrastructure in place and the current and future predictions of land use and customer trends which have been identified. Key assumptions relating to the above have been considered in our approach and are reasonable due to our long standing relationships with Local Planning authorities in terms of growth trends. As for the condition of our assets, reasonable assumptions have been made but will need to be tested in the investigation phases of the project.

A 2015 study quantified the flows contributing to DWF at Howdon from each individual Tyneside Interceptor Leg and from each drainage area (Figure 3). Growth forecasts were also included across the whole catchment.

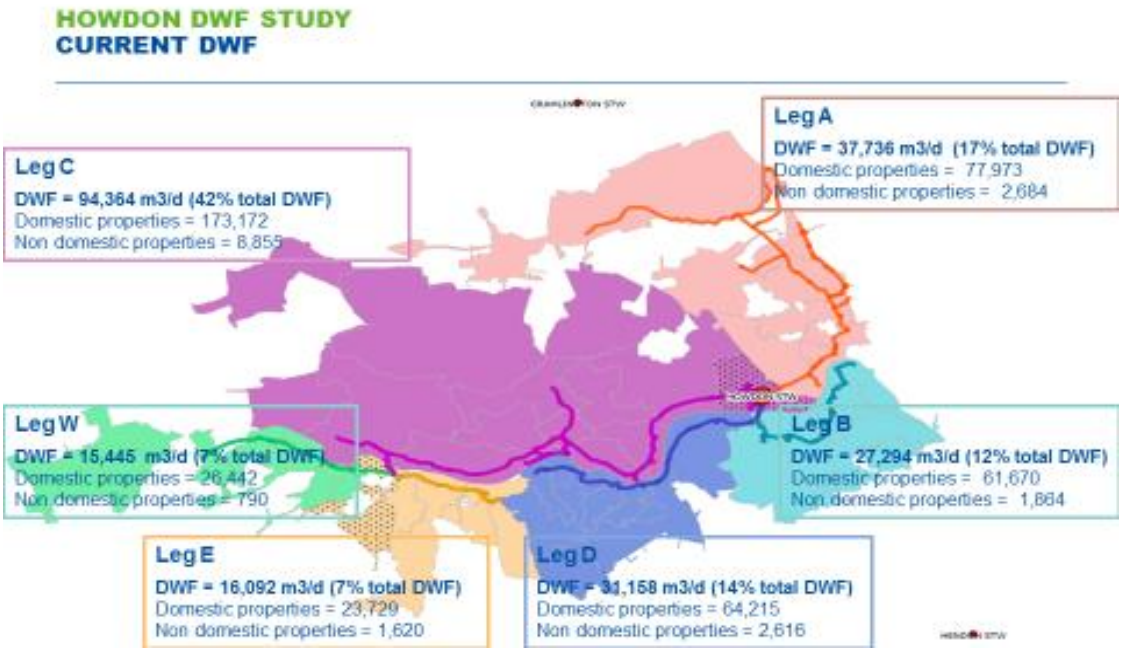
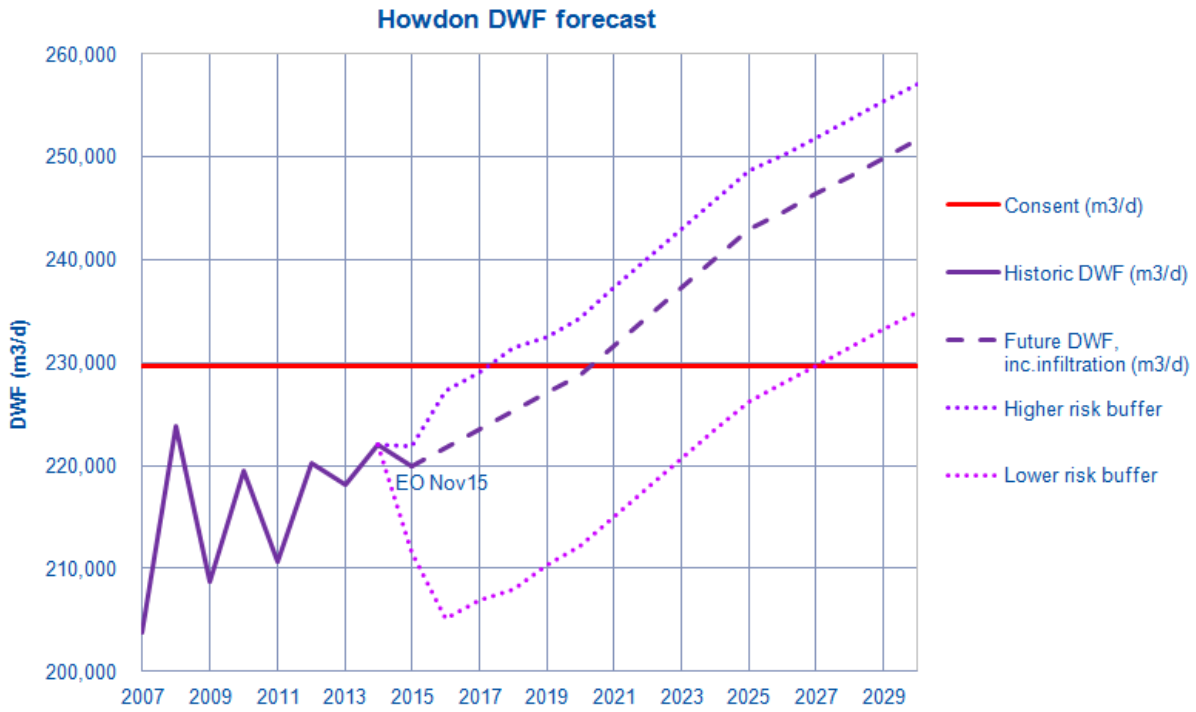


Figure 4. 2015 Interceptor Leg Study at Howdon

This study provided an understanding of the current and future risk to DWF compliance. Trigger points were then identified where interventions would be required to accommodate levels of growth (see below).



Relevant AMP6 surface water removal/management schemes, around £5.5m excluding Heworth Burn such as Marden Quarry (£2.5M), Heworth Burn (proposed £6.6m) and Killingworth (£3.0m), were also included in the Howdon DWF forecast to take account of their cumulative impact. From this, it was concluded that there is a risk to DWF compliance in the future due to climate change and changing usage. If no action is taken the DWF consent limit will be exceeded.

7 Option Appraisal

All costs included were provided and assured by internal Cost Assurance team unless otherwise stated. There are four primary approaches to costing as described below: -

1. Full iMOD cost estimate using business as usual processes
2. PR19 Costing Tool created from iMOD base estimates
3. Traditional unit rate builds up estimates
4. Assessment and forecasting of historical spend

The most appropriate costing method was chosen for each scheme.

Howdon STW Expansion

Do Nothing Scenario: This is not an option because of our duty to comply with Section 94 of the Water Industry Act.
Do Minimum: Providing adequate capacity on site at Howdon in order to accommodate growth predictions.
Do Something: Building of new assets which will complement existing treatment processes on site at Howdon to accommodate future growth and also to build in redundancy when required to safeguard from loss of service now and into the future.

Discounted option: Alternatives to building at Howdon were considered and discarded on the basis of the short term benefit that they would provide – please refer to Appendix I.

Options	Damage Avoided (Benefits)	Cost	B/C Ratio	Comment
Do Nothing	0	0	N/A	Not applicable
Do Minimum	~~£~~£	~~£~~£	=	Statutory Requirement
Do Something **Alternatives to Howdon expansion**	~~£~~£	~~£~~£~~£~~£	<1	Although the alternatives to decoupling some of the flows from the interceptor legs would be of benefit, the overall cost benefit would not stack up due to the short term gain that it would provide.
Do Something **Howdon STW Expansion**	~~£~~£	~~£~~£~~£~~	>1	Expanding at Howdon and building in redundancy within the existing infrastructure will provide a more robust whole life cost benefit and ultimately best value to the customer.

Table 1. High Level Qualitative Benefit Cost Analysis- Howdon STW Expansion

8 Our Preferred plan/Option

A review has been carried out on the current capacities of the existing site treatment process stages from the incoming flows from the Tyneside Interceptor through to final discharge of compliant treated effluent to the River Tyne. A high level process flow diagram shown in figure 5 identifies the flow of effluent through the treatment stages and their locations around the site. Required works at each treatment process stage will be detailed, outlining the considerations to growth, resilience and maintenance of existing associated assets.
For the purposes of this exercise, unless otherwise stated; maintenance of existing assets associated with these treatment process stages is assumed to be funded from base expenditure.

Howdon STW and the associated Tyneside Interceptor sewer has been a critical asset in improving the River Tyne water quality and associated environment and amenity value over the last 50 years which we hope to maintain for many years to come. The proposed scheme seeks to have no detrimental effect to the environment and the community. Furthermore the proposed scheme will look at opportunities to incorporate sustainable solutions in the design paying attention to greener and innovative options in the whole life cycle.

Through the AAD process, operational carbon is already being addressed but we feel that there is an opportunity to address the capital carbon alternatives as well though the construction phase and by the manner we procure materials. As mentioned in previous sections, Howdon is considered to be vital to the North East and its economic development. It will be an integral part of the North East's ambition of attracting people to work and live in the region promoting economic growth and cultural diversity.

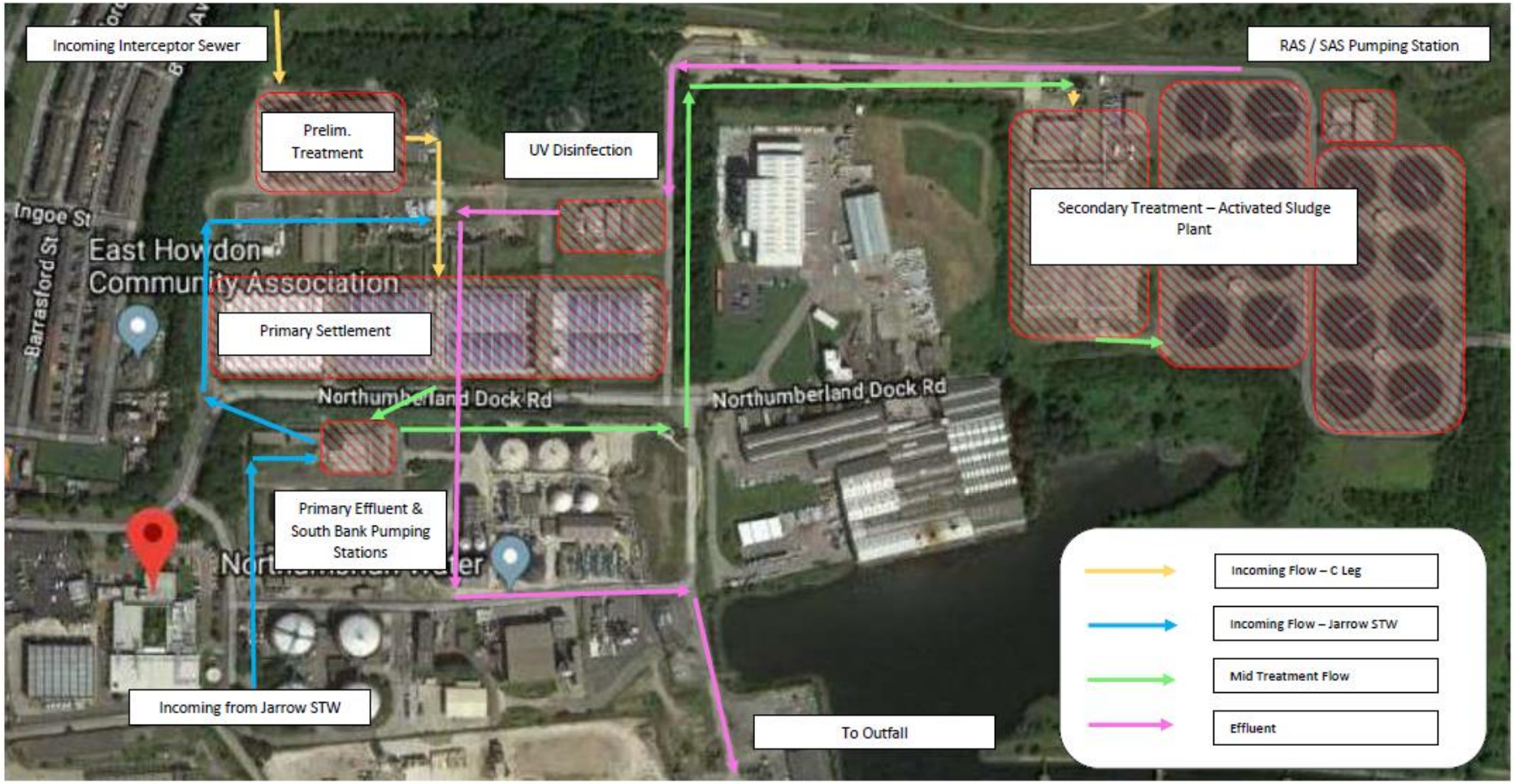


Figure 5. Process Treatment through Howdon STW

8.1 Preliminary Treatment

The preliminary treatment stage involves the removal of screenings and grit in two discrete processes and associated odour extraction and control units.
The existing screenings removal plant would not have the capacity to accept additional flows associated with growth forecasts and as such expansion of this treatment process is required.

Scope

Provision of an additional fine screening channel, providing 25% additional capacity in full flow conditions. The facility will involve providing the required connections to the existing distribution chambers and will notionally consist of:

- 6mm fine screen, associated compaction and storage for offsite disposal.
- Extension to existing screenings building to accommodate the additional channel and screening plant
- All associated Low Voltage control centres and instrumentation.

To facilitate the creation of the above facility, an existing odour control plant requires both replacement due to current asset condition and also relocation to create required space for inlet works expansion activities. It is therefore proposed to construct a new wet chemical odour control system adjacent to the existing grit removal plant. The plant will be sized for sufficient capacity to include the new inlet expansion.

Comprising:

- Complete new odour extraction and odour treatment plant.
- Chemical dosing system
- Low voltage control panel and instrumentation
- Ductwork to new location

Funding Categories Applied:

Growth –

- Provision of the additional channel and associated removal equipment
- Increased capacity to the replacement odour control system

Maintenance –

- Capital maintenance activities that would have been required to be carried out on the existing odour treatment plant (e.g. Chemical dosing pumps, Replacement media etc)

No further work has been identified as being required for the Grit Removal process plant.

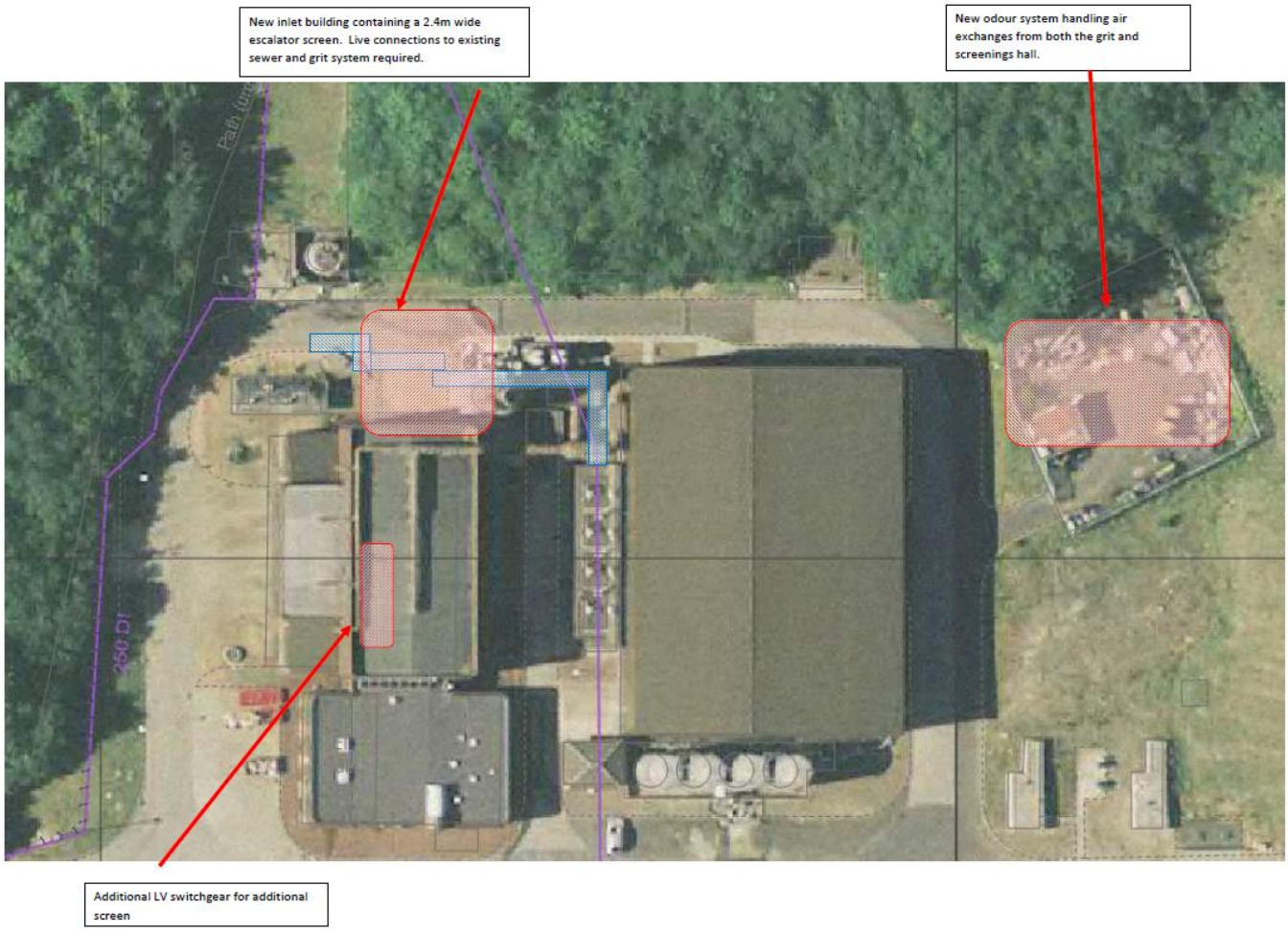


Figure 6. Preliminary Treatment Proposal

8.2 South Bank Pumping Station:

This facility receives screened and de-gritted effluent from Jarrow STW conveyed by a syphon under the Tyne. It pumps this effluent to the north of the site to combine with flows from the Preliminary Treatment Stage for Primary Treatment.

The existing facility does not have the capacity to accept additional future flows. Current arrangements prevent expansion in capacity within existing structures and also the inability to provide an appropriate standby facility to maintain flows during any refurbishment phase.

The existing rising main to the north of the site is of a GRP construction with no standby facility, and is approaching the end of its asset life. This rising main is also at hydraulic capacity and would also therefore be unable to support future growth.

It is therefore proposed to construct a new replacement South Bank Pumping Station with additional pumping and wet well capacity to accommodate the additional flows, specifically including:

- Connection into existing culvert
- New wet-well pumping station and valve chamber
- New rising main to inlet works and associated tie in points
- New HV switch gear and Low Voltage control panels
- 11Kv to 690v Transformers

Funding Categories Applied:

Growth:
The existing south bank pumping facility will require an increase in capacity to accommodate increased flows from Jarrow preliminary treatment works.

Maintenance:
The design assumes the requirement of a complete new system as the existing mechanical and electrical components are approaching the end of their asset life. The sums detailed against growth represent the total cost of the new plant minus the cost to maintain the existing plant to restore asset condition to achieve an additional 20 year asset life.

Resilience:
Whilst the pumping station or rising main are out of service there is no facility for storage of flows. The addition of a second rising main and pumping station ensures environmental compliance. It is therefore proposed to retain the existing pumping station structure, installations and connections to allow it to act as a standby facility to support future maintenance and outage activities

8.3 Primary Effluent Pumping Station (PEPS)

The Primary Effluent Pumping Station (PEPS) accepts effluent that has completed the primary settlement stage of treatment and pumps it approximately 800m through a 1400mm diameter GRP (Glass Reinforced Plastic) rising main to the Secondary Treatment Process.

The existing facility does not have the capacity to accept additional future flows. Current arrangements prevent expansion in capacity within existing structures and also the inability to provide an appropriate standby facility to maintain flows during any refurbishment phase.

The existing rising main to the north of the site is of a GRP construction with no standby facility, and is approaching the end of its asset life. This rising main is also at hydraulic capacity and would also therefore be unable to support future growth.

It is therefore proposed to construct an additional Primary Effluent Pumping Station complete with a new rising main of 1800 mm diameter is used to the next stage of the treatment process. Construction would be offline from the existing facility with increased pumping and wet well capacity to accommodate the additional flows, specifically including:

- Demolition of a disused control building to provide space for construction
- Connection into existing culvert and overflow facilities
- New dry-well pumping station and valve chamber
- New rising main to secondary works
- Connection in to secondary treatment distribution chamber
- Associated HV switch gear and Low Voltage control panels
- 11Kv to 690v Transformers

By including this facility in addition to the current asset, the site has the increased resilience to be able to plan and carry out maintenance activities whilst maintaining process performance and therefore statutory compliance.

Funding Categories Applied:

Growth:

The existing Primary Effluent pumping facility will require an increase in capacity to accommodate increased flows from the Primary Treatment stage.

Maintenance:
The design assumes the requirement of a complete new system as the existing mechanical and electrical components are approaching the end of their asset life. The sums detailed against growth represent the total cost of the new plant minus the cost to maintain the existing plant to restore asset condition to achieve an additional 20 year asset life.

Resilience:
Whilst the pumping station or rising main are out of service there is no facility for storage of flows. The addition of a second rising main and pumping station ensures environmental compliance. It is therefore proposed to retain the existing pumping station structure, installations and connections to allow it to act as a standby facility to support future maintenance and outage activities

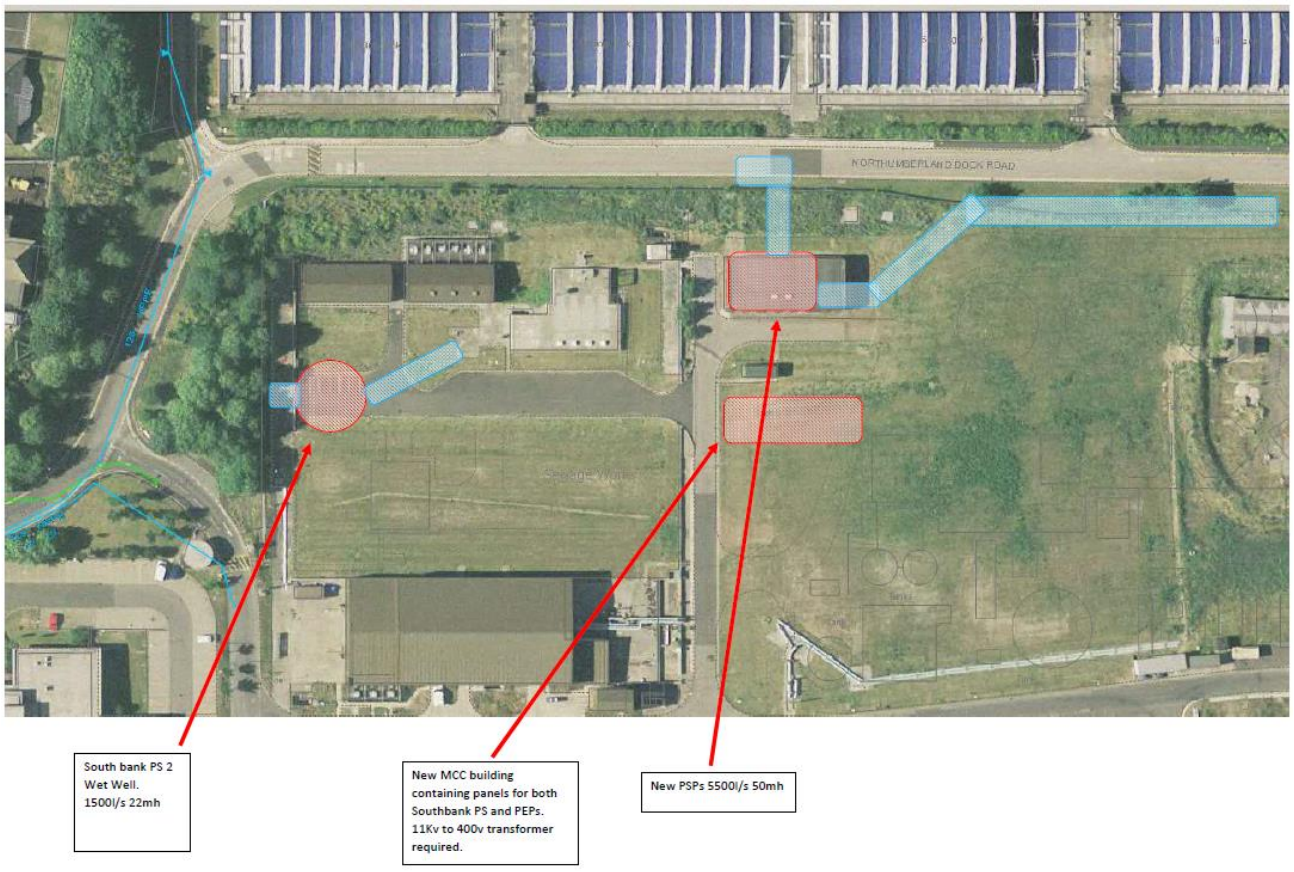


Figure 7. South Bank and PEPS Proposal

8.4 Secondary Treatment

Secondary treatment at Howdon is via a plug flow, 8 lane activated sludge plant and settlement via 16no. 39m diameter radial flow settlement tanks.

The current facility does not have the capacity to accommodate additional flows that the growth model predicts to be able to maintain performance whilst having the flexibility to maintain the asset. It is therefore proposed to expand the treatment capacity of the plant by the following:

Activated Sludge Plant

The current 8 lanes would be expanded to 10 by constructing a new structure to the East of the existing and making use of existing unused chamber connection points.

Aeration Lane Addition:

- Connection into existing distribution chambers
- All associated interconnecting and internal pipework between structures
- Appropriate expansion of the air system delivery system:
    - Additional blower, pipework and diffuser heads
- Additional HV transformer
- Additional HV switchgear
- Low Voltage control panel and instrumentation

Final Settlement Tanks (FSTs)

Provision of an additional 4 no. 39m diameter tanks to the specification of the existing (new total of 20 tanks) maintaining the existing ratio between aeration lane and FST of 1:4. These new tanks would be constructed to the North of the existing site boundary requiring expansion of the treatment site by acquisition of land.
Specific Requirements:

- Procurement of land north of existing site
- 4 number radial flow settlement tanks and scraper bridges (39m dia.)
- Interconnecting pipework
- Low Voltage control panel and instrumentation.

Funding Categories Applied:

Growth:

To allow for increased flows additional secondary treatment capacity is required as the existing facility has insufficient headroom to accommodate the increase in flows.

8.5 Sludge Pumping Systems

Both Return Activated Sludge (RAS) and Surplus Activated Sludge (SAS) are handled via a combined sludge pumping station located to the North East of the existing Final Settlement Tanks (FST's). The RAS pumping station transfers the required volume back to the aeration plant to support the ongoing treatment process whilst the SAS pumping station removes this excess and transfers it to the sludge treatment centre to south of the main works.

The existing facility does not have the capacity to accept additional future flows of activated sludge that would be generated by a larger treatment plant. Current arrangements prevent expansion in capacity within existing structures and also the inability to provide an appropriate standby facility to maintain flows and therefore treatment performance during any refurbishment phase, likely to be substantial.

The existing rising main to the north of the site is of a GRP construction with no standby facility, and is approaching the end of its asset life. This rising main is also at hydraulic capacity and would also therefore be unable to support future growth.

It is therefore proposed to construct an additional RAS/SAS Pumping Station complete with rising main to the next stage of the treatment process. Construction would be offline from the existing facility with increased pumping and wet well capacity to accommodate the additional flows, specifically including:

- New dry-well pumping station and valve chamber
- New rising main
- Connection in to pipework and distribution chambers
- Connection into existing SAS main
- Associated HV switch gear and Low Voltage control panel
- 11Kv to 690v Transformers

Funding Categories:

Growth:

The existing RAS/SAS pumping facility will require an increase in capacity to accommodate increased flows from the secondary treatment process.

Maintenance:

The design assumes the requirement of a complete new system as the existing mechanical and electrical components are approaching the end of their asset life. The sums detailed against growth represent the total cost of the new plant minus the cost to maintain the existing plant to restore asset condition to achieve an additional 20 year asset life.

Resilience:

Whilst the pumping station or rising main are out of service there is no facility for storage of flows. The addition of a second rising main and pumping station ensures environmental compliance. It is therefore proposed to retain the existing pumping station structure, installations and connections to allow it to act as a standby facility to support future maintenance and outage activities.

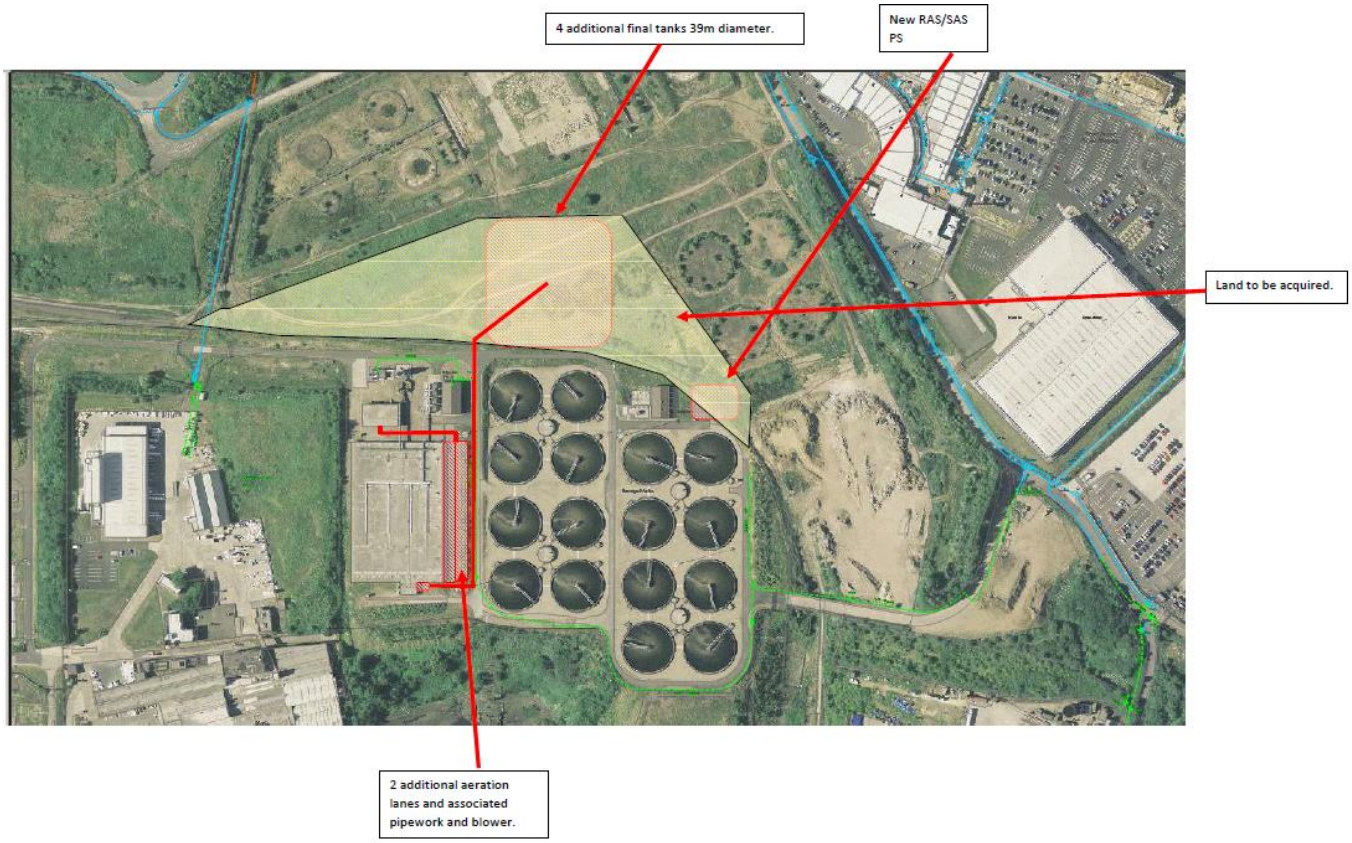


Figure 8. Sludge Pumping System Proposal

8.6 UV Disinfection System:

Effluent from the secondary treatment process undergoes a disinfection stage in order to comply with the consent associated with the Bathing Waters Directive.
The existing facility does not have the hydraulic or treatment capacity to effectively treat additional flows associated with growth estimates and maintain its current performance. It is therefore proposed to provide an additional treatment lane to the existing plant, bringing the total number of lanes to 5. This will specifically include:

- Replacement of the existing 4-distribution chamber for 5 way version
- Additional concrete channel to house the disinfection equipment
- Associated UV disinfection system based on the arrangements and capabilities of the existing
- Connection to existing collection chamber
- All associated HV and LV switchgear including additional transformer

Funding Categories:

Growth:

To allow for increased flows the UV treatment facility including HV supply and low voltage switchgear have insufficient headroom to accommodate the increase in flows and will require upsizing to accommodate increased flows.

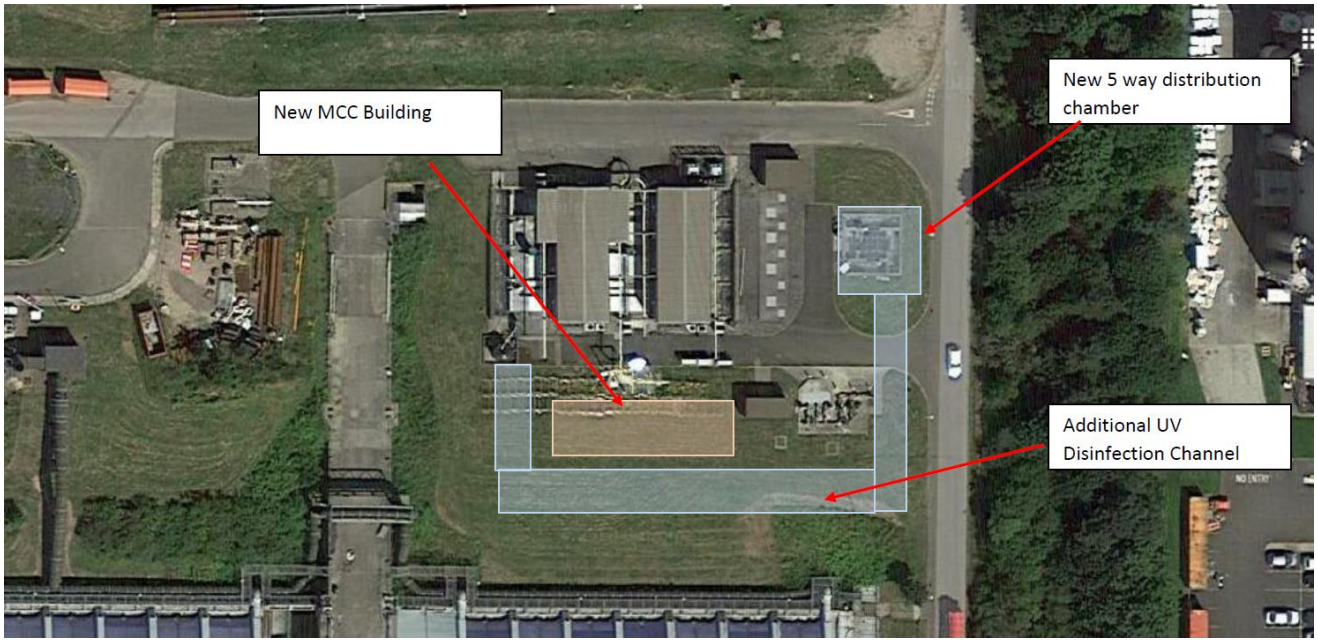


Figure 9. UV Disinfection System Proposal

8.7 Sludge Treatment

Sludge generated from both the primary and secondary treatment processes is treated via two thickening stages prior to onward treatment by an Anerobic Digestion (AD) process. By increasing flows through the works, additional sludge will be generated.

A review has determined that the first stage of this sludge treatment process; drum thickening would not have the capacity to treat the additional sludge generated. As such, an additional pair of drum thickeners is required. Additional expansion capacity already exists within the existing civil infrastructure. This will specifically include:

- 1 pair of Drum Thickeners
- All associated sludge feed pumps
- Modifications to existing Polyelectrolyte dosing system
- All associated LV switchgear, instrumentation and cabling

	Funding Category						TOTAL
Process Unit	**Growth**		**Maintenance**		**Resilience**		
	Proportion (%)	**Value (£m)**	**Proportion (%)**	**Value (£m)**	**Proportion (%)**	**Value (£m)**	**(£m)**
Inlet Works	100	2.93	-		-		2.93
Inlet Odour	85	1.16	15	0.21	-		1.37
South Bank PS	15	0.85	23	1.31	62	3.52	4.83
South Bank Rising Main	100	1.82	-		-		1.82
PEPS	20	1.15	-		80	4.62	5.77
PEPS Rising Main	100	19.33	-		-		19.33
Aeration	100	15.28	-		-		15.28
FST's	100	41.00	-		-		41.00
RAS / SAS	20	1.65			80	6.59	8.24
UV	100	2.51	-		-		2.51
Sludge Thickening	100	0.88					0.88
Misc (Power supplies and hard standing)	100	2.40					2.40
TOTAL		90.96		1.52		14.73	107.21

Table 2. Summary of scope of Expansion vs Funding Category

9 Alignment with stakeholder needs

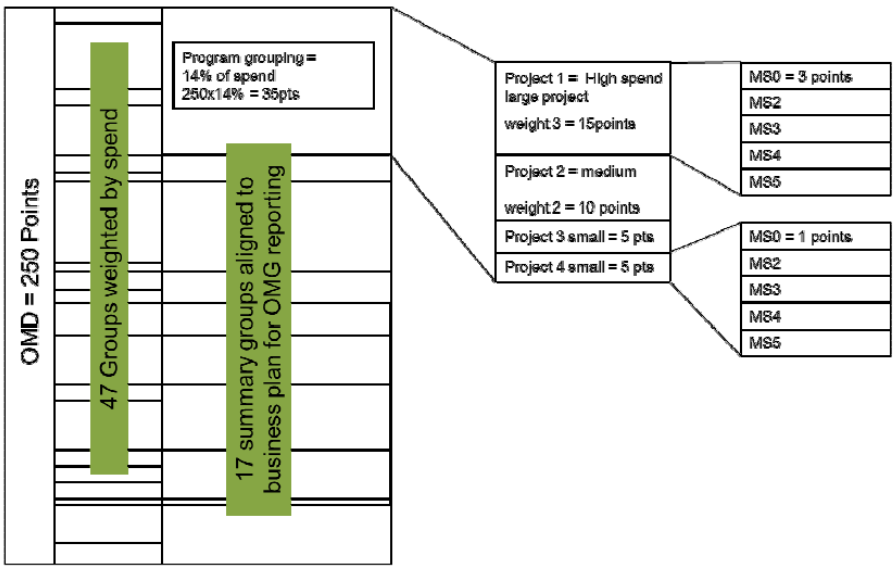
The final proposal for Howdon STW Expansion takes into consideration feedback and comments gathered through multiple engagement forums such as the NWG Innovation festival, PR19 Wastewater Design Sprint, Thinking Ahead workshops among others.

The key findings of these engagement revolved around the need to look into the future and safeguard future generations against future challenges as well as delivering innovative, cost effective solutions.

Overall, customers' preferences have been reflected in the plan and are supported by the commitments made by our customers. The engagement with customers and stakeholders was completed during the NWG's 2018 Water Forum to ensure that some of NWG's approaches deliver the best value for customers. Furthermore there is the Statement of Common Group signed by the 5 affected LPAs.

Furthermore, NWG proposes to develop an Overall Measure of Delivery to enable monitoring of the enhanced investment sought for Howdon STW Expansion. The principle is to allocate points to the project as it passes through key predetermined milestones. A target of points will be set and monitored closely by the Project Steering Group. Failure to comply and achieve milestones will result in a penalty at a rate to ensure that the customer is protected for non-delivery or lateness. Details of mechanism will mirror the KPIs set up for the Asset Investment team.

The diagram below shows the allocation of points graphically.



		AMP7					
Howdon Milestones	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
Permit Assessment	x						
Option Selection	x						
Land acquisition		x					
Planning Application		x					
Successful Procurement			x				
Start on site							
Delivery KPIs			x	x	x	x	
Asset in Use - CP5						x	
Customer receiving benefit						x	
Completion - Project Close Out							x

Figure 10. Example of an Overall Measure Delivery Point base System- courtesy of Scottish Water

10 Costing Methodology

SCOPE of Costing methodology

The purpose of this section is to describe the approach used by Northumbrian Water Group (NWG) to estimate the enhancement cost, for both CAPEX and TOTEX, associated with the PR19 business plan submission.

NWG have taken four primary approaches to costing as described below:-

1. Full iMOD cost estimate using business as usual processes
2. PR19 Costing Tool created from iMOD base estimates
3. Traditional unit rate build up estimates
4. Assessment and forecasting of historical spend

The most appropriate costing method has been chosen for each area, however, where possible either a full iMOD estimate or iMOD based tool has been favoured as it best reflects NWG's business as usual cost estimating processes.

iMOD

iMOD is a Client focussed Engineering Scoping and Cost Estimating software system, developed for Northumbrian Water, bringing project scope definition, whole life costing and tender evaluation together in one integrated system.

iMOD comprises a suite of 50 engineering scoping models and a cost database, which with a minimum of input criteria that is readily known at project inception, can provide a detailed CAPEX, OPEX and whole life costing for a range of business issues.

Supplier tender submissions can be entered directly into the system to allow tenders to be automatically checked against the iMOD asset based cost database, enabling tender evaluation to be carried out with a limited resource requirement as well as providing an enhanced confidence in a project's affordability. On completion outturn costs are captured in the system as part of the agreed project closeout procedure.

The purpose of iMOD is to form the cornerstone of our Capital Delivery Model. Allowing us to embed a should-cost culture as the entry point to working collaboratively with our delivery partners. It also supports Northumbrian Water's strategic outcome to ensure that our finances are sound, stable and achieve a fair balance between customers and investors.

iMOD CAPEX Cost Estimating

The iMOD system uses a Process and Component costing hierarchy. The relevant processes are selected for each estimate, with the engineering scoping model run for each process. This produces a quantified Work Breakdown Structure (WBS), with detailed attribute tags, with costs applied via the iMOD cost database. The process models are then supplemented with individual components and/or unit rates to complete the estimate as appropriate.

Contract overheads are then applied from a selection of 19 sub-categories that are chosen based on site specifics or work type specific considerations. Each sub-category consist of historical data cost curve and is generated using the value of the measured works. Project overheads are then applied to the combined value of the measured works and the contract overheads, based on a selection of 21 sub-categories.

All cost estimated have been produced using APG specific cost curves for Process, Component, Contract and Project Overheads. APG areas area as follows:-

- Water Treatment
- Water Networks
- Wastewater Treatment
- Wastewater Network

iMOD OPEX Cost Estimating

The iMOD engineering scoping models produce detailed OPEX cost calculations for Power, Operational labour, Chemical & Materials and Waste disposal. E.g. when running a Pumping Station model the KW pump rating and daily/monthly/annual run time would all be automatically calculated and costed via the OPEX unit cost table. The OPEX unit cost table has been updated from actual cost data provided by Management Accounts team.

PR19 COSTING TOOLS

PR19 costing tools have been created specifically for the Water Treatment and Waste Water Treatment enhancement costing for both CAPEX and OPEX.

The costing tools consist of tables where the user can input individual site data, giving site specific yardsticks (i.e PE or MLD) and can then select which processes will be required to fulfil the enhancement output needed. The tool will then calculate the CAPEX and OPEX costs for the specific site.

The costs are generated from a series of PR19 specifically generated cost curves, which are based on estimated points. These estimated points have been produced using the iMOD system previously described, using NWG's business as usual estimating processes.

UNIT COST BUILD UP

Traditional unit cost build up have been carried out for enhancement areas where either iMOD system does not have coverage or is not appropriate. In this approach traditional bills of quantities have been produced and costed using unit cost rates. Unit cost rates have been sourced from the following:-

1. Actual historical costs
2. Framework rates
3. Industry Data (SPONS etc)
4. Quotes

The above list order represents the order of preference that has been applied to the selection of rates used for costing.

Contract and Project Overheads have been applied using the same methodology as previously described.

OPEX costs for have not been calculated for the enhancement areas where unit costs have been used as it has been assumed that there would be no significant increase in OPEX costs in the areas applied.

HISTORICAL SPEND

For issues not covered by the previous costing methodologies, a historical spend approach has been used. Assessments of historical spending for programmes of work or unit costs have been completed and applied to forecasts of the activities proposed in PR19.

11 Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

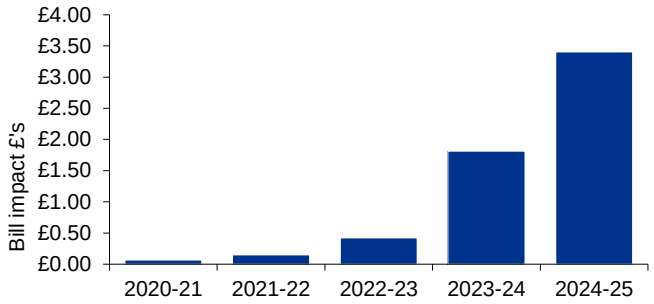
All costs for Growth Candidates were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[3]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

[3] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 costing methodology

12 Affordability

The impact of these enhancement investments on customer bills are shown below[4].



Overall the analysis shows that the bill impacts would be around £1.20 a year and generally increasing over the 5 years.

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[5] driving significant improvements to average customer affordability.

The growth candidates proposed is material to the long-term stability and health of the customer service, and will contribute to a robust future network. This is in the context of an AMP7 plan which customers fully support.
Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remains a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 2030[6] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

13 Board assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

[4] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.
[5] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast
[6] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers

The assumed costs are tabulated below.

WWSLines	Expenditure line	Totex (£m)	Costing methodology
Line 1	First time sewerage (s101A)	1.000	**Historical Spend**
Line 25	New development and growth	8.600	**Historical Spend**
Line 26	Growth at sewage treatment works (excluding sludge treatment)	94.359	**iMOD CAPEX Cost Estimating**
Line 32	Infrastructure Network Reinforcement	8.650	**Historical Spend**
	TOTAL	112.609	Refer to Cost Assurance Process

These costs were benchmarked and assured using costing methods described above.

The cost assurance process and associated costs generated for the wastewater enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[7]. This review has assessed all of the Growth costs predominantly as Green that is NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

[7] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

14 Appendix I

Alternatives to Howdon STW Expansion

Following the 2015 study, the intervention options considered were the dissociation of interceptor legs based on different catchments and re-routing of the flows towards existing STWs/SPS which would need upgrading. Each option and combination of options was tested in against impact on Howdon's forecast DWF. The options:

- Reinstate a STW at *Prudhoe* on site of the abandoned STW discharging into the River Tyne. This option would take flows from the whole drainage area, currently sent to Howdon STW through Prudhoe SPS Hagg Bank
- Build a new STW at *Ponteland* which would discharge into the River Pont. Ponteland STW would take flows from the whole drainage area, currently sent to Howdon STW through Ponteland SPS Eland Land.
- Build a new STW next to current SPS, which treated effluent would be pumped to Blyth STW sea outfall for discharge into the sea. Holywell STW would take flows from drainage area, currently sent to Howdon STW through *Holywell* SPS
- Build a new STW next to current *Derwenthaugh* SPS, which would discharge into the River Tyne by the metrocentre.

These options were appraised based on the predicted flow removed from Howdon's sewage treatment work, the associated capital and operational expenditure of implementing the options, their DWF compliance risk (in years) and the cost per removed DWF (£k/m), these are summarised in the table below.

Option	**Predicted flow removed from Howdon STW (2030)**		**CAPEX (£)**	**OPEX (£)**	**DWF Compliance risk (years)**	**£k/m^3**
	M^3/day	Housing equiv.				
Prudhoe STW	6,343	16,519	17.18m	307,982	4	3.0
Ponteland STW	7,785	20,273	23.13m	481,388	4	3.3
Holywell STW	13,300	34,635	39.02m	535,099	8	3.1
Derwenthaugh STW	34,820	90,677	80.72m	828,178	20+	2.4

Table 3. Alternatives Howdon STW Expansion

It has been assumed that the DWF forecast determined in the 2015 study is accurate. Two "buffers" have been considered: 90% confidence buffer - higher risk bank and 90% confidence buffer – lower risk buffer. This helped evaluate options by not only looking at the forecasted DWF but within the low and high-risk buffers as depicted in figure 11.

It was concluded that the alternatives solutions would offer a relatively short term solution and land risks such as land purchase and longer planning process identified would increase costs and therefore were not pursued further, but are not totally discounted.

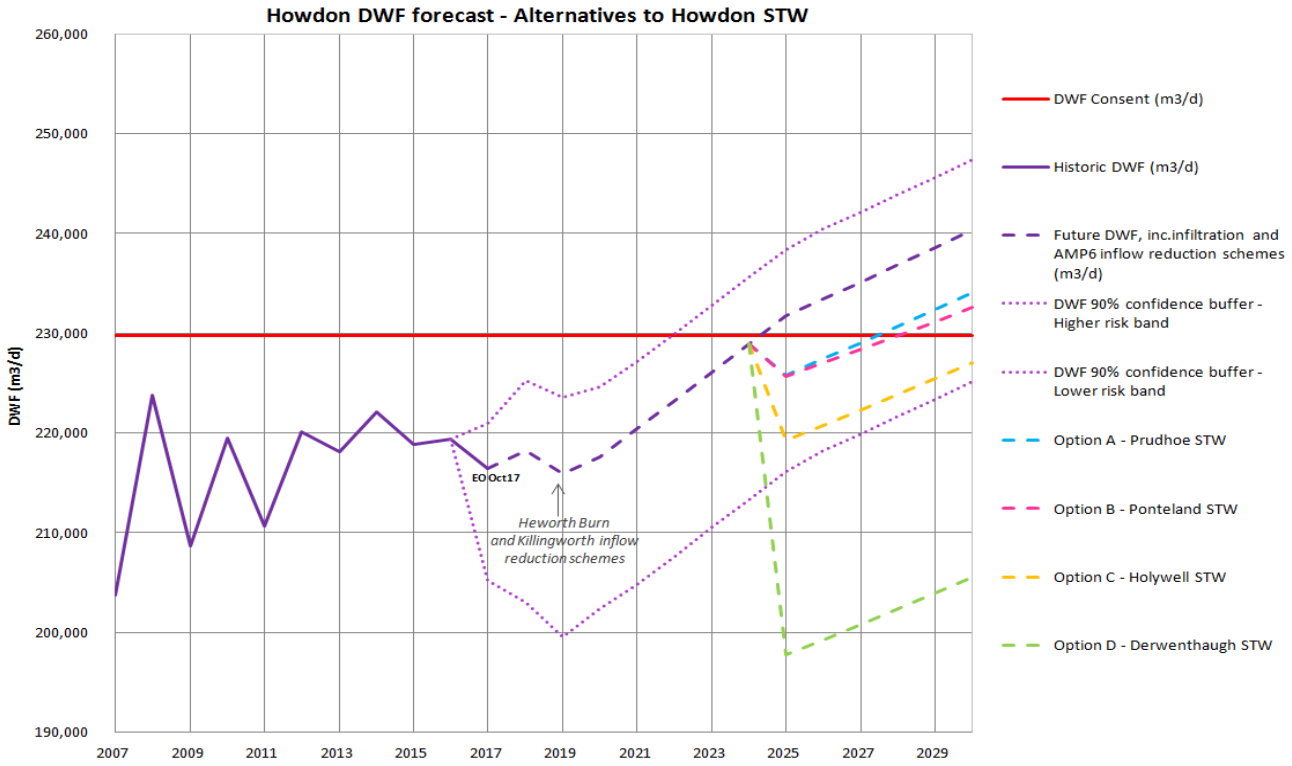


Figure 11. DWF Forecast with Alternative options

Tyneside Growth & Howdon Expansion

Introduction/Background

The Tyneside catchment is relatively recent in respect of many of the Water Industry assets, right up until 1979 most of the sewage from the catchment drained via outfalls without treatment and into the Tyne. The Tyne as a result was very polluted and the discharges from two coal coking plants made it lifeless.

The Tyneside joint sewerage board, established in 1966, developed the plan and designed for an interceptor system draining Waste to East with flows crossing the river from north to south and eventually finding their Way to Howdon STW where initially Preliminary and Primary Treatment would be provided. Construction Started in 1973 and flows were transferred in 1979.

The Catchment has 57 drainage areas, it intercepts (76KM of interceptor) more than 200 major outfalls discharging to the Tyne. It includes 10 major Pumping Stations, 150 minor Pumping Stations, over 300 Combined Sewer Overflows and dual siphons under the Tyne from Jarrow

Since the original construction we have added:

- Storm interceptor for the Bathing water Scheme at Briardene has been added and drained back to Howdon. (1995)
- Secondary Treatment for compliance with UWWTD (2000)
- UV Treatment (2003)
- The Tyne is now regarded as one of the best Salmon rivers in the UK.

Howdon is also one of two of our strategic Bioresorces (sludge) locations where we process all of Northumbrian Water's sludge through and Advanced Anaerobic Digestion Process (AAD) to generate energy either in the form of electricity or by cleaning and enhancing the Bio-methane for

direct injection to the gas grid. The site has to have both the Treatment Processes and the Bioresources processes fully integrated to manage the volumes of indigenous sludge generated from the plant and the resulting liquors back from the AAD process.

Addressing Growth

The catchment of Howdon STW serves the areas of five Local Planning Authorities (LPAs) – Newcastle, North Tyneside, Gateshead, South Tyneside and Northumberland. Each of these LPAs are required to produce strategic planning documents to demonstrate how growth will be delivered over a 15 year horizon and how this growth will be supported by critical infrastructure, including water and wastewater services.

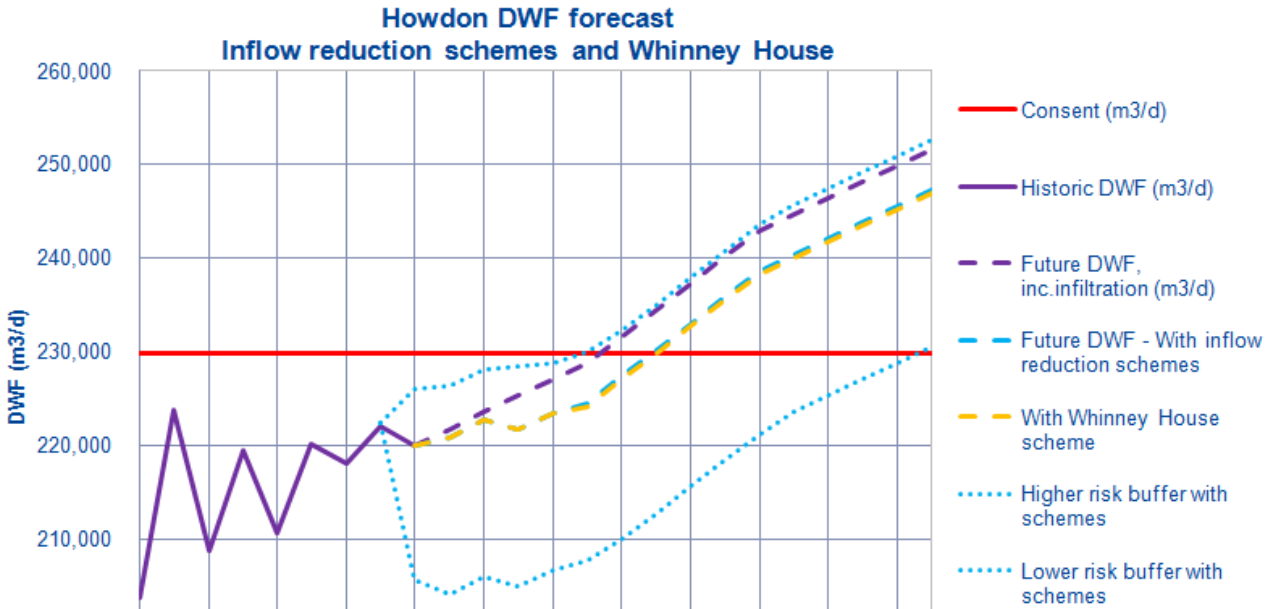
As such, NWG has actively engaged with all LPAs throughout the production of their Local Plans to identify areas where investment in water and wastewater assets may be required to support growth aspirations. This process began in 2010 with the Core Strategy and Urban Core Plan for Gateshead and Newcastle, which has now been adopted, as has the North Tyneside Local Plan. The Northumberland Local Plan is currently progressing towards examination in public and work continues on the South Tyneside Local Plan.

Through the development of Local Plans, the capacity of Howdon STW has been identified as a key element with the ability to influence the delivery of additional development across the Tyneside catchment. To support the adoption of the Plans, the LPAs have sought a reaffirmed commitment from NWG that we will invest in Howdon STW to ensure that it is capable of accommodating additional flows.

The LPAs have recognised the investigations and surface water separation schemes that have been undertaken within the catchment and the impact that this has on capacity for new development, however it is also understood that further work will be required to accommodate the scale of development proposed.

As Howdon has been edging ever closer to the maximum allowable dry weather flow (DWF) as part of our current we have been managing the dry weather flows for Howdon by removing continuous surface water from the system. These are often full watercourses that were previously intercepted, years ago, because it was easier to do than to separate the foul elements from the surface water. The graph below shows some of the most recent interventions and the latest removal schemes due to start soon.

The graph below shows that with the growth predictions discussed earlier, that we have got to the point that with all the major surface water removed, we will still exceed the permitted DWF midway through the next AMP. We therefore need to address this capacity and permit issue before this point and we need to build in enough capacity to address the demand for the next 20 to 30 years.



Options Considered

We looked at 3 ways we could manage additional flows:

A. Partition Flows at strategic Tyneside Interceptor Nodes and building a new wastewater plant
B. Direct Flows away from the existing Tyneside Catchment and to other plants.
C. Extend Howdon

A. Build a stand alone New Plant

There were 3 potential Tyneside Interceptor nodes we considered; Derwenthaugh, Jarrow and North Shields, these are all locations where a leg or legs of the Interceptor with sufficient flow terminate and have the potential to be directed to a new Wastewater plant.

North Shields, this option was discounted very early as there was no suitable land we could potentially use.
At Jarrow we already have a site which forms part of our Preliminary works on the south side of the river before flow is transferred via syphons under the Tyne to the Howdon site. We own land here and there is some land adjacent to our site that had some development potential. However, the land space is limited and the foot space would not allow us to build to treat a sufficient amount of the flow to achieve the immediate requirement and have a reasonable design horizon for the future.

Our site at Derwenthaugh comprises of a large Pumping Station which transfers flows from two of the main Interceptors on the south side of the Tyne over Scotswood Bridge where the flows are then captured by another interceptor on the north side of the Tyne. While there was no land available next to the Pumping Station, the concept of redirecting the rising main to another location with sufficient land was an option. The size of the flow gave sufficient capacity with a reasonable design horizon for the future. We therefore costed this option for further consideration.

B. Re direct to Other Plants

Two existing Sewage Treatment Works were also considered as possible ways to portion flows away from Howdon. Cramlington STW in South Northumberland was looked at, however, it had no substantive spare capacity and would require a significant amount of re-drainage and pumping to redirect flows towards Cramlington to provide what would be a limited amount of gained capacity at Howdon.

Hendon Sewage Treatment Works which serves the Sunderland catchment was also considered, whilst there was a reasonable amount of capacity at the STW following the demise of a brewery in the catchment getting flows out of the Tyneside Catchment and into the Wearside catchment would again require a substantive infrastructure redevelopment with a lot of pumping involved.

Even if both Hendon and Cramlington were combined this would only give a limited amount of capacity and design horizon with what would be a disproportionate cost in doing so.

C. Extend Howdon

Extending the Howdon plant was a viable option but not straight forward as many aspects of the plant would need to be upsized to hydraulically accept the additional flows and treat to a tighter qualitative permit to achieve a no deteriorating impact to the receiving water course.

In addition to the expansion of the works as part of NWGs PR19 submission some resilience measures were proposed to deal with single points of failure eg the Primary Effluent Pumping Station (PEPS) and its rising main would have increased pumping capacity a second rising main and wet well to avoid a scenario where we lost the pumping capability at one of our largest Sewage Pumping station. PEPS transfers flow from the original Howdon location up to the site of the Activated Sludge Plant where additional land was purchased prior to the build of the secondary treatment works in year 2000. Any additional flows for the growth would be built into this resilience work but costed for under growth.

The expansion of the Howdon works will include the following:

- Extend Preliminary Treatment Inlet Works to provide additional Hydraulic Capacity and screening capability, additional grit capacity will not be required
- Increase the Pumping Capacity of the South bank SPS to lift Flows from the siphons onto the main works. This will need more pumping capacity and an additional rising main.
- The Primary Treatment Works and storm retention tanks are undergoing a major upgrade this amp and we do not anticipate any additional work. As all new development flows would foul only because the surface water would be separated no additional storm capacity would be required at Howdon.
- All the additional flows exiting Primary Treatment would have to be accommodated by the PEPS (see previous).
- The Activated Sludge plant would require additional Aeration Capacity and Final Settlement capacity, additional land will be required to do this and we have a few lands options to locate the final tanks.
- The UV plant would require an additional Lane
- Various Pipe and distribution Chamber upsizing
- Some changes to Odour control.

This build would have to be integrated into an existing operational site and compliance for both the plant and bioresources cannot be compromised. A site plan has been marked up to show in the appendix.

Making the Decision

From the Optioneering work there was only 2 options to compare, building a new works at a location near Derwenthaugh or extending Howdon. The following table considers the two options side by side:

Consideration	Howdon	Derwenthaugh
Land Availability	Number of Land Options available adjacent to current locations	Land is available but significant constraints will need to be overcome

Consideration	Howdon	Derwenthaugh
Planning	Good relationships with Planners who understand the growth requirements.	Land Options are in conservation areas which if could be overcome will take considerable time.
Discharge Permit	The revised permit would be based on no deterioration plus. We are working with the EA on this we expect an Ammonia limit to be applied, to reduce the load into the river but not expected to be too onerous.	This would be a new permit and as this location is significantly up stream of Howdon so there will be a higher expectation on all sanitary parameters will be applied requiring extended ASP plants or tertiary treatment. Only conventional Treatment Options were costed.
Storm Treatment	No additional capacity required as only additional foul flows only will arrive at Howdon	Storm Tanks would need to be added. This was not costed for in the initial costings
UV	Extend Existing plant with an additional UV lane	Must Include because of no deterioration on Howdon Existing Flows
Energy Costs	Some additional Pumping for new flows. Some opportunities to minimise treatment energy requirements as load ramps up over time.	Increased pumping costs to transfer to new location along a longer rising main. Energy consumed on site will have to be a base load with will be a step change on commissioning of the new plant.
Operation Costs	Existing Team to absorb as the work volume will only marginally increase.	New team to be established to operate a medium/large plant.
Maintenance Costs	Assumed Common Impact	Assumed Common Impact
Sludge Costs	Incremental increase in sludge volumes would be reflected in the unit cost which would have a positive effect on revenue for power offsetting on the Howdon site.	Additional costs to Transport sludge as most of the sludge from the Derwenthaugh flows already arrive at Howdon and some loss in efficiency to remobilise sludge if transported as a cake
Ramping UP efficiencies	Options to accept flows early and minimise operational costs.	No Option once flows are turned.

Consideration	Howdon	Derwenthaugh
Resilience work	Howdon PEPS is common to both options. Efficiency in constitution costs could be gained working along side the growth work.	Howdon PEPS would still need to go forward. Further resilience for Derwenthaugh would have to be considered because of the upstream location.
Construction	Very complex with many tie-ins to existing old structures with a need to maintain flow and compliance to both the Treatment and bioresources plant.	Once Land acquired this would be relatively straight forward, rising main from the pumping station could be more difficult.
Can we achieve the additional capacity within the timescales	Best option, to deliver with the next AMP with options to ramp up over the amp and avoid a breach of the permit.	Unlikely to be delivered within the AMP. This option is on/off
DPC Opportunity	With the site integration and the complex nature of the construction, as well as the subsequent operation, DPC is not possible.	Straight Forward ideal opportunity for DPC for all aspects of the build.

Conclusion

Howdon Expansion became the preferred option as this offered both the best capital and whole life costs once the permitting impact was fully understood with the Environment agency. Howdon also gives us the best option to avoid a breach in our permit as we expect the planning process to be straighter forward as well as the potential land acquisition. Howdon also allows us to continue with our very efficient integration with the Bioresources plant and avoid any additional transportation costs.

Howdon will not be an easy construction and because of this, direct procurement opportunities are not viable.

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WASTEWATER RESILIENCE ENHANCEMENT BUSINESS CASE

WWS2 - Wholesale wastewater capital and operating enhancement expenditure by purpose Line 27

APPENDIX 3.2

Wastewater Resilience

Contents

APPENDIX 3.2

Wastewater Resilience

1 Executive Summary

The following table summarises the Resilience enhancement proposal.

Name of claim	Wastewater Resilience	
Name and identifier of related claim submitted in May 2018	N/A	
Business plan table lines w here the totex value of this claim is reported	WWS2 Line 27	
Total value of enhancement for AMP7	£87.844 m	
Total opex of enhancement for AMP7	£0.000m	
Total capex of enhancement for AMP7	£87.844m	
Depreciation on capex in AMP7 (retail controls only)	[n/a]	
Remaining capex required after AMP7 to complete construction	[Expected to complete scheme by XX]	
Whole life totex of claim	N/A	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	Material	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		No
Need for investment/expenditure	Our Wastewater Resilience Proposal is made up of two sections: **Network Resilience**; as part of our Network Resilience enhancement, we are requesting expenditure to identify targeted areas for network resilience above and beyond our current levels of service, including assessing and responding to the risk of flooding from all sources in partnership with other Risk Management Authorities, from which we would not normally be responsible for. This holistic catchment approach and co-creation of schemes will ensure that we provide our customers with best value and benefit. **Too Critical to Fail Asset Protection**; as part	

	of our proposal, we are requesting expenditure to address the continuation of essential services and offer a step change in our ability to avoid, cope and recover from specific disruptions. Our resilience package gives us the ability to cope with, and recover from disruption, as well as the ability to anticipate trends and variability associated with extreme weather conditions and climate change now and in the future. Our approach considers a range of measures which align to the four key strategic components, 4Rs, from the Resilience' Task and Finish Group'.
Need for the adjustment (if relevant)	n/a
Outside management control (if relevant)	n/a
Best option for customers (if relevant)	The resilience package proposed will allow us to develop opportunities, which have been fully appraised and are therefore in the best interest for our customers. We will also, where appropriate co-create solutions, ensuring that we develop catchment wide solutions in partnership with others, and therefore ensuring that we don't just focus on issues that only affect us.
Robustness and efficiency of claim's costs	NWL has assessed the costs through a structured and robust approach, involving benchmarking of cost estimates against alternatives. The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018.
Customer protection (if relevant)	A customer protection mechanism is proposed and is outlined within this document.
Affordability (if relevant)	Overall the analysis shows that the bill impacts would be rising from £0.16 a year (year 1) to £2.82 a year (year 5). This is set within an overall bill drop of more than 12% (wastewater) in AMP7, including all enhancement investments, one of the largest across the sector.
Board Assurance (if relevant)	The details of all our enhancement cases have been discussed with our PR19 Board Sub-Committee and full Board both prior to plan submission and following IAP. During these discussions the board sub-committee have challenged the details of our enhancement proposals in a number of ways which are reflected in our final enhancement cases.

Table 1. IN18/11- Enhancement Expenditure: Wastewater Resilience

APPENDIX 3.2

Wastewater Resilience

Resilience is one of the key themes of PR19. Ofwat's definition of resilience is the ability to cope with, recover from disruption and anticipate variability, to maintain services for people and protect the natural environment now and in the future. Ofwat has developed seven resilience principles which set Ofwat's expectations for resilience which have been used to propose schemes.

Delivering resilient services to customers is at the heart of everything NWG does, from our day to day operations to making the right long-term investment choices, all balanced against risk and customer affordability. Customers have said that they accept that things will go wrong from time to time and that every eventuality cannot be covered. NWG understands what matters to them and what their priorities and expectations are in the short, medium and long term. NWG seeks to introduce short term solutions to increase overall network resilience as well as develop plans that identify and address the long-term risk mitigation and investment requirements. These plans are supported by the use of both risk scoring and cost benefit analysis as and support meeting our long-term objectives in line with both governmental, regulatory and customers' expectations.

Our Wastewater Resilience Proposal is made up of two sections:

- **Network Resilience**; as part of our Network Resilience enhancement, we are requesting expenditure to identify targeted areas for network resilience above and beyond our current levels of service, including assessing and responding to the risk of flooding from all sources in partnership with other Risk Management Authorities, from which we would not normally be responsible for.

  This holistic catchment approach and co-creation of schemes will ensure that we provide our customers with best value and benefit.

- **Too Critical to Fail Asset Protection**; as part of our proposal, we are requesting expenditure to address the continuation of essential services and offer a step change in our ability to avoid, cope and recover from specific disruptions.

Our resilience package gives us the ability to cope with, and recover from disruption, as well as the ability to anticipate trends and variability associated with extreme weather conditions and climate change now and in the future. Our approach considers a range of measures which align to the four key strategic components, 4Rs, from the Resilience' Task and Finish Group'.

Wastewater Resilience	CAPEX(£m)	TOTEX(£m)
Network Resilience		19.606
Monitoring	4.303	
Hydraulic model enhancement	1.188	
Strategic studies	1.782	
Resilience wastewater schemes	3.168	
Drainage and Wastewater Management Plan	9.165	
Too Critical to Fail Assets		68.238
STW and SPS identified at risk of flooding	36.058	
STW identified at risk extreme temperature	16.020	
SPS'- Could not be mitigated in less than 24hrs-lead pumps	1.000	
SPS' - Could not be mitigated in less than 24hrs-fire	0.430	
Howdon STW Too Critical To fail	14.730	
Total		**87.844**

Table 2. Summary of Wastewater Resilience expenditure

2 Drivers

Network Resilience Element	Totex (£m)	Benefit and driver
Monitoring	4.303	In order to be able to identify and monitor change, and be able to respond to catchment risks, for example extreme weather and urban creep, to provide the best value option(s), we are proposing a programme consisting of innovative monitors. These will include temperature sensors to monitor saline intrusion resulting from storm surge, as well as a series of flow monitors to validate our models against extreme weather conditions, and from unplanned and unknown changes within the catchment, for example urban creep. Improving the knowledge of how our network responds to extreme conditions will enable better data gathering and data sharing with our partners, such as the Environment Agency, Lead Local Flood Authorities and the local universities, in an attempt to feed a digital twin ambition and contribute to a regional long term drainage resilience master plan. The proposed monitors are in addition to the existing monitoring of our network, for example business as usual monitoring at Combined Sewage Overflows and early warning network monitoring, which are completed under base expenditure.
Hydraulic model enhancement	1.188	In order to confirm and refine the risk to our customers from a 1 in 50 year storm (common resilience measure of success) and above, as well as to help prioritise future investment, we need to construct hydraulic models in areas where we currently do not have modelled coverage, as well as enhancing hydraulic models in other locations, where a 1 in 50 year return period storm is believed to pose a significant risk. This will also include capturing and including fluvial and coastal risk elements, which can influence the performance of our network during these large storm events. We recognise that model coverage may also be used to assess the performance of our network against other performance commitments, however we consider this enhancement not to be base expenditure for the following reasons: • Where we currently have no model coverage, we have already identified no significant risk within our normal operating conditions. The requirement for new models in these areas will be prioritised on understanding the risk from more severe events (i.e. 1 in 50 year) and from other potential sources. • Where existing models already exist and an enhancement is proposed, the cost proposed will only be that of enhancements around other sources of flood risk (i.e. surface water and/or fluvial) and/or where better modelling techniques (for example 2D modelling) is required to assess extreme weather conditions (where our sewerage system may be at, or above its full operating conditions).
Strategic studies	1.782	These are integrated catchment studies prioritised and undertaken in partnership with other Risk Management Authorities.

Wastewater Resilience

Network Resilience Element	Totex (£m)	Benefit and driver
		The studies will identify opportunities for shared partnership working, identifying a range of options that are in the best interest of our customers. All sources of flood risk will be considered and will be above the 1 in 40 year standard of protection that we normally afford under base expenditure. Storm return periods typically considered include, 1 in 75 year, 1 in 100 year and 1 in 200 years. Project costs are shared between partners, with NWG typically contributing 50% of the total cost.
Resilience wastewater schemes	3.168	Based on an assessment of the past three years, we typically expect to experience on average 2,994 newly emerging flooding properties per year. Of these, on average 32 properties per year experience flooding as a result of storm return periods of 1 in 50 year or above. In order to reduce the risk to our customers at risk of flooding in a 1 in 50 year storm (common resilience measure), we would offer a standard of protection of 1 in 50 year to those properties (96 properties) that we identify as being at risk of flooding above a 1 in 50 year return period, looking at solutions such as additional network capacity including surface water separation opportunities in partnership with other RMAs. This will include contributions to co-created schemes that protect customers from all sources of flood risk.
Drainage and Wastewater Management Plans (DWMP)	9.165	The framework for DWMPs has been developed in response to the need to improve the approaches taken by the water sector to long-term drainage and wastewater planning with a view to providing greater transparency, robustness and line of sight to investment decisions that lead to cost to customers. We are preparing to deliver DWMPs and our implementation plan, included as part of our business plan sets out our activities in AMP6 and into AMP7. We recognise that we need to start now to meet our commitment to publish a company-wide DWMP by the summer of 2022, to allow for sufficient consultation in time for inclusion in our PR24 business plan. The overarching nature of DWMPs means that their production supports the delivery of many of our customer, environment and communities outcomes. Customer research exploring expectations around resilience is relevant to the production of our DWMPs. Customers have stated that they would like to view performance information at a local level for their sewerage service, and there is a high expectation that we know more about our wastewater system as they live in a smart connected world with 24/7 services through smart devices. Our customers trust us to do the right thing and prevent risks from happening rather than being reactive. Customer also support us working in partnership. We have defined and agreed our Strategic Planning Areas (SPA) taking into account existing partnership arrangements and the River Basin District

Network Resilience Element	Totex (£m)	Benefit and driver
		(RBD) management catchments. This was developed following our DWMP workshop and also took into account the total population served, number of drainage areas and STWs, coverage by local authorities and river catchments. There are seven SPAs that we have named as: Northumberland, Rural Tyne, Tyneside, Wear, Wearside, Teesdale and Teesside. They provide the focus for the large conurbations around our main rivers as well as more rural upland areas. DWMPs represent a notable step change at an industry level for the delivery of long term drainage planning, with the results of our assessment being viewed publically through a "national picture". DWMPs will also require significant external stakeholder engagement above and beyond the level of engagement that we have previously undertaken. Our proposed expenditure recognises that the DWMPs are in their infancy and are being developed at a new and very detailed level of risk assessment. The overall cost proposal for DWMP has been reduced to £9.165m as we have now included efficiency savings developed through our industry leading early pilot studies, which we are happy to share details on, on request.
Total	**19.606**	

Table 3. Summary of Network Resilience Expenditure

Too Critical to Fail	Totex (£m)	Benefit and driver
STWs and SPS identified at risk of flooding	36.058	In order to enhance the quality of service beyond current levels, and to reduce the risk of failure of service from extreme weather events, we are proposing to offer a package of interventions at Sewage Treatment Works (STW) and Sewerage Pumping Stations (SPS) that are currently at risk, or may be at risk from future flooding. This expenditure is to provide resilient flood risk mitigation to STWs and SPS susceptible to extreme weather events, such as that experienced over the December 15th to January 16th during Storm Desmond (see major incident event logs) During this event we responded reactively and suffered from interruptions to the provision of service at a number of STWs. The expenditure seeks to address the following resilience principles: • Resistance (preventing damage or disruption by providing the strength or protection to resist the hazard or its primary impact). • Reliability (ensuring that the infrastructure components are inherently designed to operate under a range of conditions, and hence mitigate damage or loss from an event). • Response and recovery (enabling a fast and effective response to, and recovery, from disruptive events).
STW	16.020	In 2017 (including "The beast from the East"), we saw a number of our STW

Too Critical to Fail	Totex (£m)	Benefit and driver
identified at risk extreme temperature		struggle to recover from sudden temperature changes which resulted in the loss of service and interruptions. With climate change projections, it is anticipated that there will be an increase in abrupt changes in our climate and also in temperature. (https://www.gov.uk/guidance/climate-change-explained#evidence-and-analysis). This expenditure seeks to offer a step change in responding and addressing secondary treatment mitigation at STWs which are susceptible to changes in extreme temperature. The expenditure seeks to address the following resilience principles: Resistance (preventing damage or disruption by providing the strength or protection to resist the hazard or its primary impact): • Reliability (ensuring that the infrastructure components are inherently designed to operate under a range of conditions, and hence mitigate damage or loss from an event).
SPS'- Could not be mitigated in less than 24hrs-lead pumps	1.000	The expenditure requested is for enhancing the quality of service beyond current levels, and to reduce the risk of failure of service to SPS which have specialist pumps with lead times > 26 weeks for replacement pumps. The proposal is to buy specialist pumps that can then be deployed. The risk of this issue can be evidenced to an incident that occurred at Portract SPS. In the case of the Portrack incident, we exhausted the reactive options using duty and standby tanks. The expenditure seeks to address the following resilience principles: • Redundancy: The availability of backup installations or spare capacity will enable operations to be switched or diverted in the event of disruptions to ensure continuity of services. • Reliability: Ensuring that the infrastructure components are inherently designed to operate under a range of conditions, and hence mitigate damage or loss from an event.
SPS' - Could not be mitigated in less than 24hrs-fire	0.430	The expenditure requested is for enhancing the quality of service beyond current levels and to reduce the risk of failure of service to SPS which would not be able to recover from a fire incident within 24hours. • The expenditure seeks to address the following resilience principles: Resistance (preventing damage or disruption by providing the strength or protection to resist the hazard or its primary impact). • Reliability (ensuring that the infrastructure components are inherently designed to operate under a range of conditions, and hence mitigate damage or loss from an event), Response and recovery (enabling a fast and effective response to, and recovery, from disruptive events).

Too Critical to Fail	Totex (£m)	Benefit and driver
Howdon STW Too Critical To fail	14.730	This proposal is to provide mitigation to address high ranking hazards that have been identified as having an impact to the loss of service to customers The following facilities at Howdon STW have been identified as Too Critical to Fail Assets; • Howdon South Bank Pumping Station. • Primary Effluent Pumping Station (PEPS). Howdon PEPS is a very large pumping station transferring flows from the primary treatment process to the site of the secondary treatment process. This asset is identified as one too critical to fail and as such a resilience project has been integrated with the expansion plans. • The Return Activated Sludge (RAS) and Surplus Activated Sludge (SAS). Whilst these assets are out of service there are no facilities for the storage of flows. The addition of a second rising main and pumping station at the locations ensures environmental compliance. It is therefore proposed to retain the existing pumping station structures, installations and connections to allow them to act as a standby facility to support future maintenance and outage activities. Failure of service at these critical locations would result in unsustainable over pumping regimes before a loss of service (within hours) leading to a significant environmental impact.
Total	**68.238**	

Table 4. Summary of Too Critical to Fail Expenditure

3 Context and Scope

This Enhanced Wastewater Resilience Business Case supports the values included in Line 27 of the WWS2 Wholesale Wastewater Capital and Operating Expenditure By Purpose Ofwat table.

These enhanced resilience schemes contribute to our 'We deliver water and sewerage services that meet the needs of current and future generations in a changing world' service outcome. The schemes are considered enhancement because they will be enhancing the capacity or quality of service beyond current levels. The expenditure is driven by many factors, including new statutory obligations and strategic prioritisation established by customers and stakeholders.

The regulator guidelines and best practices which have driven these business plan is:

- DEFRA's strategic priorities statement which makes clear the need for long-term wastewater planning.

- Ofwat expects wastewater companies to demonstrate that they are adopting the principles and recommended best practice set out in the Drainage Strategy Framework[1] and expect companies to take a risk-based approach to wastewater planning, and go beyond the drainage strategy framework.

  This is further emphasised at a national level through our commitment to Drainage and Wastewater Management Plans, which have been developed in response to the need to improve the approaches taken by the water sector to long-term drainage and wastewater planning, with a view to providing greater transparency, robustness and line of sight to investment decisions that lead to cost to customers.

- National Flood Resilience Review Sep 16[2] carried out by the government highlights that there is need for utilities to improve mechanisms for cooperation and information sharing, identification of interdependencies between different sectors in an emergency and making the link between different industry sectors and the relevance local resilience forums and central government.

- WISER – Water Industry Strategic Environmental Requirements.

In addition, NWG is aware that environmental drivers will change the current landscape. Climate change will increase rainfall events and storminess, which will increase run off rates and cause peaks and incapacity issues.

With regards to climate change therefore our need to be more resilient is:

- There is an increased likelihood of milder, wetter winters and hotter, drier summers along with an increase in the frequency and intensity of extremes.

- The chance of seeing a summer as hot and dry as 2018 has increased from less than 10% during 1981-2000, to between 10-20% now, and could be around 50% by mid-century.

- Summers for the most recent decade (2008-2017) have been on average 17% wetter than the 1981-2010, and 20% wetter than the 1961-1990 average.

[1] https://www.ofwat.gov.uk/wp-content/uploads/2015/12/rpt_com201305drainagestrategy1.pdf

[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/551137/national-flood-resilience-review.pdf

- Total rainfall from extremely wet days (days exceeding the 99th percentile of the 1961-1990 rainfall) has increased by around 17% in the most recent decade (2008-2017), for the UK overall[3].

This is further exacerbated by our lack of understanding of network performance during extreme weather events, particularly relating to the impact of flood risk management by other risk management authorities, with relation to surface and fluvial ingress.

Changes to the urban landscape have also affected our region over the past few years, with increasing unplanned urban creep resulting in significant increases in impermeable areas discharging into our combined sewerage system. An example of this is one area in Newcastle where in the past three years, a 4% increase in impermeable area over a small area (in most cases from private house extensions) has increased peak flows by approximately 15%, for a 1 in 1 year storm return period[4].

All expenditure associated with the proposed resilience schemes will deliver an enhanced service level, where the expenditure provides an identifiable, measurable and permanent step change in overall level of service to existing customers above the standard previously provided. This can be seen in the detail of the schemes below:

[3] Supporting Climate Change Literature
[4] High Heaton Urban Creep Analysis

APPENDIX 3.2

Wastewater Resilience

Wastewater Resilience	Enhancement Proposal	Driver	Step change performance areas	Measure of success
Network Resilience	Monitoring	Climate change. • Extreme weather conditions • Rising sea levels • Flooding and coastal erosion Urban creep. Resistance: • Monitoring and predicting events and responding effectively. Reliability: • Allowing our future systems to be designed accordingly. Redundancy: • Identifying spare capacity within our network during these events. Response and recovery: • Enabling us to act rapidly and respond to these events.	Prioritisation of issues across risk management authorities. Response and recovery to the loss of service significantly above existing levels of service. Early prediction and flood warning for extreme weather events.	1 in 50 year resilience metric
Network Resilience	Hydraulic model enhancement	Climate change. • Extreme weather conditions • Rising sea levels • Flooding and coastal erosion Integrated flood risk opportunities. Reliability:	Risk identification and prioritisation above existing service levels (i.e. >1 in 40 year). Integrated flood risk opportunities.	1 in 50 year resilience metric Partnership schemes.

APPENDIX 3.2

Wastewater Resilience

Wastewater Resilience	Enhancement Proposal	Driver	Step change performance areas	Measure of success
		• Allowing our future systems to be designed accordingly. Response and recovery: • Enabling us to rapidly act and respond to these events.		
Network Resilience	Strategic studies	Climate change. • Extreme weather conditions • Rising sea levels • Flooding and coastal erosion Urban creep. Reliability: • Allowing our future systems to be designed accordingly. Response and recovery: • Enabling us to rapidly act and respond to these events.	Joint prioritisation of catchments between risk management authorities. Joint catchment opportunities and integrate catchment solutions. Risk identification and prioritisation above existing service levels (i.e. >1 in 40 year).	1 in 50 year resilience metric Partnership schemes. Customer satisfaction.
Network Resilience	Resilience wastewater schemes	Climate change. • Extreme weather conditions • Rising sea levels • Flooding and coastal erosion Urban creep. Reliability: • Allowing our future systems to be designed	Joint prioritisation of catchments between risk management authorities. Joint catchment opportunities and integrate catchment solutions. Risk identification and prioritisation above existing service levels (i.e. >1 in 40 year).	1 in 50 year resilience metric Partnership schemes. Customer satisfaction.

Wastewater Resilience	Enhancement Proposal	Driver	Step change performance areas	Measure of success
		accordingly.		
Network Resilience	DWMP	Climate change. • Extreme weather conditions • Rising sea levels • Flooding and coastal erosion Urban creep. Consumption changes. Growth • Long term projections up to 2060, above and beyond our existing levels of risk assessment. Resistance: • Monitoring and predicting events and responding effectively. Reliability: • Allowing our future systems to be designed accordingly. Redundancy: • Identifying spare capacity within our network during these events. Response and recovery: Enabling us to act	Joint prioritisation of catchments between risk management authorities. Joint catchment opportunities and integrate catchment solutions. Risk identification and prioritisation above existing service levels (i.e. >1 in 40 year). Long term drainage planning. National picture. Extensive stakeholder engagement.	National picture. Customer and stakeholder endorsement. Mandatory DWMPs from 2024 (TBC).

Wastewater Resilience	Enhancement Proposal	Driver	Step change performance areas	Measure of success
		rapidly and respond to these events.		
Too Critical to Fail Assets		Climate Change: • Extreme weather conditions • Flooding and coastal erosion • Extreme temperature differences	Sustainable and preventative measures to address reducing the hazards identified in the Too Critical to Fail Analysis	Response and recovery to the loss of service

Table 5. Enhancement proposal, proposed performance step change and measure of success

The expenditure reflects investment in addressing issues that are important to our current and future customers. They relate to the provision of a continuous wastewater service and looks into minimising disruptions which have negative impacts on the wider society through an impact on the environment, on the economy, and on the communities.

The investment also looks at providing resilient services today, but most importantly into the future, where the challenges include climate change, unplanned events, changing landscapes and urban creep.

The investment will explore new and innovative solutions co-created with customers and partners. The investment does not only seek to mitigate the impacts of these challenges but also look at how services respond and recover to these hazards.

4 Customer and Stakeholder expectation

Several sprints were held to engage with internal members to identify current and future needs for enhancing wastewater resilience.

The NWG Innovation Festival and Regional 'Thinking Ahead' Workshop enabled customers to discuss what it means to have an efficient TOTEX, and their expectations of NWG is in terms of customer service, continuous improvement and education. In addition, a water forum was held in 2018, where customers who attended the events were:

- Customers affected by flooding or other resilience scale events.
- Customers at risk from flooding.
- Young people.
- Vulnerable customers and those in the NWG risk register.
- Customers with recent contact with NWG.

Through these engagements the main outcomes were that customers:

- Expect NWG to be prepared for unexpected events and responsive when they occur.
- Expect NWG to be planning and implement preventative measures when needed.
- Expect an adequate level of investment is made in infrastructure and use new technologies to try to stop issues arising in the first place.
- Expect NWG to be working in partnership with customers and stakeholders as a key part of developing their resilience strategy going forward.
- Expect NWG to publish their plans to provide reassurance to members of the public that they are managing these risks to service adequately.

Additionally, it was concluded that customers and stakeholders prioritise the provision of a sewerage service that deals effectively with sewage and heavy rainfall. Following these engagements, schemes have been identified which respond to the customers and stakeholder's priorities and concerns.

Furthermore, our strong partnership and stakeholder engagement through the Northumbria Integrated Drainage Partnership (NIDP), has also influenced our proposals which aims to deliver multiple benefits as part of an integrated approach making the most of different sources of flooding.

5 Current and Historical Service delivery and expenditure

Network Resilience

Monitoring

On average NWG spends approximately £0.300m per year on flow monitoring, and therefore our proposed network resilience monitoring programme represents a significant increase from our baseline performance in this area. The proposed monitoring also represents the acknowledgment that a step change is required if we are to identify and efficiently respond to our future risk. However, it should also be noted that we will continue to invest, where appropriate, a similar amount of expenditure per year on this traditional network monitoring, in addition to the levels of expenditure requested as part of this enhancement.

Hydraulic Modelling

Hydraulic modelling is an area that NWG have always, and will continue to invest in as a tool to assess our catchments, and to help design schemes for addressing our existing risk. In the past three years, we have invested approximately £0.200m per year on hydraulic models. Our proposed expenditure of £1.188m for 2021-2025 will therefore match our current programme (which we will continue to invest in, and at similar levels), and is a reflection that the enhancement element is proportional, allowing us to assess our 1 in 50 year risk, and include flood risk assessments from all sources (where appropriate), in partnership with other flood risk management authorities.

Strategic Studies

We use the NIDP to facilitate this type of project work and to help align funding opportunities as we work in partnership with other flood risk management authorities, to reduce the risk of flooding by adopting the best solution for our customers.

The NIDP has allowed us to leverage significant investment from partners to reduce integrated flood risk. For example, our investment of £3.800m in three schemes has been matched by £5.500m of partner investment. Addressing the threat of flooding delivers associated benefits such as improving watercourses, public amenity, and making water environments more accessible, linking to our 'Improving the Water Environment' scheme.

This enhancement proposal will extend this to cover 44 projects in during 2021-2015, and the proposed expenditure of £1.872m clearly represents value for money when compared to the partnership funding and benefits previously identified, and is therefore the best approach for our customers.

Resilience Wastewater Schemes

Traditionally this is not an area we have been able to significantly invest in previously, as schemes have not scored favourably in our risk based prioritisation of projects, and/or have been too expensive to be able to justify the expenditure. However, in working in partnership we are able to unlock a number of additional benefits, as well as attracting wider funding opportunities, which has been demonstrated in the previous example.

DWMP

The framework for DWMPs is a new framework and has been developed in response to the need to improve the approaches taken by the water sector to long-term drainage and wastewater planning

with a view to providing greater transparency, robustness and line of sight to investment decisions that lead to cost to customers. The DWMP support wider industry guidance and future legislation. Including supporting:

- UK Government's draft Strategic Policy Statement to Ofwat and Welsh Strategy for Wales.
- Ofwat's PR19 Methodology.
- EA's WISER.
- Defra's 25 year Environmental Plan.
- National infrastructure Commission.
- Defra's Surface Water Management Action Plan.

Our proposed expenditure recognises that the DWMPs are in their infancy and are being developed at a new and very detailed level of risk assessment. The overall cost proposal for DWMP has been reduced to £9.165m as we have now included efficiency savings developed through our industry leading early pilot studies, which we are happy to share details on, on request.

Too Critical To Fail Assets

Over a number of years, NWG has invested both CAPEX and OPEX on a range of assets which have been reported as part of our base expenditure. Typically the investment has resulted in the identification of issues raised and risk prioritised against a number of other ones. Each risk is then assigned a risk reduction per pound score, before acquiring the required investment. This is a very reactive approach.

The level of investment requested through the resilience expenditure if to offer a step change approach at mitigating the loss of service to our customers.

The assets identified as requiring this level of expenditure have all been screened and validated, for example the assets at risk of flooding are part of assets which exist in the EA's Flood Zone 3, internally critical assets that have a variety of sensitive parameters, and most importantly sites that were off service through a recent storm Desmond.

6 Forward looking analysis

6.1 Network Resilience – Monitoring

In order to be able to identify and monitor change, and be able to respond to catchment risks (for example extreme weather and urban creep) to provide the best value option(s), we are proposing a programme consisting of innovative monitors. These will include temperature sensors to monitor saline intrusion resulting from storm surge, as well as a series of flow monitors to validate our models against extreme weather conditions, and from unplanned and unknown changes within the catchment, for example urban creep.

Improving the knowledge of how our network responds to extreme conditions will enable better data gathering and data sharing with our partners, such as the EA, Lead Local Flood Authorities and the local universities, in an attempt to feed a digital twin ambition and contribute to a regional long term drainage resilience master plan.

The proposed monitors are in addition to the existing monitoring of our network, for example business as usual monitoring at Combined Sewage Overflows and early warning network monitoring, which are completed under base expenditure.

Increased visibility of the network, and robust data, will aid decision making and will underpin future strategic asset investment plans, which we will share, and co-create where appropriate with other risk management authorities.

Monitoring proposals include:

- Temperature sensors: These are innovative, robust and cost effective monitors which will be used to identify and locate saline intrusion into our network during periods of storm surge. Similar devices have been successfully piloted in Berwick, a project which was recognised by NWG for a Creativity and Innovation Award, based on its drivers, measure of success, low cost solution, low customer impact and safety.

- Level monitors – network assets. These level monitors are being proposed for 26 out of over 850 existing storage locations, where this risk/likelihood of catchment change and the consequence/impact of a failure is high. The purpose of these monitors is to enable us to be to identify and monitor change, and be able to respond to catchment risks (for example extreme weather and urban creep).

- Flow monitors. These monitors will validate existing and new hydraulic models with the purposes of assessing and responding to the impact of extreme weather and urban creep. The location and installation of the equipment will be prioritised, and will also be undertaken in partnership with other risk management authorities. The Tyneside network was chosen as a pilot in light of its complexity, size and existing infrastructure.

Details of the requirements and cost breakdown has been uploaded with our submission[5].

6.2 Network Resilience - Hydraulic model build and enhancement

In order to confirm and refine the risk to our customers from a 1 in 50 year storm (common resilience measure of success) and above, as well as to help prioritise future investment, we need to construct hydraulic models in areas where we currently do not have modelled coverage, as well as enhancing hydraulic models in other locations, where a 1 in 50 year return period storm is believed to pose a significant risk. This will also include capturing and including fluvial and coastal risk elements, which can influence the performance of our network during these large storm events.

We have identified over 99% of our drainage areas are at vulnerability grade 3 or above, based on the common resilience methodology. At present, we have model coverage for approximately 70% of the population served within our northern operating region (144 hydraulic models). By building and/or enhancing a further 60 hydraulic models (out of the remaining 341 un-modelled drainage areas), we will reduce our un-modelled 1 in 50 year risk to <5%.

Details of the requirements and cost breakdown has been uploaded with our submission[6].

We recognise that model coverage may also be used to assess the performance of our network against other performance commitments, however we consider this enhancement not to be base expenditure for the following reasons:

- Where we currently have no model coverage, we have already identified no significant risk within our normal operating conditions. The requirement for new models in these areas will be prioritised on understanding the risk from more severe events (i.e. 1 in 50 year) and from other potential sources.

[5] Whitley Bay PR19 Smart Network Memo- Stantec and Monitoring Cost Breakdown
[6] Model Enhancement cost breakdown

- Where existing models already exist and an enhancement is proposed, the cost proposed will only be that of enhancements around other sources of flood risk (i.e. surface water and/or fluvial) and/or where better modelling techniques (for example 2D modelling) is required to assess extreme weather conditions (where our sewerage system may be at, or above its full operating conditions).

6.3 Network Resilience - Strategic Studies

These are integrated catchment studies prioritised and undertaken in partnership with other risk management authorities.

The studies will identify opportunities for shared partnership working, identifying a range of options that are in the best interest of our customers. All sources of flood risk will be considered and will be above the 1 in 40 year standard of protection that we normally afford under base expenditure. Storm return periods typically considered include, 1 in 75 year, 1 in 100 year and 1 in 200 years.

All 485 of our catchments have been assessed in partnership with other risk management authorities, to produce a list of prioritised projects for AMP7. Catchments have been prioritised and ranked based on individual factors, and include:

- Properties at risk of flooding (all sources and return periods).
- Interactions with Flood Zones 3.
- Capacity mapping.

- Growth (planned and un-planned).
- EA ecological river quality.

For AMP7, we have identified 22 Stage 1 and 22 Stage 2 projects to be delivered across the period, with project costs shared between partners, and NWG typically contributing 50% of the total cost.

Details of the requirements and cost breakdown has been uploaded with our submission[7].

6.4 Network Resilience - Resilience wastewater schemes

Based on an assessment of the past three years, we typically expect to experience on average 2,994 newly emerging flooding properties per year. Of these, on average 32 properties per year experience flooding as a result of storm return periods of 1 in 50 year or above.

In order to reduce the risk to our customers at risk of flooding in a 1 in 50 year storm (common resilience measure), we would offer a standard of protection of 1 in 50 year to those properties that we identify as being at risk of flooding above a 1 in 50 year return period, looking at solutions such as additional network capacity including surface water separation opportunities in partnership with other RMAs. This will include contributions to co-created schemes that protect customers from all sources of flood risk.

We expect that these will be identified and prioritised based on the outputs from a number of the enhancement proposals mentioned above, and will therefore commence in year 3. We are therefore proposing to reduce the risk to 96 properties for a 1 in 50 year return period storm. Due to the complexities associated with these types of projects, we expect that schemes will be commissioned post 2025, and therefore there will no benefit to our existing performance commitments.

[7] Northumbrian Drainage Integrated Drainage Partnership Prioritised and endorsed 10 year programme – minutes and programme

Details of the requirements and cost breakdown has been uploaded with our submission[8].

6.5 Network Resilience – DWMP

We are preparing to deliver DWMPs and our implementation plan, included as part of our business plan sets out our activities in AMP6 and into AMP7. We recognise that we need to start now to meet our commitment to publish a company-wide DWMP by the summer of 2022, to allow for sufficient consultation in time for inclusion in our PR24 business plan.

The overarching nature of DWMPs means their production supports the delivery of many of our customer, environment and communities outcomes. Customer research exploring expectations around resilience is relevant to the production of our DWMPs.

We are currently finalising our industry leading DWMP pilot studies (completion early April 2019). These will allow us to present our risk to our customers and stakeholders and further develop our methodology, which we will also share at an industry level. The pilot studies undertaken so far have allowed us to refine our costs for DWMPs from £17.8m to £9.16m which we feel demonstrates excellent and innovative efficiency and best value for our customers. The £17.8m was based on costing all elements of the framework and we have since piloted our approach and contributed to refinements to the framework which have achieved a more streamlined approach and hence reduced costs.

6.6 Too Critical To Fail Assets

This proposal is to provide mitigation to address high ranking hazards that have been identified as having an impact to the loss of service to customers. The proposal is to offer a range of solutions that reduces the risk of occurrence as practicable. This will increase the assets' ability to respond and recover thus providing a better service and mitigating interruption of service to our customers.

The same uncertainties as above apply to this project. The forward looking analysis was carried at a high level identifying hazards which were likely to affect the loss of service and their trend into the future and resulting impacting. See Table 6 below.

[8] Flooding analysis for the 1in50yr

APPENDIX 3.2

Wastewater Resilience

Risk and Opportunity Testing									
Asset								10-30yr horizon	
Scenario	Now/ current			Current mitigation	Future			Future mitigation	
	Likelih	Impa	Risk/	p	Likelih	Impa	Risk/	p	Enhanced Expenditur
Mechanical failure	High	High	HH	BP Critical spares/ BAU process/ BCM workflows/ Pro-active maintenance/ Capital maintenance / Trim and Trend	High	Medium	MM	Heavily dependent on investment, asset health measures (current performance maintained?)	No
Structural failure	Low	High	LH	Limited Condition survey, operator checks, Reservoir Act , ETW	Medium	High	MH	Ageing assets and change to a more proactive condition survey with structural assessment	No
Extreme Temperatures (High	Medium	Medium	LM	Septicity of the network increased corrosion, odour, treatment issues, use of plastic media inhibiting capacity	High	High	HH	monitoring, Adding chemical dosing - CaNO3(££) , use of water from Suds and control/ water network , reusable /grey water	No
Extreme Temperatures (Low	Medium	High	MH	Limit mitigation of mechanical parts freezing (wait for thaw) , quick thaw impacts	High	High	HH	££ maintenance : design/ build into refurbishment?, retro-fit (limited)	Yes
Loss of elec	High	High	HH	Dual supply, Permanent Back up generators on a few critical sites, ability to plug mobile generators on some, competing demands on water assets, tankering on smaller assets, inevitable consequence discharge to environment , impact on customer such as in Seaton Carew	High	High	HH	Back up? - best use and availability - redundancy in critical sites, as a minimum could we consider at least a plan for the ability of mobile ones?, batteries	Yes- WW Lead pumps
Loss of gas	Low	Medium	LM	Loss of revenue £5-6m/ yr at Howdon	Medium	High	MH	Gas network under strain; potential loss of revenue stream...3rd party awareness Defra?	No
Loss of SCADA	Medium	High	MH	x2 last yr- regional, RCC trigger, manual intervention only at critical assets (works and CSOs), resource at right place	Medium	High	MH	Manage ? Reliability - IS ?	No
Loss of telecomms	Medium	High	MH	Issue IS : mobile, manual intervention ; lone worker	Medium	High	MH	Do we need to train operational guys for procedures to react to loss of comms? BCM? Radio? Reputational risk around customers ?	Yes- overall
Fire	Medium	High	MH	x2 this yr, override pumps, electrical specs good, smoke detectors on some sites, proactive heat cameras on some sites, Halon Gas suppression, insurance assessment surveys?	High	High	HH	Maintain, E-Specs challenge ; cheaper panels - risk	Yes
Theft and vandalism	Medium	High	MH	security fencing, cameras, intruder alarms, deal with consequences of thefts of manholes - programme of vulnerable manholes.	High	High	MH	Dependent of scrap value . replacement material, trackers?	No
Cyber Attack	High	Low	HL						Yes - overall
Terrorism	Low	High	LH	Theft and vandalism	Low	High			No
Flooding (Inundation)	High	High	HH	limited activity aroiund lifting electrical panels, flood doors, CAPs, vulnerability of CSOs and pipes (submerged), accepted risk in some areas, DAS	High	High	HH	Increase recovery around assets that flood, more of everything, more monitors and controls (intelligent networks) , tidal flaps - wehere are they and which ones are missing - survey carried out £££? DAS updated and increase coverage. Long sea outfalls- Bathing water	Yes
Storm event	High	High	HH	Operational preparations, plan with RCC, early warning vulnerable customers, vulnerable assets, monitor, making sure tanks work	High	High	HH	Improved forecasting, pre-response and resistance, community resilience, flooding a field concept 'intelligent network' - understand what our options are (legislative dispensation - EA?)	Same as above
Loss of resource (people)	Low	High	LH	Engagement with workforce and pool of people to call upon (internal) and external contractors	Low	High	LH	People resilience options ? Industrial Action review	No
Access to site/asset	Medium	Medium	MM	HS overrides , negligible env impact	Medium	Medium	MM	Same	No
Loss of mobility	Low	Low	LL	Fuel cards issued, critical services maintained	Low	Low	LL	Same	No
Significant discharge to our	Medium	High	MH	Try to trace, poor response monitoring (turbidity), appropriate action - prosecution	Medium	High	MH	Increase level of sophisticated monitoring, put into storm tanks and tanker away- PLAN	No
Ability to recycle sludge - ac	Low	High	LH	Stockpiling : slow shifting	Low	High	LH	Improved already halved volume of sludge. Have pre-prepared stockpiling areas.	Commercial
Chemical spill	Low	Medium	LM	Concrete bunds, double skinned tanks, increased volumes - chemical dependency	Low	Medium	LM	Same	No
Supply chain	Medium	High	MH	Install kit that are capable to take different chemicals (some) : flexibility	Medium	High	MH	Install kit that are capable to take different chemicals and less quantities (more) : flexibility , more vulnerable sites and fewer suppliers to do this, competing demands from water, people kit and procedures	Yes- overall

Table 6. Hazards identified and future analysis

7 Option Appraisal

7.1 Network Resilience

For network resilience, we are requesting expenditure to identify targeted areas for network resilience above and beyond our current levels of service. This will include assessing and responding to the risk of flooding from all sources in partnership with other Risk Management Authorities, from which we would not normally be responsible for. The elements proposed include early data collection (monitoring), confirmation and the identification of the scale of our risk (modelling), root cause analysis and option appraisal (strategic studies) and implementation (resilience schemes). The DWMP will also allow us to develop strategies for our short and medium term scenarios, but more importantly allow us to develop and enhance our long term planning for drainage and wastewater.

At this stage we are therefore not in a position to present a range of options and their associated cost benefits. However, the resilience package proposed will allow us to develop opportunities, which have been fully appraised and are therefore in the best interest for our customers. We will also, where appropriate co-create solutions, ensuring that we develop catchment wide solutions in partnership with others, and therefore ensuring that we don't just focus on issues that only affect us.

With the future challenges previously identified likely to be exacerbated over time, which will result in significant impact on our customers, it is clear that a Do nothing scenario is not an acceptable of service to provide our customers.

The key findings of our engagement revolved around the need to look into the future and safeguard future generations against future challenges, as well as delivering innovative, cost effective solutions and was highly accepted by our customers.

Our proposals including working in partnership with others scored an acceptability level of 71%.

7.2 Too Critical To Fail Assets

Do Nothing Scenario: This would constitute leaving infrastructure at the risk of the hazards identified and providing emergency investment when a loss of service happens. With impending trends, future challenges are likely to get exacerbated and therefore the frequency at which a loss of service leading to a potential significant event will increase.

Do Minimum: Continue with the reactive investment profile on previous years, and run the risk of prioritising other issues over this area, and stressing assets into the future.

Do Something: The mitigations proposed against the highest ranking hazards constitute of a number of solutions that will look at reducing the risk of the loss of service, and establishing that response and recovery to the event is as swift as possible. This will therefore significantly reduce recovery times to a minimum after an event. A number of interventions such as flood doors, raising of control panels, and the provision of lead pumps, replacement of filter media and other relevant options have been prioritised and costed.

PE: circa 2.1m
Number of interventions: 203

Intervention	Options	Damage Avoided (Benefits)	Cost	B/C Ratio	Comment

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Wastewater Resilience

Intervention	Options	Damage Avoided (Benefits)	Cost	B/C Ratio	Comment
Mitigation against flooding **(£36.06m)**	Do Nothing Do Minimum Do Something Do Preferred – range of mitigations	N/A £ ££ ££	N/A £££ ££ £	N/A <1 = >1	The preferred solution is to offer a range of mitigation from lifting panels and installing flood doors, as opposed to building expensive flood bunds and defences.
Mitigation against extreme of temperatures **(£16.02m)**	Do Nothing Do Minimum Do Something – media filter replacement	N/A £ ££	N/A ££ £	N/A <1 >1	Secondary treatment is very susceptible to changes in temperature and the whole treatment cycle is lost whilst the media struggles to recover from these temperature extremes. Short term solutions have currently been provided, however there is the need provide alternative long term solution with the forecast of continuing extreme weather events in the future.
Howdon STW Expansion **(£14.73m**)	Do Nothing Do Alternatives Do Something – media filter replacement	N/A £ ££	N/A ££ £	N/A <1 >1	Please refer to separate Howdon STW Expansion Business Case
Mitigation against fire **(£1.00m)**	Do Nothing Do Minimum Do Something	N/A £ ££	N/A ££ £	N/A <1 >1	For a relatively small amount of investment, fire resilient systems will offer better recovery in the future against events, enabling systems to recover much faster
Intervention	**Options**	**Damage Avoided (Benefits)**	**Cost**	**B/C Ratio**	**Comment**
Mitigation – lead pumps **(£0.43m)**	Do Nothing Do Minimum Do Something	N/A £ ££	N/A ££ £	N/A <1 >1	For a relatively small amount of investment, the purchase of pumps which have long lead times and can be used as backup at alternative sites will enable redundancy to be built in the response and recovery plans.

Table 7. High Level Qualitative Cost Benefit Analysis – Too Critical to Fail

Howdon- Do Nothing Scenario (please refer to Howdon Business Case)

The resilience candidates can be split into 3 main sections: the pumping station and rising main and the implications and impact of losing either are different. In both cases, it is assumed that we will spill after primary treatment and lose the flows to the secondary works which has a maximum flow of 4500l/s in storm conditions.

At average flows, 181,000 kg/day COD goes into the primary tanks 133,000 kg/day comes out of them and 18,500 kg/day is in the final effluent so an additional 114,500 kg/day COD that could be discharged directly to the Tyne or 63% of the inlet to the primaries (or 94% of the raw). These values are affected significantly by the return liquors.

This would have a major impact to the river, significantly reducing the Dissolved Oxygen and potentially killing a lot salmon which brings in a lot of money/prestige into the region.

We would also lose UV with a possible impact on bathing waters, dependant on when the failure occurs. If the main goes, it could take a few weeks to manufacture a repair kit. We currently do not own any spares. The PEPS main is 1400mm in diameter and made of GRP therefore difficult to repair.

If the pumping station had an issue, as it is a single well, all 4 pumps will stop. If we were required to over pump , this would result in pumping about 6 to 9 weeks, mobilisation would be required as the pipes have to come from Holland, during which we will be discharging direct to the river.

In the event of a fire hazard or any loss at the pumping station, the minimum repair kit would be as below with a cost of over pumping:-

Motor 16 weeks and £40k
Pump 42 weeks and £140k
VSS 6 weeks and £40k

Minimum costs to over pump at a cost of £1.5 – 2.0m.

The costs are small compared the environmental impact and the loss of reputation. Also to reference a known incident : https://www.scotsman.com/news/sewage-probe-could-lead-to-court-charges-as-anger-grows-over-spill-1-744445- Seafiled STW in Scotland which illustrates the scale of the importance of building redundancy and resistance into the main components at Howdon STW.

The preferred option and most efficient is to therefore combine the Too Critical to Fail investment at Howdon with the expansion proposed – please see separate business case for Howdon[9].

[9] Business Case for Howdon – NWG

Too Critical To Fail - Project Summary Sheet

Client				Prepared (date)	01/06/2016
Northumbrian Water				Printed	02/07/2018
Project name				Prepared by	MSNW
Too Critical To Fail				Checked by	AL
Project reference		TBC		Checked date	25/06/2018
Base date for estimates (year 0)		18/19			
Scaling factor (e.g. £m, £k, £)		£m	(used for all costs, losses and benefits)		
Costs and benefits of options					

	Costs and benefits £m				
Option number	Option 1	Option 2	Option 3		
Option name	Do Nothing	Do Minimum	Do Something		
COSTS:					
Cash Costs (AMP7)	0.00	115.44	68.22		
Total PV Costs	0.00	185.43	71.99		
BENEFITS:					
PV Monetised damages- flooding	1,116.66	1,004.99	614.16		
		111.67	390.83		
PV Monetised damages- temperature	51.45	46.30	28.30		
		5.14	18.01		
PV Monetised damages-pumps	175.97	158.37	96.78		
		17.60	61.59		
PV Monetised damages- fire	207.56	186.80	114.16		
		20.76	72.65		
PV Monetised damages- Howdon Resilience	221.42	199.28	121.78		
		22.14	77.50		
Total PV damages	1,773.06	1,595.75	975.18		
Total PV benefits		177.31	620.57		
DECISION-MAKING CRITERIA:					
Based on total PV benefits					
Net Present Value NPV		-8.13	548.58		
Average benefit/cost ratio BCR		0.96	8.62		

Brief description of options:

Option 1	Do Nothing
Option 2	Do Minimum - Reactive maintenance
Option 3	Do Minimum - Proactive Maintenance and investment
Option 4	
Option 5	

WACC	3.00%
Inflation	3.00%

Comments and assumptions:

service to the asset (SPS,STW)
2. Assuming that in all cases of loss of service, untreated discharge would be to the environment causing a Cat1/2 Pollution
3. Assuming that the incidents increase by 0. 01% yearly
4. Assuming that the average number of weather events is 3 currently
5. Assuming that 10% of the damages is not incurred by putting protective measures - do minimum
6. Assuming that 45% of the damages is not incurred by putting protective measures - Do Something Scenario
7. Assuming that damages incurred every 25 years on exceptional storm event

Figure 1. Benefit Cost Analysis – Too Critical to Fail

7.3 Summary of Benefits assessment – provided by Frontier Economics

This subsection is split into two parts:

- Overview of resilience: We describe the challenges associated with communicating the benefits of resilience to our customers; and

- Modelling analysis: We have carried out modelling analysis to illustrate the benefits of our proposed investments, and to estimate benefit cost ratios for each investment.

7.4 Overview of resilience

Ofwat stated in 2017 that "resilience should be at the core of how the sector plans to deliver its services to customers"[10], highlighting the importance of resilience to business planning and its potential to bring benefits to customers. Becoming more resilient with our wastewater services reduces our catchment risks, which have benefits to both households and businesses, including the ability to continue operating business as usual and not needing to refurbish and replace after events.

The total benefits from the resilience programme comprise the benefit of avoiding the losses associated with severe risks and the benefit of reduction in risk for household and businesses with the greater confidence that this generates. This is consistent with the World Bank research into resilience (2015)11 which identified that avoiding losses and unlocking economic potential through addressing risk concerns as the main benefits from improved resilience.

However, estimating the benefits presents a challenge. The benefits depend partially on how much customers would pay to avoid an event and this is difficult for customers to accurately define. It is also necessary to estimate the losses that will occur if an event happens, and these dis-benefits often depend on sensitive assumptions, such as the cost of refurbishment after a particularly event.

The biggest hurdle for estimating how much customers value a lower risk of severe events is that these events occur very infrequently, but when they do the impact is very high (low frequency, high consequence events). It is well understood that customers find it difficult to engage with the concept of risk, in terms of engaging with probabilities and percentages, and thus discussing the costs and benefits associated with floods from a 1-in-50 year storm are difficult. Behavioural economics has shown that customers struggle to conceptualise the impact of moving from a small probability to an even smaller probability, and that people tend to overestimate the scale of small probabilities and give them too much weight in making decisions.[12] .

A second barrier is that customers without direct experience of an event are unlikely to have a good understanding of what the impact will be on them, or what the response from the company should be. Behavioural research has shown that people systematically incorrectly predict the impact on them from a hypothetical situation, and that prior experience can determine responses[13]. For instance, people who use natural resources have higher valuation and lower variance of valuations than those who do not use the resource and have not heard of it[14]. Additionally, customer's opinions may change over time as they gain new experiences. An example is attitudes to wind

[10] Ofwat (2017), Resilience in the round https://www.ofwat.gov.uk/wp-content/uploads/2017/09/Resilience-in-the-Round-report.pdf
[11] World Bank (2015), The Triple Dividend of Resilience https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/10103.pdf. As cited in Ofwat's Resilience in the round (2017) https://www.ofwat.gov.uk/wp-content/uploads/2017/09/Resilience-in-the-Round-report.pdf .
[12] For example, see Burns, Chiu and Wu, 2010, Overweighting of Small Probabilities
[13] Cameron and Englin, 1997, Respondent experience and contingent valuation of environmental goods
[14] Boyle, Welsh and Bishop, 1993, The role of question order and respondent experience in contingent-valuation studies

farms, whereby levels of acceptance are high while turbines are being used and then low while they are not being used [15].

Finally, the long-term nature of resilience acts as a barrier as we cannot communicate with all customers who may benefit from the enhancement, as we can only engage with current customers. This results in current customers being asked to value improvements that they know will affect them and future generations of customers too.

These issues mean that the results of traditional, stated-preference surveys in relation to resilience improvements should be assessed carefully. Ofwat has acknowledged the potential issues with WTP surveys in this regard but also that they remain an important and valid source of evidence.

7.5 Modelling analysis

We have carried out modelling analysis to demonstrate the benefits of the following proposed schemes:

Too critical to fail;

We have followed the same approach for each scheme. In particular, we have weighed up:

- **Costs:** We have forecast the cost profile for each of the schemes; and

- **Benefits:** For each scheme, we have estimated the number of negative incidents that would be avoided following investment, and multiplied this by an assumed 'consequence value' per incident.

  The 'consequence values' are a proxy for the damage to customers following incidents, and are based on our historical information on the costs which we incur following incidents. Therefore, the investments will enable us to avoid these negative incidents and also the costs associated with them. We also note that using consequence values is very conservative because they are likely to understate the benefit to customers from avoiding these incidents.

To assess the benefits, we also need to establish the relevant 'counterfactual' – i.e. our baseline level of performance in terms of the number of incidents that we would expect to have if we did not invest in these schemes – such that we can then isolate the incremental benefit that these schemes will deliver.

We have analysed the costs and benefits over a 50-year time horizon, where costs and benefits are discounted by the WACC, assumed at 3%.

The outputs of the analysis are:

- The net present value (NPV) of each scheme – estimated as the present / discounted value of the future stream of benefits minus the present / discounted value of the future stream of costs – where a NPV greater than zero denotes that the scheme is cost beneficial; and

- The benefit cost ratio (BCR) of each scheme – estimated as the present / discounted value of the future stream of benefits divided by the present value of the future stream of costs – where a BCR greater than one denotes that the scheme is cost beneficial.

The Too Critical to Fail programme is designed to reduce the severity of various low probability high impact incidents. These include failures at particular sewage treatment works and pumping stations due to flooding and exceptional storms.

In our modelling analysis, we have assumed that such events would occur every 25 years. For simplicity, we have assumed that they occur exactly once, in Year 25 of our 50 year modelling period. We assume that they would result in 5% of the population served being impacted by internal and external sewer flooding incidents, as well as there being category 1 & 2 pollution incidents.

We have then estimated that the too critical to fail scheme would result in a 45% reduction in the severity of these incidents, and multiplied the avoided number of incidents by the relevant consequence values. We have overlaid this information with the associated cost, as described in the previous subsection. This is illustrated below:

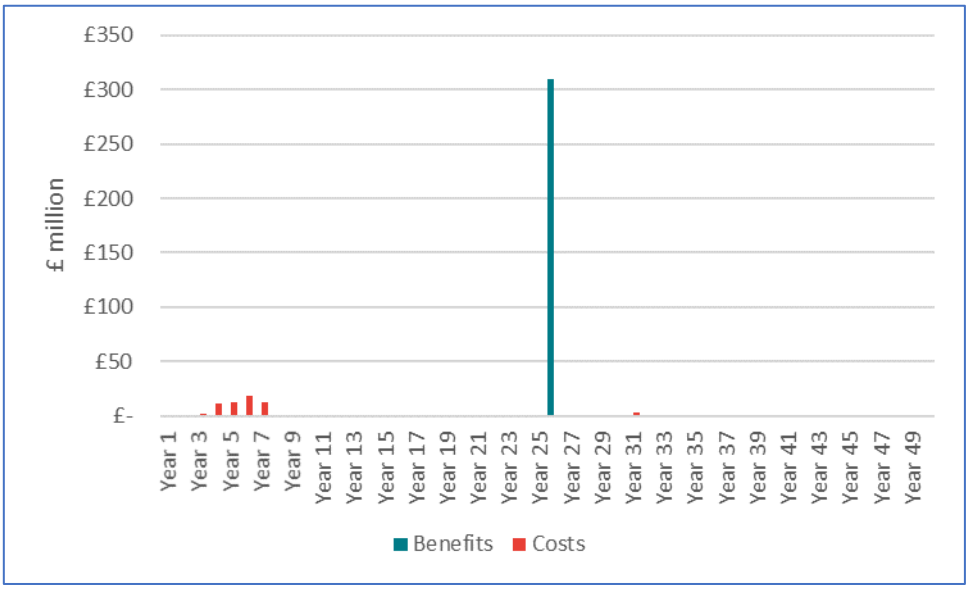


Figure 2. Illustration – Too Critical to Fail Modelling Analysis

The main results are as follows:

- Present value of costs: £72m.
- Present value of benefits: £621m.
- Net present value: £549m.
- **Benefit cost ratio: 8.6.**

The results show that the scheme has a particularly high benefit cost ratio.

8 Our Preferred plan/Option

NWG has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

APPENDIX 3.2

Wastewater Resilience

All costs for resilience enhancement were provided and assured by the NWG Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[16]:

- A full iMod cost estimate using business as usual processes.
- PR19 Costing Tool created from iMod base estimates.
- Traditional unit rates used to build up cost estimates.
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed costs for resilience are £87.844m.

These costs were benchmarked and assured using a range of the methods highlighted above.

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[17]. This review has assessed our original resilience scheme costs as Green which is that NWG have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

Costs associated with our newly proposed Network Resilience enhancement (£19.606m) have also been reviewed by our cost assurance team. The costs proposed have been based on traditional unit rates and an assessment and forecasting of historical spend. The cost assurance team have assessed these costs as Amber and we are committed to providing further information and evidence to move this to a green level of assurance by the end of April 2019, and will provide this further information on request.

There is also the recommendation that where possible and appropriate the B£st Tool or relevant industry practice will be used to determine the most sustainable solution accounting for the delivery of multi benefits.

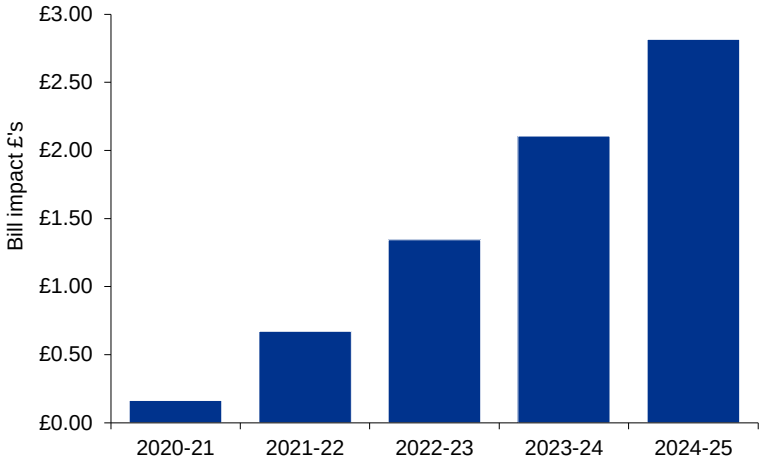
8.1 Affordability

The impact of these enhancement investments on customer bills are shown below[18].

[16] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes-NWL PR19 costing methodology

[17] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

[18] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.



Overall the analysis shows that the bill impacts would be around £1.40 a year ranging from an increase of £0.16 from 20/21 to £2.82 in 24/25.

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[19] driving significant improvements to average customer affordability.

The scheme proposed is material to the long-term stability and health of the customer service, and will contribute to a robust future network. This is in the context of an AMP7 plan which customers fully support.
Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remains a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 2030[20] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

8.2 Network Resilience

As discussed previously the resilience package proposed will allow us to develop opportunities, which have been fully appraised and are therefore in the best interest for our customers. We will also, where appropriate co-create solutions, ensuring that we develop catchment wide solutions in partnership with others and therefore ensuring that we don't just focus on issues that only affect us.

8.3 Too Critical To Fail Assets

An internal workshop was carried out with NWG experts and heads of operational divisions to identify a long list of hazards that were pertinent to the loss of wastewater service to our customers. After having identified the hazards, they were ranked in priority and in light of their future trends, highlighting that the four top priorities related to flooding, temperature changes, fire and redundancy of pumps with a long lead time.

[19] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast
[20] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

Other hazards identified were either discounted as a result that any mitigation was part of base and not to be accounted as part of enhanced expenditure and also there were some hazards that were considered to be business wide and therefore were dealt with outside of the Wastewater Resilience and as part of the Overall Resilience in the Round.

Once the top four priorities were highlighted, an optioneering exercise was carried out identifying the best value solution at each site with the expertise of the treatment work managers at each site taking into account topography, space, build ability and cost effectiveness. For e.g. flood mitigations include flood barriers, flood doors, raising of panels etc.

For the other three hazards, the number of options were limited and therefore the rationale of prioritising highly sensitive locations was the base of the cost effectiveness.

	Capex (Y1-5)					CAPEX	Opex (Y1-5)						
Resilience Project	2020/21	2021/22	2022/23	2023/24	2024/25	Y1-Y5	2020/21	2021/22	2022/23	2023/24	2024/25	OPEX	5 yr Totex (£m)
Too Critical Too Fail Assets												Y1-Y5	
STW and SPS identified at risk of flooding	£0.50	£8.88	£8.88	£8.88	£8.88	£36.02		£0.04				£0.04	£36.06
STW identified at risk extreme temperature	£0.50	£3.88	£3.88	£3.88	£3.88	£16.02						£0.00	£16.02
SPS'- Could not be mitigated in less than 24hrs-lead pumps	£0.20	£0.20	£0.20	£0.20	£0.20	£1.00						£0.00	£1.00
SPS' - Could not be mitigated in less than 24hrs-fire	£0.09	£0.09	£0.09	£0.09	£0.09	£0.43						£0.00	£0.43
Howdon STW Expansion	£0.46	£0.17	£1.81	£9.27	£3.02	£14.73						£0.00	£14.73
Sub-Total	£1.75	£13.22	£14.86	£22.32	£16.07	£68.20	£0.00	£0.04	£0.00	£0.00	£0.00	£0.04	£68.24

Table 2. Summary of costs for the Too Critical to Fail Assets

The investment required is broader ranging than just considering the options to mitigate the hazards, they not only reduce the resulting risk but enhance the ability to cope with and recover from pressures and shocks. To address this risk and improve resilience at those sites deemed at risk, a programme of investment is proposed that delivers improvements to system resilience and addresses system risks both now and into the long term.

The plan will:

- Develop a prioritised list of treatment sites and pumping stations at risk from surface, fluvial and coastal flooding and implement a program of measures to improve overall site resilience against the hazard.
- Develop a prioritised list of treatment sites at risk from extreme temperature and implement a programme of measures to improve overall site resilience against the hazard.
- Develop a prioritised list of treatment sites and pumping stations at risk from a failure of an asset or a fire that would impact site performance capability of more than 24 hours and implement a programme of measures to improve overall site resilience against the hazards.
- Explore opportunities to align our risk assessment approach to operational site criticality and resilience across all our water and wastewater assets.

9 Alignment with stakeholder needs

The wastewater resilience projects were tested with customers previously and the scores are as below:

APPENDIX 3.2

Wastewater Resilience

Wastewater Resilience	Acceptance	CAPEX(£m)	TOTEX(£m)
Network Resilience			19.606
Monitoring	Customer acceptability 81%*	4.303	
Hydraulic model enhancement	Customer acceptability 81%*	1.188	
Strategic studies	Customer acceptability 71%*	1.782	
Resilience wastewater schemes	Customer acceptability 71%*	3.168	
Drainage and Wastewater Management Plan	Customer acceptability 71%*	9.165	
Too Critical to Fail Assets			68.238
STW and SPS identified at risk of flooding	Customer acceptability 67%*	36.058	
STW identified at risk extreme temperature	Customer acceptability 67%*	16.020	
SPS'- Could not be mitigated in less than 24hrs-lead pumps	Customer acceptability 67%*	1.000	
SPS' - Could not be mitigated in less than 24hrs-fire	Customer acceptability 67%*	0.430	
Howdon STW Too Critical To fail	Customer acceptability 67%*	14.730	
Total			**87.844**

Table 9. Customer Acceptance Score (where relevant)

* Scores are applicable from the last acceptability research as the revised components are aligned to the original stated ambition and outcomes for our customers.

The final plan takes into consideration feedback and comments gathered through multiple engagement forums such as the NWG Innovation festival, PR19 Wastewater Design Sprint, Thinking Ahead workshops among others.

The final proposals have been shared with our customers and stakeholders and been endorsed. The key findings of these engagement revolved around the need to look into the future and safeguard future generations against future challenges as well as delivering innovative, cost effective solutions.

Our customers understood that some of the proposals were very innovative and would be piloted, and they welcomed such proposals with the understanding that other areas could benefit in the future.

Our partners have endorsed our proposals and are keen to be part of integrated solutions where different sources of flooding are addressed. They are particularly keen on overcoming bureaucratic challenges and sharing more data. They also welcome building on the strong foundations created through the NIDP in securing different sources of funding to address similar issues.

Overall, customers' preferences have been reflected in the plan and are supported by the commitments made by our customers. The engagement with customers and stakeholders was completed during the NWG's 2018 Water Forum to ensure that some of NWG's approaches deliver the best value for customers.

10 Customer protection

NWG are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed.

Unit Rate

To protect our customers we will apply a penalty rate for underperformance against this enhancement. As this enhancement targets a number of specified units as an output, we have based our penalty on a per unit basis. We will incur a penalty to the value of the number of units we achieve below our Performance Commitment (PC). For example, a PC of 10 and an actual performance of 9 would incur a penalty of 1/10th the value of customer funding received.

Any penalty will be calculated as a net present value neutral adjustment as part of the PR24 true up process of the relevant 2019 Final Determination cash flows should the outcome be delivered partially or not at all. The discount rate used will be 3.3% real, the CPIH stripped cost of capital.

Time Rate

To protect our customers we will apply a penalty rate for underperformance against this enhancement. As this enhancement targets a specific output by a date in the future, we have based our penalty on a per day late of delivery basis. This uses the same principle as our Performance Commitment for R-F1 Delivering a consolidated customer information and billing system, penalty rate 2 at PR14.

Any penalty will be calculated as a net present value neutral adjustment as part of the PR24 true up process of the relevant 2019 Final Determination cash flows should the outcome be delivered late, partially or not at all. The discount rate used will be 3.3% real, the CPIH stripped cost of capital.

Network resilience:

Network resilience Enhancement element	Totex (£m)	Programme delivery	Customer protection methodology
Monitoring	4.303	Yearly milestones	Unit rate
Model enhancement	1.188	Yearly milestones	Unit rate
Strategic studies	1.782	31/03/25	Unit rate
Wastewater resilience schemes	3.168	31/03/25	Unit rate
DWMP	9.165	Draft publication 01/06/22 Final publication 01/03/23	Time rate
Too critical to fail Enhancement element	**Totex (£m)**	**Programme delivery**	**ODI proposed**
Flood mitigation	36.058	Yearly milestones	Unit rate
Temperature extreme mitigation	16.020	Yearly milestones	Unit rate
Fire mitigation	0.430	Yearly milestones	Unit rate
Pump lead time mitigation	1.00	Yearly milestones	Unit rate
Howdon STW expansion	14.730	Defined milestones – refer to business case	Unit rate

Table 3. Customer protection

Completing this significant programme of work to time is extremely stretching. All enhancement costs include a stretching 1% p.a. efficiency.

11 Board assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers.

12 Appendix I- Too Critical to Fail – Benefit Cost Analysis

Too Critical To Fail - Project Summary Sheet

Client				Prepared (date)	01/06/2016
Northumbrian Water				Printed	02/07/2018
Project name				Prepared by	MSNW
Too Critical To Fail				Checked by	AL
Project reference		TBC		Checked date	25/06/2018
Base date for estimates (year 0)		18/19			
Scaling factor (e.g. £m, £k, £)		£m	(used for all costs, losses and benefits)		
Costs and benefits of options					

	Costs and benefits £m				
Option number	Option 1	Option 2	Option 3		
Option name	Do Nothing	Do Minimum	Do Something		
COSTS:					
Cash Costs (AMP7)	0.00	115.44	68.22		
Total PV Costs	0.00	185.43	71.99		
BENEFITS:					
PV Monetised damages- flooding	1,116.66	1,004.99	614.16		
		111.67	390.83		
PV Monetised damages- temperature	51.45	46.30	28.30		
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PV Monetised damages- Howdon Resilience	221.42	199.28	121.78		
		22.14	77.50		
Total PV damages	1,773.06	1,595.75	975.18		
Total PV benefits		177.31	620.57		
DECISION-MAKING CRITERIA:					
Based on total PV benefits					
Net Present Value **NPV**		-8.13	548.58		
Average benefit/cost ratio **BCR**		0.96	8.62		

Brief description of options:

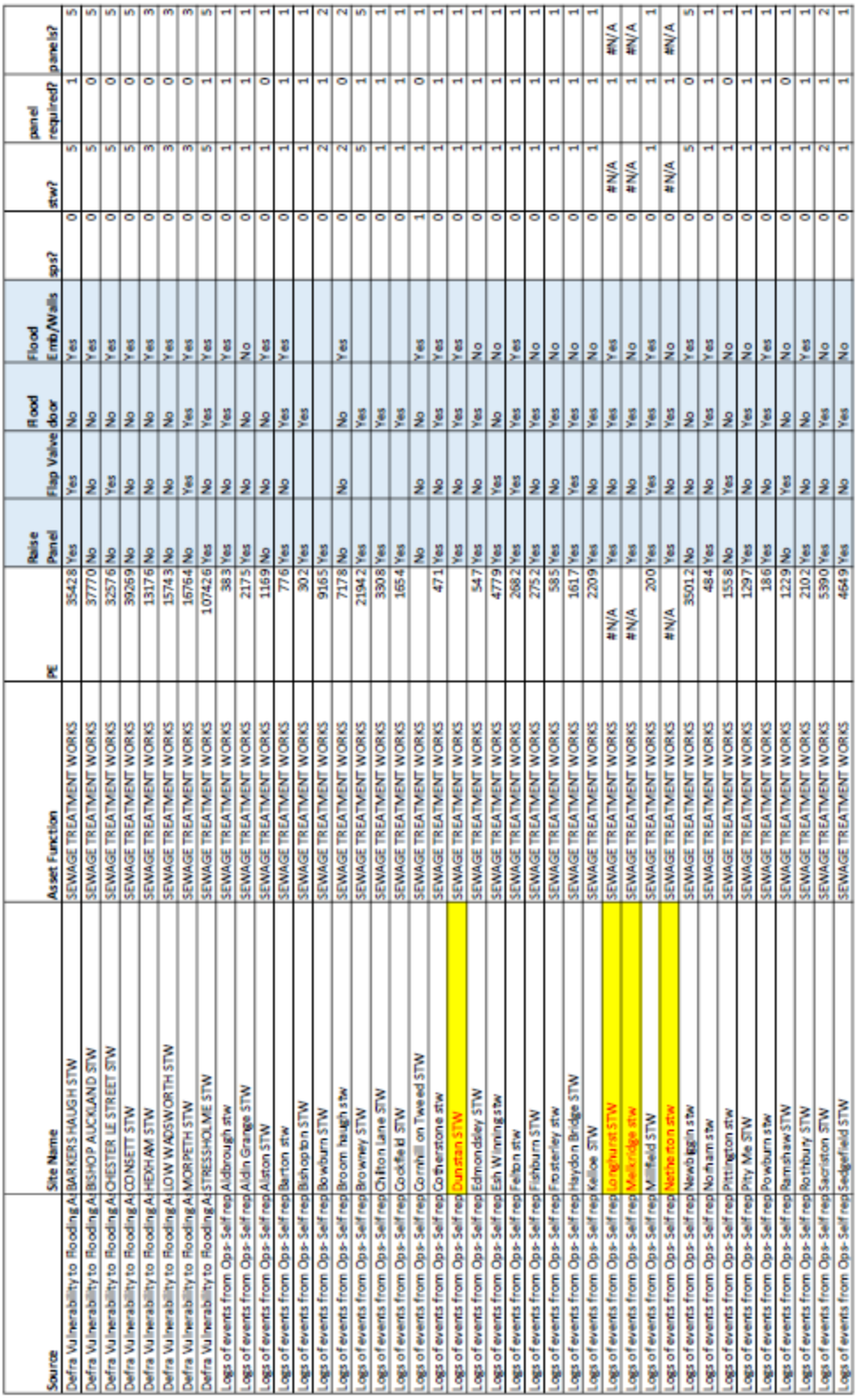
Option 1	Do Nothing
Option 2	Do Minimum - Reactive maintenance
Option 3	Do Minimum - Proactive Maintenance and investment
Option 4	
Option 5	

WACC	3.00%
Inflation	3.00%

Comments and assumptions:

service to the asset (SPS,STW)
2. Assuming that in all cases of loss of service, untreated discharge would be to the environment causing a Cat1/2 Pollution
3. Assuming that the incidents increase by 0. 01% yearly
4. Assuming that the average number of weather events is 3 currently
5. Assuming that 10% of the damages is not incurred by putting protective measures - do minimum
6. Assuming that 45% of the damages is not incurred by putting protective measures - Do Something Scenario
7. Assuming that damages incurred every 25 years on exceptional storm event

13 Appendix Ii – Too Critical To Fail Costing Tool



Source	Site Name	Asset Function	PE	Raise Panel	Flap Valve	Flood door	Flood Emb/Walls	sps?	stw?	panel required?	panels?
Defra Vulnerability to Flooding A	BARKERS HAUGH STW	SEWAGE TREATMENT WORKS	35428	Yes	Yes	No	Yes	0	5	1	5
Defra Vulnerability to Flooding A	BISHOP AUCKLAND STW	SEWAGE TREATMENT WORKS	37770	No	No	No	Yes	0	5	0	5
Defra Vulnerability to Flooding A	CHESTER LE STREET STW	SEWAGE TREATMENT WORKS	32576	No	Yes	No	Yes	0	5	0	5
Defra Vulnerability to Flooding A	CONSETT STW	SEWAGE TREATMENT WORKS	39269	No	No	No	Yes	0	5	0	5
Defra Vulnerability to Flooding A	HEXHAM STW	SEWAGE TREATMENT WORKS	13176	No	No	No	Yes	0	3	0	3
Defra Vulnerability to Flooding A	LOW WADSWORTH STW	SEWAGE TREATMENT WORKS	15743	No	No	No	Yes	0	3	0	3
Defra Vulnerability to Flooding A	MORPETH STW	SEWAGE TREATMENT WORKS	16764	No	Yes	Yes	Yes	0	3	0	3
Defra Vulnerability to Flooding A	STRESSHOLME STW	SEWAGE TREATMENT WORKS	107426	Yes	No	Yes	Yes	0	5	1	5
Logs of events from Ops-Self rep	Aldbrough stw	SEWAGE TREATMENT WORKS	383	Yes	No	Yes	Yes	0	1	1	1
Logs of events from Ops-Self rep	Aldin Grange STW	SEWAGE TREATMENT WORKS	2175	Yes	No	No	No	0	1	1	1
Logs of events from Ops-Self rep	Alston STW	SEWAGE TREATMENT WORKS	1169	No	No	No	Yes	0	1	0	1
Logs of events from Ops-Self rep	Barton stw	SEWAGE TREATMENT WORKS	776	Yes	No	Yes	Yes	0	1	1	1
Logs of events from Ops-Self rep	Bishopton STW	SEWAGE TREATMENT WORKS	302	Yes		Yes		0	1	1	1
Logs of events from Ops-Self rep	Bowburn STW	SEWAGE TREATMENT WORKS	9165	Yes				0	2	1	2
Logs of events from Ops-Self rep	Broom haugh stw	SEWAGE TREATMENT WORKS	7178	No	No	No	Yes	0	2	0	2
Logs of events from Ops-Self rep	Browney STW	SEWAGE TREATMENT WORKS	21942	Yes		Yes		0	5	1	5
Logs of events from Ops-Self rep	Chilton Lane STW	SEWAGE TREATMENT WORKS	3308	Yes		Yes		0	1	1	1
Logs of events from Ops-Self rep	Cockfield STW	SEWAGE TREATMENT WORKS	1654	Yes		Yes		0	1	1	1
Logs of events from Ops-Self rep	Cornhill on Tweed STW	SEWAGE TREATMENT WORKS		No	No	No	Yes	1	1	0	1
Logs of events from Ops-Self rep	Cotherstone stw	SEWAGE TREATMENT WORKS	471	Yes	No	Yes	Yes	0	1	1	1
Logs of events from Ops-Self rep	Dunstan STW	SEWAGE TREATMENT WORKS		Yes	No	Yes	Yes	0	1	1	1
Logs of events from Ops-Self rep	Edmondsley STW	SEWAGE TREATMENT WORKS	547	Yes	No	Yes	No	0	1	1	1
Logs of events from Ops-Self rep	Esh Winning stw	SEWAGE TREATMENT WORKS	4779	Yes	Yes	No	No	0	1	1	1
Logs of events from Ops-Self rep	Felton stw	SEWAGE TREATMENT WORKS	2682	Yes	Yes	Yes	Yes	0	1	1	1
Logs of events from Ops-Self rep	Fishburn STW	SEWAGE TREATMENT WORKS	2752	Yes	No	Yes	No	0	1	1	1
Logs of events from Ops-Self rep	Frosterley stw	SEWAGE TREATMENT WORKS	585	Yes	No	Yes	No	0	1	1	1
Logs of events from Ops-Self rep	Haydon Bridge STW	SEWAGE TREATMENT WORKS	1617	Yes	Yes	Yes	No	0	1	1	1
Logs of events from Ops-Self rep	Kelloe STW	SEWAGE TREATMENT WORKS	2209	Yes	No	Yes	No	0	1	1	1
Logs of events from Ops-Self rep	Lanchester STW	SEWAGE TREATMENT WORKS	#N/A	Yes	No	Yes	Yes	0	#N/A	1	#N/A
Logs of events from Ops-Self rep	Malkridge stw	SEWAGE TREATMENT WORKS	#N/A	Yes	No	Yes	No	0	#N/A	1	#N/A
Logs of events from Ops-Self rep	Millfield STW	SEWAGE TREATMENT WORKS	200	Yes	Yes	Yes	Yes	0	1	1	1
Logs of events from Ops-Self rep	Netherton stw	SEWAGE TREATMENT WORKS	#N/A	Yes	No	Yes	No	0	#N/A	1	#N/A
Logs of events from Ops-Self rep	Newbiggin stw	SEWAGE TREATMENT WORKS	35012	No	No	No	Yes	0	5	0	5
Logs of events from Ops-Self rep	Norham stw	SEWAGE TREATMENT WORKS	484	Yes	No	Yes	Yes	0	1	1	1
Logs of events from Ops-Self rep	Pittington stw	SEWAGE TREATMENT WORKS	1558	No	Yes	No	No	0	1	0	1
Logs of events from Ops-Self rep	Pity Me STW	SEWAGE TREATMENT WORKS	1297	Yes	No	Yes	No	0	1	1	1
Logs of events from Ops-Self rep	Powburn stw	SEWAGE TREATMENT WORKS	186	Yes	No	Yes	Yes	0	1	1	1
Logs of events from Ops-Self rep	Ramshaw STW	SEWAGE TREATMENT WORKS	1229	No	Yes	No	No	0	1	0	1
Logs of events from Ops-Self rep	Rothbury STW	SEWAGE TREATMENT WORKS	2102	Yes	No	No	Yes	0	1	1	1
Logs of events from Ops-Self rep	Sacriston STW	SEWAGE TREATMENT WORKS	5390	Yes	No	Yes	No	0	2	1	2
Logs of events from Ops-Self rep	Sedgefield STW	SEWAGE TREATMENT WORKS	4649	Yes	No	Yes	No	0	1	1	1

APPENDIX 3.2

Wastewater Resilience

Source	Site Name	np panels	unit cost	panel cost	flap valve?	no	required no	flap valve cost	door?	no	required no	door cost	embankment	unit cost
Defra Vulnerability to Flooding A	BARKERS HAUGH STW	5	93936.65	469683.3	1	2	2	6670.01	0	3	0	0	1	299298.5
Defra Vulnerability to Flooding A	BISHOP AUCKLAND STW	0	93936.65	0	0	2	0	0	0	3	0	0	1	299298.5
Defra Vulnerability to Flooding A	CHESTER LE STREET STW	0	93936.65	0	1	2	2	6670.01	0	3	0	0	1	299298.5
Defra Vulnerability to Flooding A	CONSETT STW	0	93936.65	0	0	2	0	0	0	3	0	0	1	299298.5
Defra Vulnerability to Flooding A	HEXHAM STW	0	93936.65	0	0	2	0	0	0	3	0	0	1	299298.5
Defra Vulnerability to Flooding A	LOW WADSWORTH STW	0	93936.65	0	0	2	0	0	0	3	0	0	1	299298.5
Defra Vulnerability to Flooding A	MORPETH STW	0	93936.65	0	1	2	2	6670.01	1	3	3	19903.14	1	299298.5
Defra Vulnerability to Flooding A	STRESSHOLME STW	5	93936.65	469683.3	0	2	0	0	1	3	3	19903.14	1	299298.5
Logs of events from Ops-Self rep	Aldbrough stw	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	1	299298.5
Logs of events from Ops-Self rep	Aldin Grange STW	1	93936.65	93936.65	0	2	0	0	0	3	0	0	0	299298.5
Logs of events from Ops-Self rep	Alston STW	0	93936.65	0	0	2	0	0	0	3	0	0	1	299298.5
Logs of events from Ops-Self rep	Barton stw	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	1	299298.5
Logs of events from Ops-Self rep	Bishopton STW	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	0	299298.5
Logs of events from Ops-Self rep	Bowburn STW	2	93936.65	187873.3	0	2	0	0	0	3	0	0	0	299298.5
Logs of events from Ops-Self rep	Broom haugh stw	0	93936.65	0	0	2	0	0	1	3	0	0	1	299298.5
Logs of events from Ops-Self rep	Browney STW	5	93936.65	469683.3	0	2	0	0	1	3	3	19903.14	0	299298.5
Logs of events from Ops-Self rep	Chilton Lane STW	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	0	299298.5
Logs of events from Ops-Self rep	Cockfield STW	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	0	299298.5
Logs of events from Ops-Self rep	Cornhill on Tweed STW	0	93936.65	0	0	1	0	0	0	1	0	0	1	299298.5
Logs of events from Ops-Self rep	Coxhoe stw	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	1	299298.5
Logs of events from Ops-Self rep	Dunston STW	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	1	299298.5
Logs of events from Ops-Self rep	Edmondsley STW	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	0	299298.5
Logs of events from Ops-Self rep	Esh Winning stw	1	93936.65	93936.65	1	2	2	6670.01	0	3	0	0	0	299298.5
Logs of events from Ops-Self rep	Felton stw	1	93936.65	93936.65	1	2	2	6670.01	1	3	3	19903.14	1	299298.5
Logs of events from Ops-Self rep	Fishburn STW	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	0	299298.5
Logs of events from Ops-Self rep	Frosterley stw	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	0	299298.5
Logs of events from Ops-Self rep	Haydon Bridge STW	1	93936.65	93936.65	1	2	2	6670.01	1	3	3	19903.14	0	299298.5
Logs of events from Ops-Self rep	Kelloe STW	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	0	299298.5
Logs of events from Ops-Self rep	Longhurst STW	#N/A	93936.65	#N/A	0	2	0	0	1	3	3	19903.14	1	299298.5
Logs of events from Ops-Self rep	Malkridge stw	#N/A	93936.65	#N/A	0	2	0	0	1	3	3	19903.14	0	299298.5
Logs of events from Ops-Self rep	Millfield STW	1	93936.65	93936.65	1	2	2	6670.01	1	3	3	19903.14	1	299298.5
Logs of events from Ops-Self rep	Nethelton stw	#N/A	93936.65	#N/A	0	2	0	0	1	3	3	19903.14	0	299298.5
Logs of events from Ops-Self rep	Newbiggin stw	0	93936.65	0	0	2	0	0	0	3	0	0	1	299298.5
Logs of events from Ops-Self rep	Norham stw	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	1	299298.5
Logs of events from Ops-Self rep	Pittington stw	0	93936.65	0	1	2	2	6670.01	0	3	0	0	0	299298.5
Logs of events from Ops-Self rep	Pity Me STW	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	0	299298.5
Logs of events from Ops-Self rep	Powburn stw	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	1	299298.5
Logs of events from Ops-Self rep	Ramshaw STW	0	93936.65	0	1	2	2	6670.01	0	3	0	0	0	299298.5
Logs of events from Ops-Self rep	Rothbury STW	1	93936.65	93936.65	0	2	0	0	0	3	0	0	1	299298.5
Logs of events from Ops-Self rep	Saxniton STW	2	93936.65	187873.3	0	2	0	0	1	3	3	19903.14	0	299298.5
Logs of events from Ops-Self rep	Sedgefield STW	1	93936.65	93936.65	0	2	0	0	1	3	3	19903.14	0	299298.5

APPENDIX 3.2

Wastewater Resilience

Source	Site Name	embankment cost	Total Cost	pe?			Total Project Cost
Defra Vulnerability to flooding A	BARKERS HAUGH STW	299298.5	775651.8		1		£775,651.76
Defra Vulnerability to flooding A	BISHOP AUCKLAND STW	299298.5	299298.5		1	1	£299,298.50
Defra Vulnerability to flooding A	CHESTER LE STREET STW	299298.5	305968.5		1	1	£305,968.51
Defra Vulnerability to flooding A	CONSETT STW	299298.5	299298.5		1	1	£299,298.50
Defra Vulnerability to flooding A	HEXHAM STW	299298.5	299298.5		1	1	£299,298.50
Defra Vulnerability to flooding A	LOW WADSWORTH STW	299298.5	299298.5		1	1	£299,298.50
Defra Vulnerability to flooding A	MORPETH STW	299298.5	325871.7		1	1	£325,871.65
Defra Vulnerability to flooding A	STRESSHOLME STW	299298.5	788884.9		1	1	£788,884.89
Logs of events from Ops-Self rep	Aldbrough stw	299298.5	413138.3		1	1	£413,138.29
Logs of events from Ops-Self rep	Aldin Grange STW	0	93936.65		1	1	£93,936.65
Logs of events from Ops-Self rep	Alston STW	299298.5	299298.5		1	1	£299,298.50
Logs of events from Ops-Self rep	Barton stw	299298.5	413138.3		1	1	£413,138.29
Logs of events from Ops-Self rep	Bishopton STW	0	113839.8		1	1	£113,839.79
Logs of events from Ops-Self rep	Bowburn STW	0	187873.3		1	1	£187,873.30
Logs of events from Ops-Self rep	Broom haugh stw	299298.5	299298.5		1	1	£299,298.50
Logs of events from Ops-Self rep	Browney STW	0	489586.4		1	1	£489,586.39
Logs of events from Ops-Self rep	Chilton Lane STW	0	113839.8		1	1	£113,839.79
Logs of events from Ops-Self rep	Cockfield STW	0	113839.8		1	1	£113,839.79
Logs of events from Ops-Self rep	Cornhill on Tweed STW	299298.5	299298.5		0	1	£299,298.50
Logs of events from Ops-Self rep	Cotherstone stw	299298.5	413138.3		1	1	£413,138.29
Logs of events from Ops-Self rep	Dunstan STW	299298.5	413138.3		0	0	£0.00
Logs of events from Ops-Self rep	Edmondsley STW	0	113839.8		1	1	£113,839.79
Logs of events from Ops-Self rep	Esh Winning stw	0	100606.7		1	1	£100,606.66
Logs of events from Ops-Self rep	Felton stw	299298.5	419808.3		1	1	£419,808.30
Logs of events from Ops-Self rep	Fishburn STW	0	113839.8		1	1	£113,839.79
Logs of events from Ops-Self rep	Frosterley stw	0	113839.8		1	1	£113,839.79
Logs of events from Ops-Self rep	Haydon Bridge STW	0	120509.8		1	1	£120,509.80
Logs of events from Ops-Self rep	Kellow STW	0	113839.8		1	1	£113,839.79
Logs of events from Ops-Self rep	Longhurst STW	299298.5	#N/A	#N/A	#N/A		#N/A
Logs of events from Ops-Self rep	Meldridge stw	0	#N/A	#N/A	#N/A		#N/A
Logs of events from Ops-Self rep	Millfield STW	299298.5	419808.3		1	1	£419,808.30
Logs of events from Ops-Self rep	Nathe ton stw	0	#N/A	#N/A	#N/A		#N/A
Logs of events from Ops-Self rep	Newbiggin stw	299298.5	299298.5		1	1	£299,298.50
Logs of events from Ops-Self rep	Nofham stw	299298.5	413138.3		1	1	£413,138.29
Logs of events from Ops-Self rep	Pittington stw	0	6670.01		1	1	£6,670.01
Logs of events from Ops-Self rep	Pity Me STW	0	113839.8		1	1	£113,839.79
Logs of events from Ops-Self rep	Powburn stw	299298.5	413138.3		1	1	£413,138.29
Logs of events from Ops-Self rep	Ramshaw STW	0	6670.01		1	1	£6,670.01
Logs of events from Ops-Self rep	Rothbury STW	299298.5	393235.2		1	1	£393,235.15
Logs of events from Ops-Self rep	Sacriston STW	0	207776.4		1	1	£207,776.44
Logs of events from Ops-Self rep	Sedgefield STW	0	113839.8		1	1	£113,839.79

APPENDIX 3.2

Wastewater Resilience

NORTHUMBRIAN WATER living water | ESSEX&SUFFOLK WATER living water

CYBER RESILIENCE ENHANCEMENT BUSINESS CASE

WS2 - Wholesale water capital and operating enhancement expenditure by purpose Line 16 and

WWS2 - Wholesale wastewater capital and operating enhancement expenditure by purpose Line 29

APPENDIX 3.2
CYBER RESILIENCE ENHANCEMENT BUSINESS CASE

Contents

APPENDIX 3.2
CYBER RESILIENCE ENHANCEMENT BUSINESS CASE

Executive summary

Name of claim	Cyber resilience enhancements	
Name and identifier of related claim submitted in May 2018	NA	
Business plan table lines w here the totex value of this claim is reported	WS2 – Wholesale water Line 16 WWS2 – Wholesale wastewater Line 27	
Total value of enhancement for AMP7	£14,531,000	
Total opex of enhancement for AMP7	£0	
Total capex of enhancement for AMP7	£14,531,000	
Depreciation on capex in AMP7 (retail controls only)	n/a	
Remaining capex required after AMP7 to complete construction	None as all schemes expected to be delivered in AMP 7	
Whole life totex of enhancement	n/a.	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	Material	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		No
Need for investment/expenditure	To protect against increasing cyber security risks driven by a mixture of statutory and non-statutory drivers with customer support for the investment	
Need for the adjustment (if relevant)	n/a	
Outside management control (if relevant)	n/a	
Best option for customers (if relevant)	Page 13/16	

Robustness and efficiency of claim's costs	Page 16
Customer protection (if relevant)	Page 16
Affordability (if relevant)	Page 17/18
Board Assurance (if relevant)	Page 18

It is widely acknowledged and documented by the HM Governments National Cyber Security Strategy[i] that the cyber threats to Critical National Infrastructure (CNI) companies are increasing at an extremely fast pace. The 'Network Information Systems Directive' (NIS-D) has introduced new regulatory compliance measures to ensure appropriate enhancements are made to the cyber security posture of all water companies. Meeting these obligations will not be possible without additional investment in new security services and solutions as out lined in the NIS-D/ DWI Cyber Assessment Framework (CAF) which can be provided if necessary. Government advice is that it is imperative that cyber security capability is enhanced to mitigate against this increasing and constantly evolving threat to protect our business, our customers and the UK as a whole. This applies not only to services covered by the NIS-D but also to waste water systems and traditional IT systems that protect our customer, employee and financial information.

NWL currently employs proportionate cyber security controls to protect our data and systems from cyber interference. However, simply replacing or updating our current base cyber security controls and assets will be insufficient in the wake of new attack techniques, advances in technology and increasing focus from hostile external third parties. Throughout August and September 2018 we employed a 3rd party specialist 'F-Secure', to try and hack us using any means necessary (technical, physical and social). The results of this test highlighted that although we were doing a lot of good things, our security needed further enhancement and investment to bring us up to a level that is capable of combatting the dynamically changing threat landscape and sophistication of modern threats. We are therefore proposing an enhanced investment in cyber-security in order to maintain compliance with new legal requirements and to keep our customers and assets safe in line with best practice.

Current government advice and evidence shared by the National Cyber Security Centre (NCSC), Centre for the Protection of Critical National Infrastructure (CPNI) and other Water companies at closed water sector security forums indicates that the water sector is increasingly being targeted by both hostile foreign state and cyber criminals.

The House of Lords, House of Commons Joint Committee Report dated 12 Nov 2018 states:
https://publications.parliament.uk/pa/jt201719/jtselect/jtnatsec/1708/1708.pdf

- *The head of the National Cyber Security Centre (NCSC) has said that a major cyber*
  attack on the United Kingdom is a matter of 'when, not if'. The UK's critical national
  infrastructure (CNI) is a natural target for such an attack because of its importance to

daily life and the economy.

- *The Government has explicitly acknowledged that it must do more to improve the cyber*

resilience of our critical national infrastructure, irrespective of whether it is owned or

operated in the public or private sector. While we applaud the aspiration, it appears the

Government is not delivering on it with a meaningful sense of purpose or urgency. Its

efforts so far certainly fail to do justice to its own assessment that major cyber attacks

on the UK and interests are a top-tier threat to national security

Protecting ourselves from a multitude of current and future threats including attacks on our systems and data breaches will allow us to ensure that we continue providing our services and protect our customers. It is essential that we follow government advice to prepare for new and emerging threats and enhance our cyber resilience and capability into the next AMP in line with Ofwat's guidelines and legislative requirements by continuingly assessing the threat and responding accordingly.

Our objective is to protect our services and customers in light of the increasing threat landscape. The main focus of the enhancement will be to increase the protection and resilience of the water supply. However, due to the interconnected nature of cyber across the entire business, additional benefits to the protection of customer and employee data and other IT systems will be inherited and highlighted below.

As documented in the Government's impact assessment of the Network and Information Systems Regulation 2018[i]: *The main expected benefits (of enhancing cyber security) are a reduction in the level and scale of cyber security breaches. This has benefits for the companies controlling the networks, other organisations operating on the network and the wider economy where breaches would otherwise disrupt everyday activity.*

As such we intend to implement a cyber-resilience programme that incorporates:

- Robust cyber security defences
- Adequate cyber risk preventative measures; and
- Appropriate tools and systems for alerting, dealing with and reporting incidents

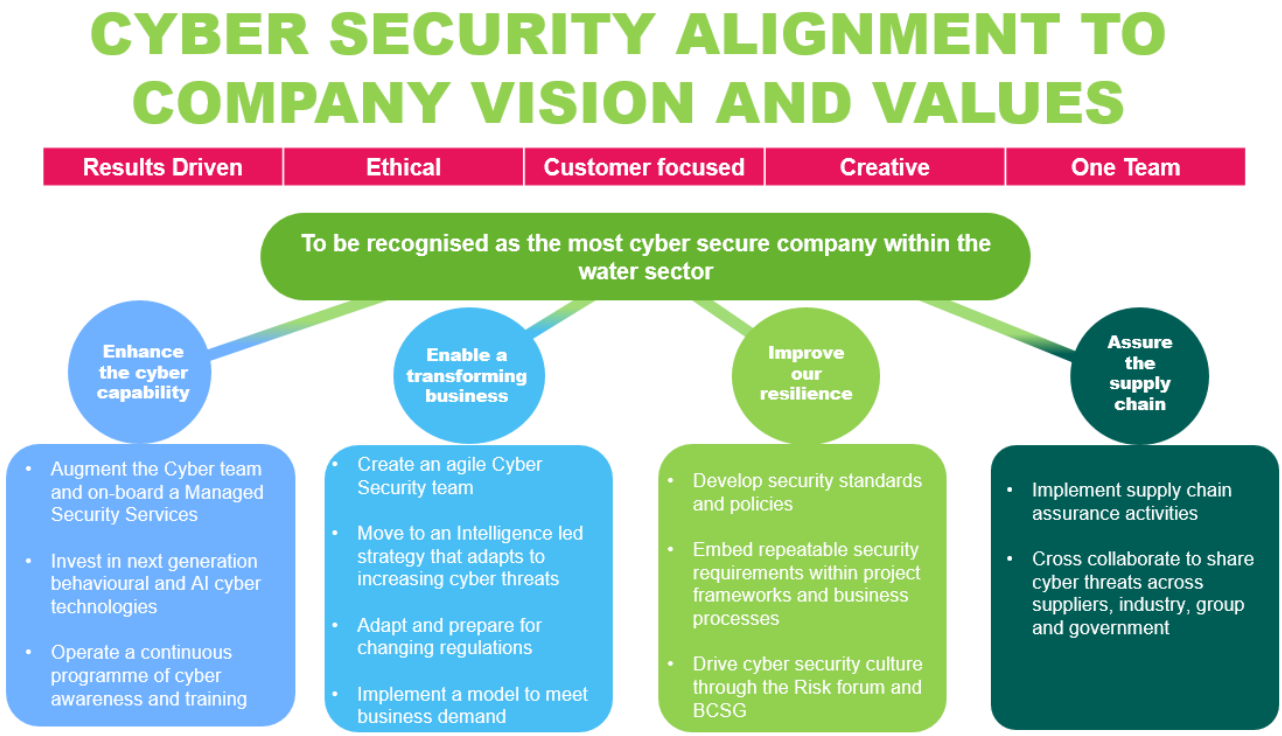
Context and scope

This resilience (cyber security) business case supports the values included in Line 27 of the WWS2 – wholesale wastewater expenditure by purpose Ofwat table and Line 16 of the WS2 wholesale water expenditure by purpose Ofwat table.

Cyber security is the overarching term used in ISO27001 and many other frameworks to describe the 'confidentiality, integrity and availability' of our computer systems and information from both malicious and accidental compromise. Ensuring the security of our systems and

information is paramount in the effective running of NWL and as such we take our responsibility very seriously.

Our cyber-resilience strategy, shown below also supports our innovation strategy and is aligned with the NWL vision of becoming National Leader in the provision of sustainable water and waste water services:



In line with CPNI guidance NWL take a holistic approach to security and as such physical, personnel and cyber are all vital components of our security posture. However, this enhanced investment falls predominantly under the 'cyber' element due to the increasing cyber threat as outlined in HM-Government National Cyber Security Strategy[1].

In line with DEFRA's Water Sector Cyber Security Strategy[ii] this enhanced cyber security proposal supports the development of a mature cyber security function capable of managing the increasing global and asymmetric threat across the next AMP.

According to DEFRA's Water Sector Cyber Security Strategy[3] within the next decade, cyber tools and techniques that are presently the preserve of nation states will be much more widely available and the offensive cyber capabilities of state actors will improve. Furthermore, a number of threat actors including terrorists, hacktivist, criminals and foreign intelligence services can use cyberspace as a means to expose vulnerabilities and cause damage. This could manifest itself in several ways, including the disruption of water supply, affecting the quality of the water supply, causing pollution incidents or the theft of customer data. Technological developments have increased the attackers' reach and made their identification more difficult which leads to a bolder approach when attacking businesses. The increasing use of the

darkweb for anonymity will only increase the number of threat actors taking an aggressive stance whilst hiding behind the shields of new technologies.

We have three main areas of focus to ensure cyber resilience:

- Protecting our Operational Technology (OT) assets that treat and distribute clean water and waste water and protect the natural environment in which we operate;
- Protecting our Information Technology (IT) assets that help us function as a business and support our customers;
- Protecting our customer and employee data.

Cyber security is not simply about buying technology to mitigate against the threats, and a robust cyber security strategy needs to be built around 'People, Process and Technology', including but not limited to employee training, supply chain management and governance. A weakness in any of these areas is open to potential exploitation and our proposal is to enhance our defences in all areas. We could invest hundreds of millions on technical controls but if an employee writes their password down or clicks on a malicious email attachment, those technical controls could be meaningless.

The UK Government has published 14 high-level security principles developed by the NCSC which all operators are expected to comply with (see Table 1).

Table 1. UK Government's 14 high level security principles

Objective A. Managing security risk - Governance - Risk management - Asset management - Supply chain	**Objective B.** Defending systems against cyber attack - Service protection policies and procedures - Identify and access control - Data security - System security - Resilient networks and systems - Staff awareness and training
Objective C. Detecting cyber security events - Security monitoring - Anomaly detection	**Objective D.** Minimising the impact of cyber security incidents - Response and recovery planning improvements - Impact on the natural environment by prevention of pollution events caused by compromised sites and assets

In line with these 14 principles we will not only invest to help 'prevent' cyber incidents and breaches, but must also invest for 'when' an incident occurs so that we can recover promptly to minimise the impact to our customers. This includes access to threat intelligence, early alerting and testing and incident response capabilities.

This investment is not for the replacement of existing controls such as firewalls, anti-malware software, mobile device management, penetration testing or the any of the other security controls we employ to currently protect our infrastructure. In order to maintain service in the face of an increasing threat to cyber security NWL needs to enhance its capability to manage, defend, detect and respond against the expected threats associated with new cyber threat vectors of the next AMP. They also comply with new legally enforceable quality obligations which aligns with Ofwat's definition of base and enhanced expenditure.

Customer and stakeholder expectation

There have been numerous meetings and workshops with DEFRA, Water UK, Drinking Water Inspectorate (DWI), CPNI, NCSC and other Government contractors and all those bodies agrees that the cyber threat is significantly increasing and we must enhance our cyber security resilience during AMP7.

We have also been taking advice from reputable security companies, news sources and collaborating with other water company and CNI cyber security professionals to understand their views about the future.

This business case is driven by statutory and non-statutory drivers and therefore to an extent some of the investment is discretionary. In March and April 2018, we conducted two phases of deliberative qualitative research with customers to explore their acceptability for a range of discretionary enhancement schemes including cyber resilience. The schemes were presented in the context that in 2020 customers' bills would be reduced by 10% and that the schemes could be funded by making the 10% reduction smaller.

When reviewing the results of the engagement, we considered customers' acceptability to be anything over 70%. This was based on CCWater's threshold of acceptability research that was carried out for PR14.

The second phase of research was conducted because in the first phase a number of customers stated that they did not know if they accepted the schemes. We discussed this with the Water Forums and agreed that we should carry out additional engagement to understand why this was, and what information we would need to provide to customers to allow them to answer the acceptability question.

The results from the acceptability engagement were discussed with the Water Forums, who welcomed the generally very high levels of customer support for the schemes. Members did not agree on a definitive threshold for support in percentage terms, however some views shared were that anything over about 60% would be acceptable.

All our enhancements were included in our overall acceptability research, where our plan was supported by 91% of customers.

Specifically for cyber security the scheme we tested with customers was based on how and to what extent we could increase investment to enhance the way we could control and secure our computer systems to make them more resistant to cyber-attacks. Customers were told that this scheme would include investment in new ways to prevent, detect, respond and recover from cyber-attacks.

We presented the scheme to 78 customers, across our NW and ESW operating areas and asked them whether or not they accepted it in return for taking 0.12% (NW) / 0.17% (ESW) less of the 10% bill decrease. Participants were told that this would be equivalent to £0.48 (NW) / £0.40 (ESW) per year. The scheme achieved a level of acceptance of 84% in NW and 85% in ESW.

The Water Forums challenged whether this was an enhancement scheme or something that all companies should be doing anyway. We believe that it is a valid enhancement in response to significantly increasing risk in this area, along with customers' desire for their data to be protected.

Current and historical service delivery and expenditure

We have been advised by Government that the maturity and investment in water sector cyber security lags other CNI industries; however, NWL have been one of the leading water companies in this arena for many years and have invested appropriately. The NWL Cyber Security team won team of the year at the 2016 Utility Awards for their innovative approach to managing cyber security employee awareness and our IT Security Manager was highly commended at the IT Industry Awards in 2015 for his work in cyber security.

Investment in the current AMP has been proportionate to manage the risk and NWL have been extremely innovative with their investment. NWL were the first water company in the world to invest in anomaly threat detection on the IT network with the procurement of 'Darktrace' and as such were finalists for 'IT Initiative of the year' at the UK Computing Security Awards.

The Government assessment into the NIS Directive[iii] has highlighted the following points which help clarify some of the difficulties associated with identifying past, and predicting future cyber investment compared to traditional water asset investment:

- Businesses do not have full visibility of the threat against them and therefore have a level of uncertainty as to what they should be doing to protect themselves. As many cannot calculate accurately the cost or benefits to their businesses;
- The 'digital' domain is characterised by dynamic phenomena with heavy-tailed statistical distributions. Past outcomes are a poor guide to future outcomes. There are thus few simple and definitive answers and, where there are, there is no guarantee that the answers will remain 'true' in the future. These challenges inhibit the ability to measure and generate comparable results over time and across research methods. At a more practical level, these methodological issues subsequently impede the ability to determine the probabilities and impacts of digital security incidents. Cyber security also has a unique problem when it comes to requesting information from businesses and individuals in that they can only report attacks and breaches that are detected. Technical experts know that viruses and malware can embed themselves deep into IT systems making them hard to detect. Therefore reports from businesses on the scale and impact of the problem are likely to be underestimates.

Because of the above, cyber investment cannot be based on traditional methodologies used to define Physical security ie traditional (SEMD) investment. Ofwat's unit cost enhancement models for security suffer from this problem and we therefore consider they are not an appropriate way for benchmarking these costs.

Despite numerous well documented high-profile data breaches and system outages such as the Talk Talk hack or Wannacry malware that affected thousands of large organisations including the NHS (discussed further in the benefits section), NWL has not had a cyber-incident resulting in an impact on the customer in AMP 6. This is testament to a very professional team but the rate of threats attempting to disrupt the business are increasing at such a fast pace that enhancing our security posture is essential if we are to maintain this high standard.

We are experiencing significantly more attempts to compromise our service on a daily basis and simply maintaining the same level of investment is not an option if we are to continue to protect our customers and assets. The fraud and data theft attempts are becoming increasingly sophisticated and we are seeing a significant increase in activity from hostile foreign state threat actors.

The below table taken from our firewall logs demonstrates the exponentially increasing numbers of malicious devices scanning our firewall for vulnerabilities on a typical daily basis.

Year	Malicious scans or attempts to penetrate our firewall per typical day
2013	6,255
2014	8,900
2015	11,632
2016	16,905
2017	45,751
2018	312,553

As well as our firewall we also see significantly increasing and elaborate attempts to access our systems via email and other social engineering means such as malware on USB sticks and hoax callers phoning the business and asking for passwords. Whilst producing this document we are seeing increased cyber aggression from a hostile foreign state attempting to compromise our infrastructure and this is supported by alerts from the UK's intelligence services.

To equip us for AMP7 it is imperative that we take a more proactive approach in our investment and focus on threat intelligence, early detection and the ability to respond and recover from incidents as well as updating our current base security controls.

Forward looking analysis

As seen from the table in section 4 the threat is increasing exponentially. As well as these figures we know from our own experiences of attempted hacks and breaches through other means and through talking to other water companies, CNI companies and Government bodies that new threats are emerging on a daily basis. For example, one of the threats we face today is cyber criminals trying to install bit coin mining services on our infrastructure to leverage our processing power to generate virtual currency, threats like this hadn't even been considered 12 months ago but could bring our IT and OT Operations to a standstill. In a few years' time and in line with our vision to innovate, artificial intelligence or technologies such as block chain may play a significant role in our business. These innovative and exciting technologies will bring their own risks and we must ensure that we enhance our security to mitigate against this innovation being compromised.

New regulatory obligations were introduced during 2018 which ensures sufficient priority is given to cyber security. General Data Protection Regulations (GDPR) ensure we protect both employee and customer data. In addition, the NIS-D ensures Critical National Infrastructure facilities such as the treatment and distribution of drinking water are protected from cyber incidents. Failure to comply with these regulations carries significant financial penalties as well as potentially compromising the operation and service we provide to our customers.

It must be emphasised that unlike traditional water company investment, the cyber security environment is extremely dynamic and there are many uncertainties:

- Technology changes quickly and new technology presents new threats;
- Security solutions may disappear or merge with other solutions i.e. Microsoft introduced encryption into their Windows Operating Systems negating the need for investment in laptop encryption. A solution that may be for sale today may not be available by AMP 7, for example we were investigating options to secure Windows phones and a month later Microsoft decided to stop manufacturing Windows phones;
- The threat landscape changes very quickly depending upon areas outside of our control. This could be anything from cyber criminals inventing new malicious software, to cyber conflict from the other side of the world resulting in our water systems being attacked by hostile foreign states;
- The threat will change in line with foreign state investment, malicious and mischievous members of the public, IT savvy members of the public, terrorism, as well as new technology creating more opportunities for accidental breaches. We know that the high-tech hacking technology that was only in the hands of Governments and the intelligence services a few years ago is now in the hands of cyber criminals and school children who hack for fun have brought harm to several large organisations in recent years. This trend will continue in line with the rapid pace of technology;
- Licence costs can change dramatically based on the business decisions of the supplier and who our wider technology is tied into;
- The European NIS directive (Network Information Security) has not been finalised despite going live in May 2018. DEFRA and DWI appreciate that water companies will not be compliant with from day one and that significant investment to comply will be needed and that water companies should be preparing now to invest in the next AMP.

Option appraisal

Our approach to investment was taken in which the NIST Cyber Security Framework controls of 'identify, protect, detect, respond and recover' were explored and areas were identified where

good practice enhancements could be made to provide pragmatic levels of mitigation for the predicted threat.

- **Identify** Understanding the environment is essential to managing cybersecurity risks. This includes all digital and physical assets and their interconnections, including understand the risks and exposure.
- **Protect** The appropriate safeguards and controls to prevent, limit or contain the impact of a potential cybersecurity event.
- **Detect** The appropriate measures to quickly identify cybersecurity events. Continuous monitoring solutions to detect anomalous activity and other threats. Visibility to anticipate a cyber-incident and have all information at hand to support an appropriate response.
- **Respond** The ability to contain an incident and respond quickly.
- **Recover** Appropriate activities to restore services following a cybersecurity event.

Options and associated costs have been developed through preliminary market engagement and pricing, which we expect to be refined over time as the requirement is finalised. Specifically we expect at the point of formal tendering that the market may propose further changes than those highlighted in our early market engagement.

We have collated costs to enhance our security across AMP7 based on all the above criteria but being mindful that we must remain flexible and able to adapt quickly to new threats and technology, and optioneering of solutions and services will happen as part of the individual projects.

Benefits Assessment

In principle, a cyber-attack could lead to significant negative impacts across our business, including the following:

- Disruption to water services;
- Poisoning of water (changes to chemical levels);
- Disruption to waste water services;
- Pollution incidents;
- Disruption to traditional IT systems (Customer service impact);
- Loss or theft of Customer or Employee data
- Financial theft and fraud;
- Intellectual property or commercial data theft (causing greater harm to the UK economy);
- Regulatory requirement (GDPR, NIS).

In short, a cyber-incident could potentially affect every measure and outcome of NWL. Therefore, the benefits of enhanced cyber security would to be to reduce the risk of these negative impacts.

The Impact Assessment into the NIS-D by DCMS[2] notes that there are many limitations to conducting a cost benefit analysis of cyber security for several reasons:

- Past outcomes are a poor guide to future outcomes;
- Only breaches and attacks that are detected can be reported;
- Limited robust evidence on effective prevention measures.

The assessment therefore recommends that the results of the cost benefit analysis are only seen as indicative, but stresses the importance of conducting such assessments. It cites the Cyber Security Breaches Survey (2017) which estimated that the average cost of a breach for a large company is £19,600[iv].

To get a sense of the potential cost of failure by not enhancing cyber security in line with Government recommendations, we have considered the following:

- An illustrative example: We have considered what a cyber-attack could mean for our business and the potential impact that it could have on our customers;
- The cost of losing personal data; and
- Examples of fines and costs to other companies who have had a cyber-security incident recently.

These are described in turn below.

An illustrative example

We have considered a scenario where a cyber-attack results in a 12 hour+ supply interruption to a large group of our customers. We have assumed that this would impact around 5% of our customer base, or around 100,000 properties in total (household and no-household). Based on our risk assessment this is not an inconceivable scenario for an attack.

We recently commissioned Explain to carry out research into customer valuations of long-term supply interruptions. The research showed that customers valued avoiding a 12 hour+ supply interruption at £6,472 per property on average. Therefore, if this impacted 100,000 customers, the impact would be in the order of £650 million in terms of customer valuations. Again, we cannot comment on how likely this scenario is, but it highlights that cyber-attacks could potentially cause significant damage and harm to our customers, and highlights the importance of enhancing our cyber security.

Cost of lost personal data

Estimating the cost of commercial data loss includes the costs to customers of having their records and personal data stolen. Research by IBM and Ponemon (2017) estimated that in the USA the cost per person of a lost or stolen record containing sensitive and personal information was $141[v]. If all of our household customers were affected, around 1.77 million customers then this could imply a cost of $250 million (or around £190m)[vi].

Potential costs to the business

Although our enhanced cyber resilience business case is not directly aligned to mitigating against fines we have included fines in the following to provide a wider appreciation of potential impacts. We have reviewed high profile examples of companies being breached by cyber-attacks and looked at the costs and fines that they incurred. According to the ICO, there were 380 cyber security events in 2017, and over 450 data security incidents[vii]. There have been several recent high profile examples of the costs associated with such events:

- Maersk malware hacking 2017[viii];

Maersk was hit by the NotPetya malware which affected 4,000 servers, 45,000 PCs and 2,500 apps. It estimates the total cost of replacing this infrastructure to be between $250m to $300m, and it lost 20% of volumes during the incident;

- TalkTalk data breach fines in 2017[ix];
  TalkTalk was fined £400,000 by the ICO for a data breach in 2015 where a cyber-attack stole customer data for 156,959 customers. It was fined an additional £100,000 for illegal access to 21,000 customers' data by an IT services company and;
- NHS ransomware hacking 2017.

The NHS was one of the entities affected by the Wannacry ransomware attack in May 2017. The identifiable cost of the emergency measures cost NHS Digital and NHS England £180,000[x]. Each of the 48 affected trusts will have also incurred additional costs. No data is publicly available but an estimate of £1m in costs for one trust have emerged[xi]. The Health Services Journal estimates that 1 in 5 affected trusts had not made crucial software updates before the attack[xii].

Data protection laws in the UK have recently changed to allow the ICO to fine up to up to €20m or 4% of global annual turnover (whichever is higher). Our revenue to the year ending March 2017 was £853.7m[xiii], and so a 4% fine could be around £34m or higher depending on the findings of a legal query as to what constitutes our turnover (NWL or our holding company).

Our preferred plan/option

NWL are currently on the path to a 'cloud first' IT/OT offering. This means we plan to migrate a lot of our current in-house IT/OT services into third party data centres and that our technical environment is changing quickly. By focusing on the areas that require investment (identify, protect, detect, respond and recover), yet being pragmatic about the final solutions puts us in a much more realistic position to be able to invest and enhance our resilience appropriately.

Table 2 is a summary of our enhanced investment proposal. The table is collated based on costs to enhance our cyber defences using today's technology and today's prices. The areas for enhancement are areas we believe need investment to cope with the increasing threat landscape, risk and new regulations.

Table 2. Summary of security controls and their associated costs

Security Enhancement	Control	Capex (£m)	Total (£m)
Services and tools to detect incidents	Detect	£6.39	£6.39
Services and tools to protect systems	Prevent	£6.25	£6.25
Services to respond and test capability	Respond & Recover	£0.44	£0.44
Resources and systems to govern and comply	Govern/ Identify	£1.45	£1.45
			£14.531

For the purposes of our submission the above total is split and uploaded as follows:
2/3rds to WS2 and 1/3rd to WWS2 both under Non-SEMD
Comparing this cost to the potential cost savings from a cyber-security event shows the benefits outweigh the enhancement costs (although it is worth noting again that it is not possible to put a probability on either the water supply interruption scenario described above or the scale, complexity or recovery costs):

- The customer valuation of avoiding a 12 hour + supply interruption for 100,000 customers (£650 million) is nearly 50 times greater than the investment;
- Avoiding the cost of the lost personal data (£190 million) is around 14 times greater than the investment;
- Avoiding the maximum fine from the ICO (£34 million) is approximately 2.5 times the investment;
- None of these costs include the disruption to the wider economy that may result in an attack on a CNI organisation.

Our proposal includes a commitment to:

- Implement a mature Security Operations Centre (SOC) and 3rd party incident response capability within a budget of £5,850,000 across the AMP;
- The additional £8,681,000 will be invested in enhancing our cyber security function which will be capable of proportionately protecting NWLs operational assets and customer's data from cyber-attacks into the next AMP. This investments will be implemented appropriately across the AMP based on risk to both the business and our customers. As the risk changes the solutions may change and this investment may be reallocated to other cyber security initiatives where it will have more benefit.

The enhancement scheme and cost summary in Table 2 consists of numerous smaller services and solutions. We have been through a robust initial market engagement process to determine a baseline set of investments but recognize that some of the requirements may need to evolve over time as new threats emerge. A summary of some of the investments based on our current assumptions of enhanced investment is included below.

Detect: These solutions are to promptly identify cyber-attacks and systems compromise, so as to reduce, or potentially eliminate the impact to our customers.

Security Operations Centre (SOC) is by far the largest of the investments and would give us the ability to detect and respond to future threats as quickly as possible thus reducing the impact of a cyber-event. The SOC would also act as a threat intelligence aggregator to alert and provide advice on appropriate actions based on the latest threat intelligence. Informal estimates were obtained from two leading service providers, both advising at about £1.2m PA. SOC managed services are already widely used within mature sectors such as energy and banking. Optioneering would happen closer to implementation to ensure best value for our customers and would include investigation to understand if a managed service or an 'in-house' SOC would represent the best option.

Advanced Persistence Threat (APT) solutions would be able to detect, alert and block APT's across our estate and could be bundled with the SOC offering.

OT anomaly detection would let us monitor anomalies and malicious behaviour on the OT network. This would increase detection and alert on strange and possibly malicious activity on the OT network. We already have anomaly detection on the IT network so replacement of this is not included in this submission and would be replaced under base investment.

Prevent: These proposed solutions are proportionate security measures to help protect essential services and systems from cyber-attack.

Privilege management*, *permissions management*, *network access control and 'end point zero-day' solutions will all enhance our security and help prevent incidents from happening to reduce the risk to our customers. Traditional prevention solutions such as firewalls, AV software, patching solutions, mobile device management etc. are not included in this submission as they are currently part of our 'base' spend.

Microsoft E5 licences provide additional security functionality not currently provided by our E3 licences and would help secure our future O365 estate against advanced threats. This funding is purely to enhance security above the current 'E3' licences we use now and not to support current licence costs.

Enhance employee awareness by deploying innovative training solutions. This would build on the traditional training and test phishing email simulations ensuring the cyber security culture of the business is enhanced into the next decade.

2000 OT outstations need to be migrated to new IP technology meaning new cyber risks will be introduced that didn't exist with serial interfaces. Enhancing the security of the OT network in support of this migration is paramount to protect our business.

Respond and recover: These solutions will ensure we have the capabilities to respond and recover promptly in line with Government advice that companies should start preparing for 'when' a cyber-incident happens, not 'if'.

Incidence response capability investment will give us the capability to call on 3rd part cyber security specialists to assist in the event of an incident. This will improve the response time and impact of a security incident and may be bundled with SOC investment.

Identify and govern: We must have appropriate controls to identify and manage our assets as well as a robust frameworks and resource to manage security in an increasingly fast paced and changing landscape. The below investments are areas that need to be enhanced in the next AMP.

Implementing an ***Information Security Management System*** (ISMS) based on ISO 27001 and Cyber Essential Plus. These will help us guard against cyber threats and help us manage NIS-D, PCI-DSS, GDPR and other future compliance frameworks.

Enhanced/red team testing in line with CPNI advice. Companies should be taking a holistic approach to security so we will employ a 3rd party specialist to test the holistic security at NWL. With the advice of the specialists the likelihood of malicious threat actors exploiting the weakest links including physical and personal security is reduced.

MS Operations manager's suite would provide us with security compliance reporting and asset management.

Additional internal resource is required to help manage security appropriately in line with new and increasing threats. This would ensure all security processes, controls, procedures and policies are kept up to date and followed across the entire business.

With ***continuous vulnerability testing***, we can regularly scan ingress points for vulnerabilities, which reduces risk of perimeter security being penetrated.

The amount of investment allocated to each area is based on estimates to deploy today. Each area will be thoroughly explored and implemented based on the risk and technology at the time. Although the final solution may vary, the outcome and the area requiring enhancement should not. This will ensure we don't deploy out of date solutions but do enhance our security and reduce the risk to our service and customers.

Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives.

All costs for the cyber resilience enhancement scheme were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[1]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed costs for the cyber resilience enhancement scheme are £14.531M Capex.

These costs were benchmarked and assured using the Traditional unit rate and historical spend composite cost.

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[2]. This review has assessed cyber resilience enhancement costs as 'Amber', that is NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

Customer protection

NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed.

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[1] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology.

[2] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

To protect our customers we will apply a penalty rate for underperformance against this enhancement. As this enhancement targets a range of deliverables by 31 March 2025, we have based our penalty on a per day late of delivery basis. This uses the same principle as our Performance Commitment for R-F1 Delivering a consolidated customer information and billing system, penalty rate 2 at PR14.

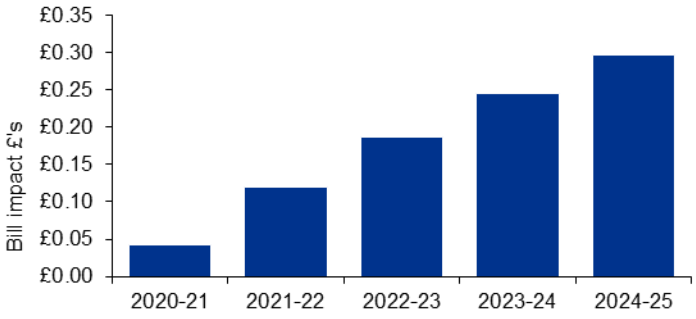
Any penalty will be calculated as a net present value neutral adjustment as part of the PR24 true up process of the relevant 2019 Final Determination cash flows should the outcome be delivered late, partially or not at all. The discount rate used will be 3.3% real, the CPIH stripped cost of capital.

Full details of our enhancements delivery incentive mechanisms are included in Chapter 4: Measuring and Incentivising Success of our final business plan.

Affordability

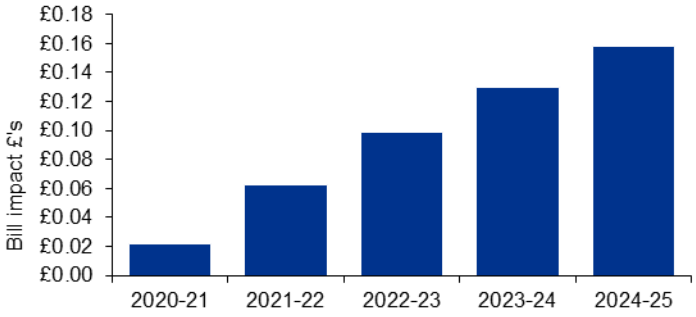
The impact of these enhancement investments on customer bills are shown below[3].

Water Network



Waste Water Network

[3] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates consistent with App16 and using revenues and combined bill average values consistent with App7.



Overall the analysis shows the bill impact would be around 6p in the first year rising to around 46p by the end of the AMP across the combined water and waste water submissions

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[4] driving significant improvements to average customer affordability.

Our final cyber resilience plans have been shared with and are supported by our customers including a willingness to invest more of their future bill to deliver a more reliable and resilient service for them whilst protecting and enhancing the environment we operate within. We have received significant levels of support from customers, over 84% which is an exceptionally high level of acceptance.

We are therefore assured we have identified the right schemes for customers that deliver the most cost beneficial reduction in risk, improve overall cyber resilience and are acceptable within the context of balanced and affordable bills in the future.

Alignment with customers and stakeholder needs

Board assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

[4] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers"[5].

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[i][i]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/567242/national_cyber_security_strategy_2016.pdf

[i] http://www.legislation.gov.uk/ukia/2018/74/pdfs/ukia_20180074_en.pdf

[ii] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/602379/water-sector-cyber-security-strategy-170322.pdf

[iii] https://www.ncsc.gov.uk/guidance/nis-directive-top-level-objectives

[iv] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/609186/Cyber_Security_Breaches_Survey_2017_main_report_PUBLIC.pdf

[v] http://info.resilientsystems.com/hubfs/IBM_Resilient_Branded_Content/White_Papers/2017_Global_CODB_Report_Final.pdf?t=1510933508399

[vi] Bank of England exchange rate of 1.3483 on 17/05/2018.

[vii] https://ico.org.uk/media/action-weve-taken/reports/2014675/data-security-trends-pdf.pdf

[viii] https://www.theregister.co.uk/2018/01/25/after_notpetya_maersk_replaced_everything/

[ix] https://www.ft.com/content/c3c95a00-7dc0-11e7-ab01-a13271d1ee9c

[x] https://www.parliament.uk/business/publications/written-questions-answers-statements/written-question/Commons/2017-06-22/781/

[xi] https://www.digitalhealth.net/2017/05/cyber-attack-recovery-costs-yet-to-be-determined/

[xii] https://www.hsj.co.uk/technology-and-innovation/exclusive-one-in-five-trusts-did-not-make-critical-security-updates-before-cyberattack/7020083.article?adredir=1

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[5] See Board Assurance Statement

[xiii] http://www.NWL.co.uk/_assets/pdf/NWL_31_March_2017_Final.pdf

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SEMD ENHANCEMENT BUSINESS CASE

WS2 - Wholesale water capital and operating enhancement expenditure by purpose Line 15 and
WWS2 - Wholesale wastewater capital and operating enhancement expenditure by purpose Line 28

APPENDIX 3.2

SEMD ENHANCEMENT BUSINESS CASE

Name of claim	SEMD and security enhancements	
Name and identifier of related claim submitted in May 2018	n/a	
Business plan table lines w here the totex value of this claim is reported	Line 28 on the WWS2 and Line 15 on the WS2	
Total value of enhancement for AMP7	£22,267k	
Total opex of enhancement for AMP7	£0k	
Total capex of enhancement for AMP7	£22,267k	
Depreciation on capex in AMP7 (retail controls only)	n/a	
Remaining capex required after AMP7 to complete construction	Costs are provided for AMP 7 only	
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No - some elements of cost have been excluded from the enhancement cost request, for example £190,000 is in base for the SR Locks (estimated to be the physical lock replacement costs rather than the electronic element upgrade)	
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	Material	
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	Yes	No
		No
Need for investment/expenditure	Investments are driven by SEMD and statutory requirements but there is some flexibility under the framework as a result of changes so we have supported by deliberative customer research.	
Need for the adjustment (if relevant)	n/a	
Outside management control (if relevant)	n/a	
Best option for customers (if relevant)	The requirements remain somewhat restrictive. Our options appraisal for key elements has focussed on delivering the requirement at least cost based on our AMP 6 experience at our water sites which face the same requirements.	
Robustness and efficiency of claim's costs	Cost estimates have been developed based on unit cost benchmarking and forecasting of historical spend in AMP 6 for similar solutions and have undergone preliminary market testing. Cost estimates and methods have been independently assured.	
Customer protection (if relevant)	We have not introduced an ODI to protect customers. The SEMD requirement is a legal requirement and therefore failure to meet the requirement would result in enforcement action against NWL. This already provides a strong incentive for delivery.	
Affordability (if relevant)	Proposals have been tested with customers through specific deliberative research and are supported. Proposals sit within one of the highest overall bill reductions in the sector at a time of rising real incomes. Our plan also includes substantial support for vulnerable and low income	

	customers.
Board Assurance (if relevant)	This and other enhancement cases have been considered by our Board sub-committee and full board. See our Board Assurance Statement for further details.

APPENDIX 3.2

SEMD ENHANCEMENT BUSINESS CASE

Contents

APPENDIX 3.2

SEMD ENHANCEMENT BUSINESS CASE

1 Executive Summary

As a water company Northumbrian Water (NWL) own and manage a complex network of assets to provide safe, clean drinking water to our customers and treat sewage to protect the environment. In order to provide this service we store hazardous chemicals, employ thousands of people in offices and on operational sites, as well as having sites which are considered critical to the UK National Infrastructure. We are obligated to comply with the legal requirements of the Security and Emergency Measures Direction: 1998 – SEMD - (enabling legislation under Section 208 of the Water Industry Act 1991). Up until recently SEMD was implemented through the issuing of Advice Notes (instructions) by Defra Water Security and Resilience (WSR) to the water companies in England and Wales. As we go into AMP7 these Advice Notes have typically been superseded by the Protective Security Guidance 2020 (PSG) document. This document, recently issued by Defra WSR, sets out new requirements relating predominantly to physical security. The technical elements previously contained in the Advice Notes are also being incorporated into the Water UK Security Standards (WUK SS) document.

All of NWL's above ground assets are categorised according to defined criteria set out in the agreed National Standards previously described. NWL, and other water companies, are required to improve the security of sites on their network to address security risks based on a risk categorisation of those sites, the guidance sets out how that categorisation is undertaken. Categorisation of the assets takes into account the potential threat at each asset, the likelihood of that threat materialising and the consequences should the asset be impacted upon. The categorisation also takes into account any history of unauthorised site intrusion. Once categorised specific measures need to be installed to ensure appropriate security is applied at each of these sites. Again, these requirements are specifically detailed in the National Standards.

The schemes proposed are to comply with Defra WSR requirements (via guidance, e.g. the PSG or instruction such as alternative water supplies) and/or national agreed standards (e.g. Water UK Security Standards). These schemes are therefore statutory driven investments, to either enhance existing requirements (e.g. moving to electronic keys/locks for those that are coming out of patent and needing replacement), or deliver new requirements (e.g. increases to required alternative water response capability from 40,000 population to around 65,000) or the ongoing implementation of our long-term SEMD investment plan (compliance with Water UK Security Standards – commence implementation at Wastewater sites in AMP7). A summary of the investments we need to make is set out below.

Figure 1: Summary of investment requirement

Requirement	Source of requirement	Preferred investment options	Totex proposed in AMP 7 (5 years)
Upgrade security measures on our most critical wastewater assets (top 2 categories based on Water UK Standards) to conform to the nationally agreed standard to prevent harmful discharges to the environment	Based on Water UK Standards and part of an ongoing programme of security improvements under SEMD.	• Most efficient option to comply with the Standard as per the instructions within the Standard. • This largely involves fencing and securing existing sites.	£15,876k
Make further improvements to	As per Advice Note 9 and anticipated	• Purchase additional rapid deployment	£ 2,150k

response capabilities to the loss of piped water supplies to customers	amendments from Defra[1]	water storage tanks • Deliver further tanker filling points	
Deliver further security improvements at the Enhanced (major) service reservoirs and water towers	As per Advice Note 8 and 8/A.	• Install improved monitoring capability on sites by increasing the 'live' coverage of the assets with CCTV or other technical solutions.	£ 3,098k
Invest in improved technology systems to aid the 24/7 security monitoring of assets			£ 1,344k

Since this is a statutory requirement, the most cost effective solution is installed from the widest range of options considered based on the guidance, which whilst improved does remain quite restrictive by defining relatively narrow outcomes to be delivered and in most cases a prescriptive set of ways to meet the requirement. The proposal is to install a new physical and electronic security solutions at the relevant sites. A desk-top study has been completed to determine the most cost-effective solution at these sites and actual costs from similar solutions being currently deployed in AMP 6 were used to determine an overall proposed cost. The AMP 6 sites generally have the same requirement and the most cost effective and practicable solution that delivers the requirement usually involves fencing and securing each site rather than securing each access point to the asset (valve's etc).

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach involving benchmarking of cost estimates against alternatives. Costs for SEMD were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on a range of different approaches[2]. These costs were benchmarked and assured using a mixture of unit cost benchmarks and assessment and forecasting of historical spend. The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[3]. This review has assessed SEMD costs as Amber and that NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

Whilst the driver of these investments is a statutory one, we do have some flexibility around how we choose to meet that statutory requirement. As part of our assessment of affordability we have engaged with our customers on what resilience means to them and their understanding of and appetite to risks to service during three specific phases of engagement. The Phase 3 research undertaken shows customers are supportive of our plans for increasing our resilience against natural and manmade hazards as well as the increasing cyber threat. Our overall business plan involves the largest bill reduction in the sector, more than 10%, at a time when average real incomes are forecast to rise making these proposals more affordable for customers on an average basis. We have also proposed in our plan various enhancements to our package of measures to support vulnerable and low income customers for whom affordability challenges will remain, including eradicating water poverty by 2030, again supporting affordable proposals.

[1] Defra confirmed at a workshop in January 2018 that they expected to require companies to meet a standard of 1.25% population coverage in their potable water response in AMP 7 but the legal requirement has yet to be finalised.
[2] For further detail on the cost estimation approach, please see separate paper on cost assessment for enhancement schemes- NWL, 2019, Assessing efficient costs of enhancements
[3] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

Finally, this and all our enhancement cases were considered by our board sub-committee and reviewed by our full board in March 2019. The board's sign-off is reflected in our revised board assurance statement[4].

2 Context and the need for investment

This business case supports Line 28 on the WWS2 – Wholesale wastewater capital enhancement expenditure by purpose and Line 15 on the WS2 – Wholesale water capital enhancement by purpose table of Ofwat.

This business case is aligned to the UK Government strategic priorities and objectives for Ofwat and the water industry as set out in its Strategic Policy Statement, including the theme of securing long-term resilience. NWL's approach to resilience in the round includes a risk-based approach to protecting customers by providing the necessary protections to our assets and our people from acts of terrorism, criminality or malicious activity.

This case also considers the obligations and the expectations from regulators as set out in several guidance documents to support enhanced Security Emergency Measure Direction (SEMD)[5] as summarised below;

- Protective Security Guidance (SEMD PSG) Issue 1 – DEFRA
- Water UK Security Standards (WUK SS) – Water UK
- Current guidance contained in DEFRA/CPNI Advice Notes[6]
- SEMD Advice Notes on protective security for water assets
- SEMD Advice Note No. 9 on required alternative supply capability
- The UK Government strategy for countering terrorism[7]

The proposed investments are part of a long-term strategic approach to resilience in the round, based on recommendations from NWL's Improving Water Supply Resilience Project (2011). As an example, compliance with the Water UK Security Standards document commenced in AMP5 (2010 to 2015) with the protection of the major water supply assets, with the aim of completing the remaining water supply assets in AMP6 (2015 to 2020), both of which were supported by Ofwat in previous price reviews. As part of the development of the cost proposals, categorisation of the wastewater treatment assets has been completed based on the Water UK standards documented and those assets (24 sites) that were identified in the top 2 categories have been identified for investment. The aim of NWL is to implement these standards at the 24 most critical wastewater assets in AMP7 (2020 to 2025) and we will review the remaining wastewater assets as we look to invest beyond 2025.

Protective security

The most significant driver for enhancement of protective security is the increased probability of terrorist or malicious attack on our water assets, together with the emergence of new types of threat. National threat levels are determined by the Joint Terrorism Analysis Centre (JTAC)[8]. The stated threat levels at the time when our PR14 proposals were submitted was Substantial; since then the threat level has risen to the current level of Severe, and there were two periods of Critical. The threat level for the Water sector is currently determined to be Low, requiring a response level of

[4] See our Board Assurance Statement
[5] Under section 208 of the Water Industry Act 1991 ("WIA 91") - *The Security and Emergency Measures (Water and Sewerage Undertakers) Direction 1998*, and *The Security and Emergency Measures (Water Undertakers) Direction 2006*
[6] Under section 2A of the Water Industry Act 1991, as amended by section 24 of the Water Act 2014
[7] CONTEST: The United Kingdom's Strategy for Countering Terrorism July 2011
[8] Operated by MI5, under the statutory authority of the Home Secretary

Normal. However, NWL must be prepared for the eventuality that this could be raised if JTAC receives information of potential or actual incidents.

The regulatory guidance that we have used to guide our protective security states that it is for protection at the Normal response level. In the light of increased probability of attack, NWL is required to adopt a risk-based approach to enhancement of its protective security arrangements.

We take constant note of guidance and information received from both local Police Counter Terrorism Security Advisors (CTSAs) and the Centre for Protection of National Infrastructure (CPNI). The general message that we are receiving is that of increased threat and that we should be more prepared than previously expected.

Emergency contingency

The materialisation of natural and manmade risks are often beyond the control of NWL and include things such as climate change impact, flooding risk, loss of network power supplies, malicious intent, etc. Optioneering of solutions to mitigate these risks is minded by our respond and recover capability and we have ensured an appropriate balance in risk mitigation, resilience and cost is considered. An example is where we reduce the size of impact from an interruption of water supply event on customers to a level that enables us to be able to adequately respond with alternative water supplies. This ensures we are striking the right balance between Capex and Opex solutions to manage the risk whilst improving overall business and system resilience. The optioneering and cost benefits of these schemes are covered in separate business cases – Water Resilience and Wastewater Resilience.

The main driver for proposed enhancement of NWL's emergency response capabilities is related to indications that have been received from Defra Water Security & Resilience (WSR) that the proportion of our customer population that we must be prepared to supply with potable water in the event of a water emergency will be raised. This proposed enhancement expenditure increases our capability to store, transport and dispense the required levels of water.

Personnel Security and Business Continuity

We have excluded Personnel Security and Business Continuity from enhancement proposals. These areas are expected to be covered by enhanced processes and implemented as part of business as usual activities and base costs as the most efficient way to improve our overall resilience.

For AMP7 we intend to:

- Upgrade security measures on our most key wastewater assets to conform to the nationally agreed standard to prevent harmful discharges to the environment;
- Make further improvements to response capabilities to the loss of piped water supplies to customers, including additional rapid deployment water storage tanks;
- Deliver further improvements to our water tanker fleet to aid the deployment of alternative water;
- Install additional equipment to assist with the prevention of flooding of assets (not in the SEMD submission – this is elsewhere with Operational Resilience);
- Deliver further security improvements at the Enhanced (major) service reservoirs and water towers, and;
- Invest in improved technology systems to aid the 24/7 security monitoring of assets.

3 Current and historical service delivery and expenditure

In support of NWL's resilience strategy, all of our commitments and regulatory requirements will continue in regard to security of the sites and buildings to the end of 2020. The current investment period could be seen as the second of four investment periods in the delivery of the long-term strategy for securing our assets. Key milestones and current status are:

- All enhanced (major) service reservoirs and water towers are now secured to the agreed national security standards;
- Aquifers, from which we extract water, have been protected to the agreed national security standards;
- The number of rapid deployment water storage tanks that NWL can deploy has doubled, this has increased and improved NWL's alternative water capabilities across all water supply areas. This supports customers priorities that NWL should have effective respond and recover plans and capability in place;
- Currently on target to complete the installation of physical and electronic security at all of the above ground water assets to the agreed national security standards;
- Our CCTV capability is being moved from an old analogue to digital platform, ensuring that they are future-proof.

Across the last two AMPs NWL has invested c.£63.2m (£31.0m in AMP 5 and £32.2m in AMP 6) and our AMP 7 programmes builds on and continues this major work as we move closer to an asset base that fully meets all the SEMD and security requirements. The investment scale is smaller that previous AMPs and we have considered the phasing of our investments in line with customer preferences from our deliberative research (see affordability section).

4 Forward looking analysis

Although the threat to the Water industry continues to currently be determined to be 'Low', through meetings and confidential information provided by, for example, the CPNI and NCSC the general threat level is increasing. 2017 was the first occasion when the UK moved to 'Severe' threat level twice in a single year. As such NWL believe that it is prudent to take note of this increasing risk and appropriately prepare and secure our assets.

Through the Water UK SSAOA, the main risks highlighted include:

- unauthorized access to sites – theft, malicious damage;
- polluting/malicious interference; and
- consequence – pollution, water safety, supply disruption.

Although NWL is currently compliant to the nationally agreed security standards with regards to certain assets, the equipment installed at these assets will shortly be 10 years old. Technology has improved significantly during this period and this means that alternative solutions can now be installed that greatly enhance the security at these assets, which was not available at the time of the original installation. As an example, at our Service Reservoirs we now have an option to secure these using a mechanical/electronic key combination (similar to that used in vehicles), which was not available at the time of the original investment. The existing key system is mechanical only and if a key was lost (or stolen) then there is no means to delete that key and stop it from being used by an unauthorised person. The proposed key system will enable NWL to remotely disable any lost/stolen key so that it cannot be used, greatly enhancing the security. Also at our Service Reservoirs we are proposing to install CCTV at some of our most critical sites to allow verification of any intrusion to site, enabling a much more rapid third party response to a breach, again greatly

improving the security at these sites. This is only possible now due to the improved mobile communications network and the availability of 4G currently (and possibly 5G in the near future). NWL believes it is prudent to make these security improvements in light of the increasing frequency of higher level threat being advised by DEFRA/CPNI.

5 Option Appraisal

All of NWL's above ground assets are categorised according to defined criteria set out in the agreed National Standards, detailed earlier in this document. Categorisation of the assets takes into account the potential threat at each asset, the likelihood of that threat materialising and the consequences (such as environmental pollution, public access to amenities, loss of piped water supplies to customers and the number of customers impacted, etc.) should the asset be impacted upon. The categorisation also takes into account any history of unauthorised site intrusion. Once categorised specific measures need to be installed to ensure appropriate security is applied at each of these sites. Again, these requirements are specifically detailed in the National Standards. The most cost effective solution is installed from the limited options available. Options vary between physical security at these sites (such as increasing the security of access points, e.g. fences, gates, doors, windows or installing electronic security systems that can be remotely monitored, e.g. electronic alarm systems, electronic fences, CCTV, etc.). There is no requirement to assess the benefit of these proposals as they are part of our regulatory obligations. NWL does, however, explore the various options within the limited scope available to ensure that the best value for money solution is implemented at each site/asset. As part of the development of the cost proposals, categorisation of the wastewater treatment assets has been completed and those assets (24 sites) that were identified in the top 2 categories have been identified for investment. The proposal is to install a new physical and electronic security solution at these sites. A desk-top study has been completed to determine the most cost-effective solution at these sites and actual costs from similar solutions being current deployed were used to determine an overall proposed cost[9]. These costs were verified by external third parties. The options and costings were heavily informed by our AMP 6 experience, where we needed to install similar security levels at several of our water asset sites. Our AMP 6 experience highlights the obvious benefit to fencing and site security solutions over providing security to every access point or valve on the works.

With regard to alternative water provision, should the large scale loss of water supply occur, NWL adopts industry best practice for a large scale incident in the use of rapid deployment static tanks as being the most effective response capability. NWL already has a significant capability in this regard. To meet increased requirements stipulated by Defra WSR NWL will increase the number of rapid deployment assets in-line with the increased requirements under SEMD. The proposed solutions have been reviewed and assessed and the most cost effective solution proposed.

Interaction between this submission and other submissions (in particular the water and wastewater resilience proposals) have been co-ordinated to ensure that they complement each other and do not overlap. For example, as stated previously, a mobile flood protection capability, which was identified in the SEMD assessment, was moved into the Operational Resilience proposals to be considered alongside the other flood protection measures being considered, ensuring that each resilience measure is only considered once in the overall NWL proposals. Increasing our alternative water response capability has been taken into account when determining the thresholds for identifying water supply assets that should be targeted for resilience investment.

6 Our Preferred Plan/Option

NWL is one of the main water and wastewater companies in the UK and as such has signed up to comply with the collectively agreed National Standards for the security of its assets. NWL also

[9] This study is available upon request

intend to comply with requirements stipulated by Defra WSR, ensuring compliance with regulatory requirements. To this end, NWL will make its assets and response capability resilient, ensuring, as far as is reasonably practical, consistent services to customers.

Figure 2: **Totex over AMP 7 from enhancement**

Investments	**Totex (£) over AMP 7**
Security Controls	
SR locks and keys- Abloy Cliq	*£ 947,500*
NB Wastewater allowance stream. Top wastewater sites for SSAOA (24) CAT 2	*£ 15,875,652*
CCTV data compression Development/Cameras, etc. – SR alternative, mobile capability	*£ 1,343,750*
Service Reservoir enhanced monitoring electronic security system	*£ 2,150,000*
Emergency Planning Controls	
Arlington tanks	*£ 600,000*
Further water filing points	*£ 500,000*
Internal tanker fleet	*£ 850,000*
Fuel Bunkering	*£ 200,000*
Total	***£ 22,266,902***

A more detailed description of each of the line items above is provided below. Full details of the split of costs for water and wastewater controls by year can be found in tables WS2 (line 15) and WWS2 (line 28).

- **SR locks and keys- Abloy Cliq-** The installation of keys is considered enhanced because the intention is to replace old keys with electronic keys, which will result in enhanced level of security. This will be achieved by disabling keys on identification of them being lost/stolen making them inactive and as such unable to open the relevant locks on Company premises.

- **Wastewater allowance stream. Top wastewater sites for SSAOA (24) CAT 2-** This will be new security installations at these sites ensuring compliance with the agreed Water UK security standards. This will significantly increase the security at these sites and significantly reduce the likelihood of any environmental impact as a result of unauthorised intrusion on these sites.

- **CCTV data compression Development/Cameras, etc. – SR alternative, mobile capability-** New capability to increase the on-line 24/7 monitoring of NWL's strategic Service Reservoirs. This is possible due to improved communications capability (currently 4G – potentially moving to 5G during AMP7). This is a more cost-effective solution than the current technology deployed, which will improve operational efficiency in the longer-term. It will also significantly improve the verification capabilities of any intruder on site, and thus improving the speed of any third party response. It will also provide a mobile remote surveillance capability, which we do not have now.

- **Service Reservoir enhanced monitoring electronic security system-** Enhanced monitoring capability at NWL's strategic Service Reservoirs in consideration of the increase in the general threat levels. Implementing this new digital technology will improve the accuracy of the alarm information, and as such will improve the speed of response to any activation.

- **Purchase of additional Arlington tanks -** Purchase of a further 500 Arlington tanks to increase the response capacity to loss of mains water supply in-line with new Defra requirements.

- **Further water filing points -** This is to increase the number of sites where tankers and static tanks can be filled with potable water to meet the increased response capability defined in-line with new Defra requirements.

- **Internal tanker fleet -** This entails adding increased facilities to the existing internal tanker fleet (e.g. pumps and pump control systems) along with additional tankers. This is required to meet the increased response capability in-line with new Defra requirements.

- **Fuel Bunkering -** This will enable NWL to have a capability to supply fuel to its fleet of vehicles to maintain essential services to customers for up to 10 days, as per the recommendations by Defra. NWL has no current capability.

7 Efficient costs

NWL has assessed the costs for this and other enhancement claims through a structured and robust approach, involving benchmarking of cost estimates against alternatives. Costs for SEMD were provided and assured by the NW Cost Assurance team whose methodology to costing the schemes was based on the following different approaches[10]:

- A full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rates used to build up cost estimates;
- Assessment and forecasting of historical spend; and
- Estimates from other data.

The assumed costs for the SEMD enhancements are £20,168k Capex and £307k Opex. These costs were benchmarked and assured using a mixture of unit cost benchmarks and assessment and forecasting of historical spend.

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018[11]. This review has assessed SEMD costs as Amber and that NWL have followed an appropriate costing methodology and has evidenced that the costs we have used are robust and consistent with good industry practice.

Many of the proposed and considered solutions have already been installed, in some way, on the NWL estate during AMP6 (2015 to 2020). As examples, the proposed solutions for the wastewater sites have been installed on the water treatment works between 2015 and 2018, CCTV systems have been installed at several remote sites. Detailed costings of these solutions have been gathered and verified by third parties through market testing and have therefore been used and extrapolated to prepare the detailed costings for the AMP7 schemes. There is therefore a high degree of confidence in the costings submitted.

Where there are some schemes that have both an enhanced element and a base element, only the additional costs associated with the enhancement are requested in this business case. As an example, for the Service Reservoir locks and keys scheme only 80% of the Capex costs are requested as this is reflective of the enhanced (electronic) element of the solution. The remaining 20% of the costs will be funded from the base plan, which is reflective of the requirement to replace the locks/keys becoming out of patent.

8 Customer protection

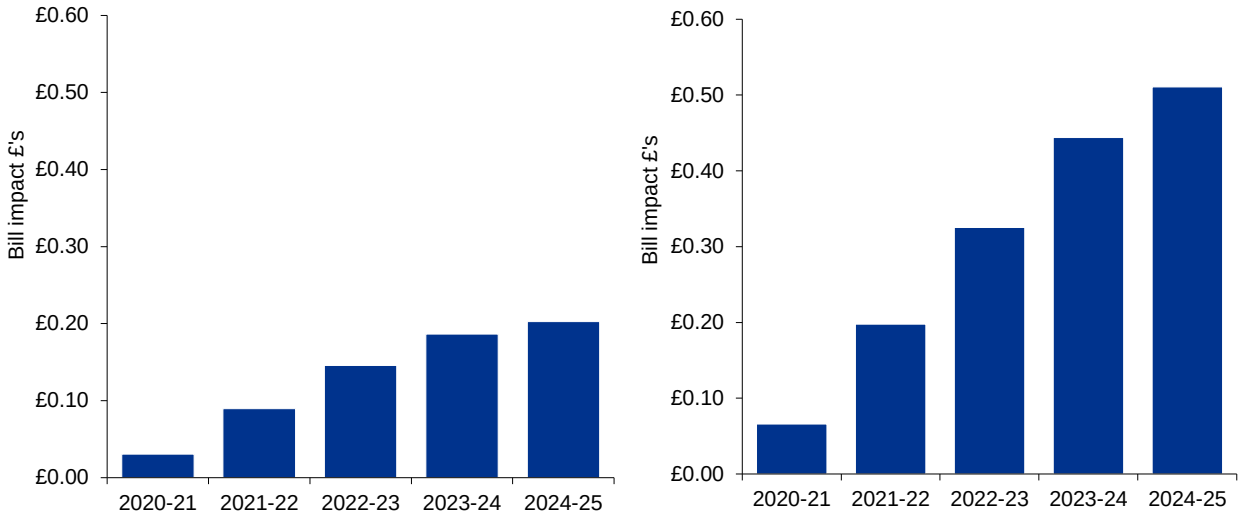
NWL are proposing appropriate mechanisms to incentivise delivery of our proposed enhancement schemes and protect customers between 2020 and 2025 in the event that schemes are not developed or delivery is delayed. We have not proposed a cost adjustment mechanism for this enhancement case, as NWL are obligated to deliver these schemes under the banner of SEMD, failure to do so would result in potential enforcement by the regulator, Defra. In an extreme case of non-compliance this could impact on the Company's operator licence. It is also a requirement that the Company provides an update to Defra on progress of these particular schemes each 6 months. In this way customers are protected, such that assurance is given in the delivery of these schemes.

[10] For further detail on the cost estimation approach, please see separate document on cost assessment for enhancement schemes- NWL PR19 Costing methodology
[11] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

9 Affordability

The impact of these enhancement investments on customer bills are shown below[12].

Figure 3: Water and Waste Bill impacts from SEMD investments



Overall the analysis shows that the bill impacts would be small at around £0.44 a year on average but rising across the period from under 10pence per customer to around 70pence by the end of the AMP.

This is set within an overall bill drop of more than 12% in AMP7, including all enhancement investments, one of the largest across the sector. At an aggregate level recent changes in average earnings have been positive and third party projections from the OBR for 2020-23 suggest that, at a national level, real earnings is predicted grow at between 0.8-1.2% per annum[13] driving significant improvements to average customer affordability.

We have engaged with our customers on what resilience means to them and their understanding of and appetite to risks to service during three specific phases of engagement summarised below;

- Phase 1: Resilience, trust in NWL, customer expectations on future challenges and appetite to risk (2016);
- Phase 2: Resilience, asset health and long term affordability (2017);
- Phase 3: Discretionary resilience schemes and willingness to invest (2018).

Water Forum received updates on Phase 1 and 2 research in January 2018. We concluded our final phase of customer engagement on discretionary resilience enhancements during March and April 2018.

Phase 3 research shows customers are supportive of our plans for increasing our resilience against natural and manmade hazards as well as the increasing cyber threat.

Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remains a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain

[12] Bill impacts were calculated using a simple ready reckoner based on profiles of opex and capex costs for the specific enhancement, asset lives and run-off rates consistent with overall price control specific rates and using revenues and combined bill average values consistent with App7.
[13] See: https://obr.uk/efo/economic-fiscal-outlook-october-2018/ Table 1.1 difference between CPI and average earnings forecast

affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 2030[14] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

10 Board assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers"[15].

[14] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf
[15] See Board Assurance Statement

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Traffic Management Act (TMA) Enhancement Business Case

WS2 - Wholesale water capital and operating enhancement expenditure by purpose Lines 24, 63 and
WWS2 - Wholesale wastewater capital and operating enhancement expenditure by purpose Line 33

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TRAFFIC MANAGEMENT ACT

Name of claim	Traffic Management Act
Name and identifier of related claim submitted in May 2018	Traffic Management Act
Business plan table lines w here the totex value of this claim is reported	WS2 – Wholesale capital and operating expenditure by purpose Line 24 and Line 58 WWS2 - Wholesale wastewater capital and operating enhancement expenditure by purpose Line 33
Total value of enhancement for AMP7	£17.652m (£16.015m Water & £1.637m Wastewater)
Total opex of enhancement for AMP7	£4.748m (£4.339m Water & £0.409m Wastewater)
Total capex of enhancement for AMP7	£12.904m (£11.676 Water & £1.228m Wastewater)
Depreciation on capex in AMP7 (retail controls only)	n/a
Remaining capex required after AMP7 to complete construction	Ongoing requirement due to Act.
Whole life totex of enhancement	n/a
Do you consider that part of the claim should be covered by our cost baselines? If yes, please provide an estimate	No
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls	1.33% of Water Totex & 0.14% of Wastewater Totex
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	No
Need for investment/expenditure	Traffic Management Act Requirements related to implementation of lane rental changing schemes.
Need for the adjustment (if relevant)	n/a
Outside management control (if relevant)	n/a
Best option for customers (if relevant)	Refer to main text of business case
Robustness and efficiency of claim's costs	Refer to main text of business case
Customer protection (if relevant)	Refer to main text of business case

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TRAFFIC MANAGEMENT ACT

Affordability (if relevant)	Refer to main text of business case
Board Assurance (if relevant)	Board assurance on FBP including enhanced resilience proposals

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TRAFFIC MANAGEMENT ACT

Summary

The driver for this investment is the commencement of lane rental charging schemes for the purposes of undertaking street works activities in the highway. The legal instrument for this is the Traffic Management Act 2004, subsequently supported by a Government Consultation in 2017 on lane rental charging that was confirmed along with the scale of charges in 2018. It is expected that most local authorities within NWL's operating areas will move to operating lane rental charging schemes for utility street works either during or immediately before AMP7, which will result in additional cost to NWL. Such schemes are designed to result in less congestion and disruption to customers and road users in these areas. Ofwat has confirmed that such costs do potentially count as enhancements and as such we have factored these into our plans. This business case covers permit costs for both water and wastewater activities, with an anticipated total totex requirement of £17.652m

Context and scope

Permit schemes under the Traffic Management Act (TMA) for utility street works have been operating by local authorities in a number of parts of NWL's supply areas in recent years, and are currently most prevalent in our Essex supply area. In the north a permit scheme has also been operated by North Tyneside District Council for a few years and a new scheme has recently started by North Yorkshire County Council. Other authorities operating within both our regions have also expressed a desire to operate such schemes and most authorities are also interested in lane rental schemes. Lane rental can be viewed as a specific kind of permit scheme.

The Government consulted on the future for lane rental schemes between 2 September and 28 October 2017. Lane rental involves charging 'promoters' (including water companies and their contractors), who carry out road and street works, for the time that their works occupy the highway. Charges are meant to be focused on the busiest streets at the busiest times.

Lane rental allows the local highway authority to impose a charge of up to £2,500 for each day the highway is occupied by the works. The charge was set at a level that reflected the costs of congestion caused by the works to encourage works promoters to:

- Reduce the time taken to carry out the works
- Improve planning, coordination and working methods
- Carry out more works outside of peak times, for example, making greater use of weekend and evening working where the local environmental impact was acceptable
- Complete works to the required standard first time and with a permanent reinstatement, reducing the need for the works promoter to return to the site to carry out remedial work

The consultation asked for comments on four options for the future of lane rental (including do nothing). In February 2018 the Government published its response to the consultation in the following document:

> ***Department for Transport; Government Response to Consultation on the Future of Lane Rental, Moving Britain Ahead; February 2018***

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In summary the Government has decided to proceed with the option to allow other local authorities to bid for and set up lane rental schemes (Option 2 in the consultation), as a way of reducing the impact of street works on the busiest roads at the busiest times. Additionally the response confirmed that:

- The current maximum daily charge of £2,500 per day will be retained going forwards;
- As per existing regulations, any surplus funds from lane rental schemes can be used by local authorities to 'reduce the disruption and other adverse effects caused by the street works';
- New lane rental schemes will need to be approved by the Secretary of State for Transport in line with existing primary legislation. The Department for Transport will draft and issue bidding guidance for authorities that will be available in the autumn 2018. It then typically takes an authority around 12 months or so to develop, consult and implement a scheme;
- Bidding guidance for new schemes is to be developed on the basis of the following conditions:
    - Authorities would need to have a well-run permit scheme, for example, permit fees are proportionate, discounts are offered for joint works, compliance with permitting regulations and guidance, and schemes fully supported the delivery of national infrastructure projects like HS2 and broadband/full fibre roll-out;
    - Schemes would apply to a local authority's own works in the same way as in Kent and London;
    - Lane rental charges should be used to incentivise work outside of peak times, they are waived for joint works, caps are put in place for major works to install and to replace apparatus so that these works are not unfairly penalised and delayed.

The schemes are likely to be implemented between 2019 and 2020.

Customer and stakeholder expectation

This enhancement relates to the need for us to pay mandatory charges in relation to street works under the TMA legislation. We have not engaged with customers directly on the TMA as we have no choice but to comply with the Act regardless of the level of customer support.

Whilst we have not specifically engaged with our customers on the impacts from the TMA as there is a statutory duty for us to comply we have engaged with customers regarding our long term strategy for "building successful economies in our regions". Customers were extremely supportive of this aspect of our strategy and the underlying aim of the TMA is consistent with this – in terms of supporting the local economy by reducing traffic disruption through spending less time in the highway. There is additional evidence that customers support minimising traffic disruption in terms of support for prioritising response to any flooding which affects major roads, and also improving our service levels in relation to response times to visible leaks.

For the preferred option see section 7 for specific detail on Customer Protection, and Benefits Assessment.

Current and historical expenditure

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Under the current TMA permit schemes currently operate in a number of parts of NWL's supply areas;

South (Essex & Suffolk)

Permit schemes currently operating in our Essex and Suffolk supply area, include those run by Essex County Council, London Borough of Barking & Dagenham, London Borough of Havering, London Borough of Redbridge, Southend on Sea Borough Council, Transport for London, and Norfolk County Council.

In our southern operating area, total permit costs (capex and opex combined) for 2016 and 2017 were £573,565 and £598,088 respectively. Almost two-thirds of the costs were associated with capital expenditure (capex) related work. Actual costs from the first part of 2018 indicate an overall increase in totex costs such that a year-end out-turn of £674,891 is currently forecast.

North (Northumbrian Water)

Permit schemes operating in our Northumbrian supply area have, until recently been limited to a scheme operated by North Tyneside District Council. A further scheme operating under North Yorkshire County Council has only been in place since February 2018, with only minor costs incurred thus far.

In our northern operating area, total permit costs (capex and opex combined) incurred under the North Tyneside District Council scheme for 2016 and 2017, were £183,641 and £145,355 respectively. Approximately three quarters of the costs were associated with capital expenditure (capex) related work.

Forward looking analysis

To understand the impact of the upcoming lane rental schemes we have considered the number of notices served over the last three years. We expect the bulk of the increase to come from new schemes coming into operation across our northern supply area. The number of notices served in our northern operating area is summarised as follows:

Highway Authority	Actual Number of Notices Served 2016	Actual Number of Notices Served 2015	Actual Number of Notices Served 2014
Newcastle upon Tyne	6442	6559	6485
North Tyneside	2750	n/a	4214
Northumberland	5694	7936	7739
Cumbria	11	15	11
Durham	8240	9368	9461

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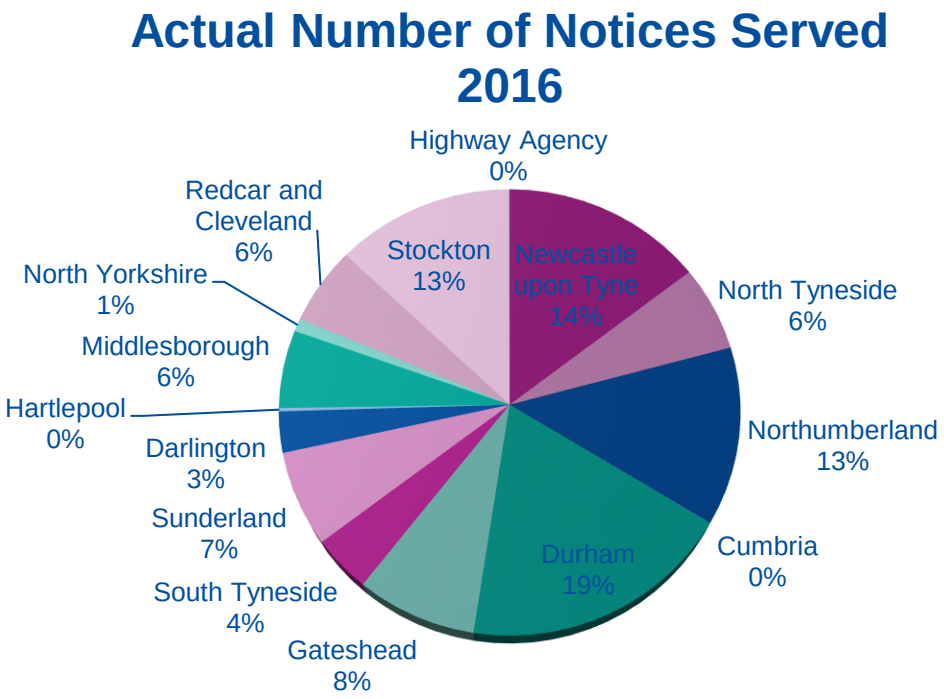
Gateshead	3625	3964	4031
South Tyneside	1785	2051	2158
Sunderland	3024	3228	4422
Darlington	1314	1464	1486
Hartlepool	106	93	104
Middlesborough	2505	3001	2903
North Yorkshire	411	347	440
Redcar & Cleveland	2517	3185	2642
Stockton	5670	3915	3744
Highway Agency	37	33	29
Grand totals	**44131**	**45159**	**49869**

Using 2016 as an example the split of notices served in the north can be visualised as follows:



Using a similar approach for the south, historic numbers of notices are as follows:

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Highway Authority	Actual Number of Notices Served 2016
London Borough of Barking & Dagenham	879
Essex County Council	3298
London Borough of Havering	1157
Thurrock Borough Council	521
Southend on Sea Borough Council	739
London Borough of Redbridge	607
Transport for London	0
Suffolk County Council	924
Norfolk County Council	467
Grand total	**8592**

Option appraisal

We developed the following options based on three year averages of job numbers and a number of assumptions. The options and assumptions are as follows:

- **Option 1 - Status Quo** – This scenario assumes that only the current permit schemes in operation will continue into the future, and that no specific lane rental permits will be in place;
- **Option 2 - Low Lane Rental Take Up** - Same as option 1 but also assumes only the same two authorities currently operating permit schemes in the north will move to lane rental, and that no further authorities in the south would move to lane rental. This option assumes that 5% of permits are in traffic sensitive areas and permit costs are daily at the defined maximum cost (£2,500 per day);
- **Option 3 - Full Lane Rental Take Up** – Full take up of all Lane Rental Schemes by all authorities. Again only assumed 5% of permits are in traffic sensitive areas and permit costs are daily and defined at the defined maximum cost (£2,500 per day);
- **Option 4 - Moderate Lane Rental Take Up with Efficiency Applied in Planning** – 70% take up of Lane Rental Schemes by local authorities. Same assumption of 5% of permits on traffic sensitive area and permit costs are daily with an efficiency applied (due to improved planning facilitation and repair techniques) passed through as an 'equivalent' 70% of the defined maximum cost (equivalent to £1,750 per day).

For all of the above options the following assumptions have been made based on historic job numbers:

North job splits:	88.98% Water	11.02% Wastewater

North totex splits:	75% Capex	25% Opex
South totex splits:	63% Capex	37% Opex

All the lane rental options (options 2, 3, and 4) have a common assumption that 5% of permits will be in traffic sensitive areas thereby attracting the lane rental permit fee variant. The 5% assumption is supported by a recent Guidance Note produced in September 2017 for the Joint Authorities Group UK ('JAG UK') by GeoPlace;

> ***JAG UK and GeoPlace; Traffic Sensitive Streets Guidance Note, GeoPlace Streets Team; September 2017***

'Traffic sensitive streets' require works promoters to give greater advanced warning of proposed works or activities, and streets defined as such also highlights that works in these areas is likely to be particularly disruptive to other road users. The criteria used to define traffic sensitive streets is outlined in the above JAG UK document, which also indicates that regular review of street designations can be monitored by local authorities through an entity known as the Additional Street Data (ASD) Review. An example of designations is given which supports the broad 5% assumption of all streets being traffic sensitive with figures of 4.22% in open type 1 and 2 carriageways, and an additional 2.79% in motorways. Additionally 5% has been used a general rule of thumb in planning for some time.

All four options have been costed based on the indicated assumptions, and can be summarised as follows:

Option	Water Capex £m/annum	Water Opex £m/annum	Wastewater Capex £m/annum	Wastewater Opex £M/annum
1 – Status Quo	0.554	0.283	0.021	0.007
2 – Low Lane	0.844	0.380	0.056	0.019
3 – Max Lane	4.628	1.722	0.486	0.162
4 – Moderate Lane	2.335	0.868	0.246	0.082

As the government's response to the recent consultation has confirmed that lane rental schemes will be available for local authorities to bid for, and a number of those authorities in our area have confirmed their intention to implement such schemes, the status quo option (Option 1) is considered unlikely. The lower and upper envelopes of actual costs could be viewed as being Option 2 and Option 3 respectively. Given that the actual timescales for implementation are uncertain Option 4 which considers a 70% take-up of lane rental is considered the preferred option until further information becomes available. At the time of writing this will not be before submission of our business plan.

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Our preferred plan/option

Costs and risks

The preferred option is Option 4; moderate lane rental.

Over the five year AMP7 period the total costs for Option 4 would be:

Option	Water Capex £m AMP7	Water Opex £m AMP7	Wastewater Capex £m AMP7	Wastewater Opex £m AMP7
4 – Moderate Lane	11.676	4.339	1.228	0.409

This option assumed 70% of the local authorities in our areas, will be operating a lane rental permit scheme in traffic sensitive areas, assumed to be 5% of a local authorities network. We have used a reduction in the maximum daily charging rate (taken as 70% of £2500) as a surrogate for the efficiencies we expect to make through improved planning and outperformance of our activities in the highway. To reduce time in the highway we will look to optimise both our planning and scheduling activities, and our pipe repair and main laying strategies wherever possible; this could include a raft of options already available to us including directional drilling, pipe bursting and slip lining etc.

The bulk of the new permit charges are expected to be from schemes operating in the north.

The scenario has uncertainty (and hence risk) around the likely timing of when local authorities may move to lane rental permit schemes. All previous scenarios apart from Option 3 carry this uncertainty.

All costs included were provided and assured by internal Cost Assurance team. There are four primary approaches to costing as described below:

- Full iMod cost estimate using business as usual processes;
- PR19 Costing Tool created from iMod base estimates;
- Traditional unit rate builds up estimates;
- Assessment and forecasting of historical spend.

The most appropriate costing method was chosen for each scheme.

The cost assurance process and associated costs generated for the water enhancement schemes have been subject to third part assurance provided by Mott Macdonald in July 2018. This review

has assessed all TMA costs as 'green', that is NWL have evidenced that the costs we have used are robust and consistent with good industry practice.[1]

Affordability

The scheme proposed is material to the long-term stability and health of the customer service, and will contribute to a robust future network. This is in the context of an AMP7 plan which customers fully support.

Customers support these proposals and consider them to be affordable and the overall position in the plan will reduce bills considerably in AMP 7 at a time of expected real earnings increases. However, we recognise that affordability will remains a concern particularly for some low income customer groups. Our plan sets out detailed proposals and mechanisms to help our services remain affordable for our most vulnerable customers including specific proposals to eradicate water poverty by 2030[2] and to meet Ofwat's new sector specific PC on the number of customers on our Priority Services Register.

Customer protection

The likelihood of lane rental being introduced earlier than expected and requiring risk mitigation is considered very low. This is because the government's own consultation response has indicated that bidding guidance for authorities will not be available until autumn 2018, and that it typically takes 12 months to develop, consult and implement a scheme. This means that the earliest lane rental schemes would be up and running would be towards the end of 2019. As AMP7 commences in April 2020, any additional costs incurred in the interim would need to be absorbed from existing budgets.

In the event that lane rental is introduced later than expected and our actual charges are less than forecast, then our risk mitigation to protect customers will be to make an adjustment based on unit rates and the actual volume of permit costs incurred at the end of the 2020-25 period.

Further detail on cost calculations are reproduced in Appendix 1.

There is no double counting in our costs with respect to existing rates as this has been factored in. Currently whilst there are permit schemes in some parts of our areas of supply this is not lane rental

Benefits assessment

In relation to NWL's own outcomes and performance commitments the key benefits are in supporting local economies and the linkages to the average time to respond to visible leaks. This approach will deliver additional benefits to our customers by considering the wider socio-economic impact our activities can have within the regions we serve.

By better planning of our work on key transport corridors we are aiming to reduce commuter delays and traffic congestion caused by our planned work. Our approach will deliver our communities

[1] NWL PR19 Enhancement Assurance - Summary Report Rev B, Mott MacDonald, July 2018

[2] See section 3.2 of our business plan, https://www.nwl.co.uk/_assets/documents/NWG_PR19_Interactive_FINAL_RS.pdf

additional benefits above improved service from NWL by reducing the health and environmental impact our activities can have on our communities. This could include reducing the localised public health risks caused by increased vehicle exhaust gas emissions from an increase in stationary traffic on busy, urban routes to the wider environmental impact from NO_x and CO_2 levels seen from increases in vehicle engines idling whilst waiting in traffic queues.

Customers should expect other less quantifiable financial and social benefits from reductions in traffic congestion with less impact on their day to day lives. For example reduced vehicle fuel costs by ensuring car journeys become less disrupted and less personal impacts, for example extra costs incurred as a direct result of delayed commutes e.g. child care costs etc.

We also expect fewer excavations in the highway resulting not just in the use of less imported backfill material and material ending up in landfill but a reduction in operational vehicle journeys and corresponding emissions as well.

Board assurance

The details of all our enhancement cases have been shared with and discussed by our PR19 Board Sub-group on 20 February, 8 March and 14 May 2018 and 12 February, 4 March and 21 March 2019 and by the full NWL Board on 18 July 2019. During these discussions the details of the enhancement proposals were carefully reviewed and were challenged in a number of ways which have been taken into account in our final enhancement cases.

The full Board approved a revised Board Assurance Statement at the full Board meeting on 29 March 2019, confirming that the Board has reviewed and has confidence in the enhancement cases. The Board has, accordingly, signed the Assurance Statement, confirming that "large investment proposals are robust and deliverable, that a proper assessment of options has taken place, and that the option proposed is the best one for customers".[3].

[3] See Board Assurance Statement

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Appendix 1 – Cost calculations

Option 1

Option 1 - Status Quo - This is the charge if no other local authority were to take up a permit scheme and lane rental. Essentially numbers all based on existing actuals. For the north numbers are all based on average actual notices served over the past three years.

Highway Authority	North Permit Costs			South Permit Costs	South Permit Costs
North Tyneside	£203,919.000			Essex & Suffolk 3 year average	£615,514.583
North Yorkshire	£26,336.000				
Total	**£230,255.000**			**Total**	**£615,514.583**
*Variations included in actual costs for North Tyneside.					
Northumbrian					
*** 10% Uplift on North Yorkshire all @ £35 for variations**	£11,921.000				
*** 1.5% FPN failures @ £120**	£6,240.000				
	£18,161.000				
North Total	**£248,416.000**			**South Total**	**£615,514.583**
North Water	£221,042.59			South Water	£615,514.583
North Wastewater	£27,373.41				
North Water capex	£165,781.95			South Water capex	£387,774.19
North Water opex	£55,260.65			South Water opex	£227,740.40
Total Water capex	**£553,556.133**			Water capex AMP7 (£m)	£2.77
Total Water opex	**£283,001.044**			Water opex AMP7 (£m)	£1.42
North Wastewater capex	£20,530.055				
North Wastewater opex	£6,843.352				

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Option 2

Option 2 - This is the charge if no other local autority within the North East area where to take up a permit scheme but the exisitng permit authorities were to introduce lane rental. **Assumes no further lane rental in the south**. Numbers are all based on average actual notices served over the past three years. North Tyneside numbers based on actuals.

					*Avg 5% of LA's are Traffic Sensitive - 5% from the overall numbers	£2500 Max Charge for Lane Rental based on 1 day
Highway Authority	**Permit Costs (without Lane Rental)**			**Highway Authority**	**5%- Traffic Sensitive (number)**	**Lane Rental**
North Tyneside	£203,919			North Tyneside	156	£390,000
North Yorkshire	£26,336			North Yorkshire	18	£45,000
Total	**£230,255**			**Total**	**174**	**£435,000**
*Variations included in actual costs for North Tyneside.						
Northumbrian						
*** 10% Uplift on North Yorkshire all @ £35 for variations**	£11,921			**South Permit Costs**	**South Permit Costs**	
*** 1.5% FPN failures @ £120**	£6,240			Essex & Suffolk 3 year averag	£615,514.583	
	£18,161					
				Total	**£615,514.583**	
North Total	**£683,416.00**			**South Total**	**£615,514.583**	
North Water	£608,109.16			South Water	£615,514.583	
North Wastewater	£75,306.84					
North Water capex	£456,081.87			South Water capex	£387,774.19	
North Water opex	£152,027.29			South Water opex	£227,740.40	
Total Water capex	**£843,856.057**			Water capex AMP7 (£m)	£4.22	
Total Water opex	**£379,767.686**			Water opex AMP7 (£m)	£1.90	
North Wastewater capex	£56,480.130					
North Wastewater opex	£18,826.710					

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Option 3

Option 3 - This is the charge if all Local Authorities moved to a Permit scheme that already have not, this is all street permit scheme based on the maximum permit charges. Numbers are all based on average actual notices served over the past three years.

Highway Authority	Permit Costs (without Lane Rental)
Durham	554254
Northumberland	482006
Newcastle	509878
Stockton	288273
Gateshead	274738
Sunderland	247576
Middlesbrough	184518
Redcar & Cleveland	174091
South Tyneside	134341
Darlington	92436
North Yorkshire	26336
Hartlepool	5810
Cumbria	712
Highway Agency	4230
Total	**£2,979,199**

*Total cost without Super Permits Columns F and R added

Highway Authority	*Avg 5% of LA's are Traffic Sensitive -5% from the overall numbers	£2500 Max Charge for Lane Rental
	5%- Traffic Sensitive (number)	**Lane Rental**
Durham	450	£1,125,000
Northumberland	354	£885,000
Newcastle	322	£805,000
Stockton	221	£552,500
Gateshead	192	£480,000
Sunderland	174	£435,000
Middlesbrough	138	£345,000
Redcar & Cleveland	137	£342,500
South Tyneside	98	£245,000
Darlington	69	£172,500
North Yorkshire	18	£45,000
Hartlepool	3	£7,500
Cumbria	0	£0
Highway Agency	0	£0
Total	**2176**	**£5,440,000**
	*5% taken away from the number of notices	*Column (I and U x£1000) + J and V

Northumbrian	
Lane Rental	£5,440,000
North Tyneside Permit	£203,919
*** 10% Uplift on all @ £35 for variations**	£154,140
*** 1.5% FPN failures @ £120**	£79,320
	£5,877,379

Essex and Suffolk	
Lane Rental	**£1,075,000**
*** 10% Uplift on all @ £35 for variations**	£30,100.00
*** 1.5% FPN failures @ £120**	£15,480.00
	£1,120,580.00

North pa	
Water	£5,229,740.02
Wastewater	£647,638.98
Water capex	£3,922,305.02
Water opex	£1,307,435.01
Wastewater capex	£485,729.23
Wastewater opex	£161,909.74

South pa	
Water only	£1,120,580.00
Water capex	£705,965.40
Water opex	£414,614.60

Companywide pa		**£m**	**AMP**
Wastewater capex	£485,729.23	£0.486	£2.43
Wastewater opex	£161,909.74	£0.162	£0.81
Water capex	£4,628,270.42	£4.628	£23.14
Water opex	£1,722,049.61	£1.722	£8.61
Companywide totex	£6,997,959.00	£6.998	£34.99

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Option 4

Option 4 - Moderate Lane Rental Take Up with Efficiency Applied in Planning – 70% take up of Lane Rental Schemes by local authorities. Same assumption of 5% of permits on traffic sensitive area and permit costs are daily with an efficiency applied (due to improved planning facilitation) passed through as an 'equivalent' 70% of the defined maximum cost (equivalent to £1750 per day).

					*Avg 5% of LA's are Traffic Sensitive - 5% from the overall numbers	£1750 (70% of max) Charge for Lane Rental
Highway Authority	**Permit Costs (without Lane Rental)**			**Highway Authority**	**5%- Traffic Sensitive (number)**	**Lane Rental**
Durham	554254			Durham	450	£787,500
Northumberland	482006			Northumberland	354	£619,500
Newcastle	509878			Newcastle	322	£563,500
Stockton	288273			Stockton	221	£386,750
Gateshead	274738			Gateshead	192	£336,000
Sunderland	247576			Sunderland	174	£304,500
Middlesbrough	184518			Middlesbrough	138	£241,500
Redcar & Cleveland	174091			Redcar & Cleveland	137	£239,750
South Tyneside	134341			South Tyneside	98	£171,500
Darlington	92436			Darlington	69	£120,750
North Yorkshire	26336			North Yorkshire	18	£31,500
Hartlepool	5810			Hartlepool	3	£5,250
Cumbria	712			Cumbria	0	£0
Highway Agency	4230			Highway Agency	0	£0
Total	**£2,979,199**			**Total**	**2176**	**£3,808,000**
					*5% taken away from the number of notices	*Column (I and U x£1000) + J and V
Northumbrian				**Essex and Suffolk**		
Lane Rental @ 70% take up	£2,665,600			**Lane Rental with 70%**	£526,750	
North Tyneside Permit @70% c	£142,743			*** 10% Uplift on all @ £35 for variations (@ 70%)**	£21,070.00	
*** 10% Uplift on all @ £35 for variations (@70%)**	£107,898			*** 1.5% FPN failures @ £120 (@ 70%)**	£10,836.00	
*** 1.5% FPN failures @ £120 (@ 70%)**	£55,524				**£558,656.00**	
	£2,971,765					
North pa				**South pa**		
	future & current combined				future	
Water	£2,644,301.13			Water only	£558,656.00	
Wastewater	£327,464.17					
Water capex	£1,983,225.85			Water capex	£351,953.28	
Water opex	£661,075.28			Water opex	£206,702.72	
Wastewater capex	£245,598.13					
Wastewater opex	£81,866.04					
Companywide pa				**£m**	**AMP**	
Wastewater capex	£245,598.13			£0.246	£1.228	
Wastewater opex	£81,866.04			£0.082	£0.409	
Water capex	£2,335,179.13			£2.335	£11.676	
Water opex	£867,778.00			£0.868	£4.339	
Companywide totex	£3,530,421.30			£3.530	£17.652	

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NWL PR19 COSTING METHODOLOGY

March 2019

Assessing efficient costs of enhancements

Scope and purpose

The purpose of this document is to describe the approach used by Northumbrian Water Group (NWG) to estimate the enhancement cost, for both CAPEX and OPEX, associated with the PR19 business plan submission.

NWG have taken four primary approaches to costing as described below:-

1. Full iMOD cost estimate using business as usual processes;
2. PR19 Costing Tool created from iMOD base estimates;
3. Traditional unit rate build up estimates; and
4. Assessment and forecasting of historical spend

Where possible either a full iMOD estimate or iMOD based tool has been used as it provides the most robust range of benchmarks for estimating the efficient cost and best reflects NWG's business as usual cost estimating processes. This has been used for 99% of proposed enhancement spend.

Approaches

1. iMOD

iMOD is an engineering scoping and cost estimating software system, developed for Northumbrian Water, bringing project scope definition, whole life costing and tender evaluation together in one integrated system.

iMOD comprises a suite of 50 engineering scoping models and a large and detailed cost database containing many thousands of costing data-points on a range of components and assets. With a minimum of input criteria that is readily known at project inception, the system can provide a detailed CAPEX, OPEX and whole life costing for a range of business issues by developing relevant cost curves for the investments in question.

Supplier tender submissions are entered directly into the system to allow tenders to be automatically checked against the iMOD asset based cost database, enabling tender evaluation to be carried out with a limited resource requirement as well as providing an enhanced confidence in a project's affordability. On completion outturn costs of competitively tendered projects are captured in the system as part of the agreed project closeout procedure providing a constantly improving evidence base for benchmarking at observed market rates.

iMOD CAPEX Cost Estimating

The iMOD system uses a Process and Component costing hierarchy. The relevant processes are selected for each estimate, with the engineering scoping model run for each process. This produces a quantified Work Breakdown Structure (WBS), with detailed attribute tags, with costs applied via the iMOD cost database. The process models are then supplemented with individual components and/or unit rates to complete the estimate as appropriate.

Contract overheads are then applied from a selection of 19 sub-categories that are chosen based on site specifics or work type specific considerations. Each sub-category consists of a historical data cost curve and is generated using the value of the measured works. Project overheads are then applied to the combined value of the measured works and the contract overheads, based on a selection of 21 sub-categories.

All costs estimated have been produced using Asset Policy Group (APG) specific cost curves for Process, Component, Contract and Project Overheads. APG areas area as follows:-

- Water Treatment;
- Water Networks;
- Wastewater Treatment; and
- Wastewater Network.

iMOD OPEX Cost Estimating

The iMOD engineering scoping models produce detailed OPEX calculations for Power, Operational labour, Chemical & Materials and Waste disposal. E.g. when running a Pumping Station model the KW pump rating and daily/monthly/annual run time are all be automatically calculated and costed via the OPEX unit cost table. The OPEX unit cost table has been updated from actual cost data provided by the NWL Management Accounts team.

2. PR19 Costing Tool created from iMOD base estimates

PR19 costing tools have been created specifically for the Water Treatment and Waste Water Treatment enhancement costing for both CAPEX and OPEX.

The costing tools consist of tables where the user can input individual site data, giving site specific yardsticks (i.e. Population Equivalent or Ml per Day) and can then select which processes will be required to fulfil the enhancement output needed. The tool will then calculate the CAPEX and OPEX costs for the specific site.

The costs are generated from a series of PR19 specifically generated cost curves, which are based on estimated points. These estimated points have been produced using the iMOD system previously described, using NWG's business as usual estimating processes.

3. Unit cost build up

Traditional unit cost build up have been carried out for enhancement areas where either the iMOD system does not have coverage or is not appropriate. In this approach traditional bills of quantities have been produced and costed using unit cost rates. Unit cost rates have been sourced from the following:-

1. Actual historical costs
2. Framework rates
3. Industry Data (SPONS etc)
4. Market testing

The above list order represents the order of preference that has been applied to the selection of rates used for costing.

Contract and Project Overheads have been applied using the same methodology as previously described.

OPEX has not been calculated for the enhancement areas where unit costs have been used as it has been assumed that there would be no significant increase in OPEX costs in the areas applied.

4. Historical spend

For issues not covered by the previous costing methodologies, a historical spend approach has been used. Assessments of historical spending for programmes of work or unit costs have been completed and applied to forecasts of the activities proposed in PR19.

5. Other data

For some limited expenditure lines on a single enhancement case other estimates were used.

NWGs costing methodology has been independently assessed and benchmarked by Mott MacDonald and was found to be either 'aligned' or 'robust' status compared to the Industry[1].

Application to enhancement cases

Different approaches have been used from the above list to challenge each of these enhancement cases and develop efficient costing estimates. The choice of approach is driven by a range of factors but principally these are related to how well developed the solution is and the extent to which the investment can be compared sensibly to historical data and benchmarks. For example, where an investment is similar to historical investments and well developed, a full assessment can generally be undertaken by iMOD (e.g. water resilience investments, metering, etc), where investments are new or different (e.g. Cyber security) from historical data other approaches have been used (e.g. unit cost build up through market testing or developments from some historical spend estimates).

Each cost used in the enhancement business cases has been assessed to ensure the costs have been produced in line with the methods outlined in the costing methodology. A Cost Assurance RAG Criteria has been applied to the costs to provide a view on the confidence of those costs[2].

A summary of the approaches taken to each enhancement case with the associated RAG assessment of costs as a result of this review is provided below.

[1] Mott Macdonald, Oct 2018, PR19 Enhancement Programme Business Case Assurance Summary Report (Report available upon request)

[2] See Annex A for further detail on this.

Figure 1: Summary of enhancement cases and costing approaches

Enhancement business case	RAG	Cost assessment approaches used to derive enhancement cost estimates	RAG Assessment Notes
Traffic Management Act		3. Unit cost build-up & 4. Historical spend	100% Green Cost Assurance RAG
Howdon STW Extension		1. iMOD	100% Green Cost Assurance RAG
WINEP - DWPA		4. Historical spend	100% Amber Cost Assurance RAG
WINEP - Eels		3. Unit cost build-up & 4. Historical spend	99% Amber Cost Assurance RAG
WINEP - INNS		3. Unit cost build-up	100% Amber Cost Assurance RAG
WINEP - NERC		4. Historical spend & 5. Other data	78% Green or Amber Cost Assurance RAG
WINEP - WFD		1. iMOD & 3. Unit cost build up	91% Green or Amber Cost Assurance RAG
WINEP - Waste Water		1. iMOD, 2. PR19 tools & 3. Unit cost build up	99% Green Cost Assurance RAG
Growth - Water		1. iMOD, 3. Unit cost build up and 5. Other data	95% Green Cost Assurance RAG
Growth - Waste Water		1. iMOD	100% Green Cost Assurance RAG
Lead		3. Unit cost build-up & 4. Historical spend	100% Green Cost Assurance RAG
Metering		4. Historical spend	100% Green Cost Assurance RAG
Resilience - Water		1. iMOD & 3. Unit cost build up	93% Green Cost Assurance RAG
Resilience - Waste Water		1. iMOD	100% Green Cost Assurance RAG
Cyber Security		3. Unit cost build-up & 4. Historical spend	100% Amber Cost Assurance RAG
SEMD		3. Unit cost build-up & 4. Historical spend	70% Green Cost Assurance RAG

Annex A: RAG assessment for cost assurance

A Cost Assurance RAG Criteria has been applied to the costs to provide a view on the confidence of those costs.

1. Full iMOD cost estimate using business as usual processes

Green - Cost Estimate has been produced using iMOD, utilising Engineering Scoping Engine and Costing Database

Amber - Cost Estimate has been largely produced using iMOD, utilising Engineering Scoping Engine and Costing Database, with partial costs from other sources

Red - Not Applicable - Approval processes built into iMOD would ensure that no RED estimates could be produced

2. PR19 Costing Tool created from iMOD base estimates

Green - Cost Estimate has been produced using PR19 Costing Tool and has been correctly applied

Amber - Cost Estimate has been largely produced using PR19 Costing Tool, with partial costs from other sources, and has been correctly applied

Red - PR19 Costing Tool has been used, but not correctly applied

3. Traditional unit rate build up estimates

Green - Unit rates are valid historical NWG costs or current Framework Rates and the rates build up is sufficient and appropriate to the scope

Amber - Unit rates are largely valid historical NWG costs, current Framework Rates or Industry available rates and the rates build up is sufficient and appropriate to the scope

Red - No cost evidence available for rate source and/or rates build up is insufficient or does not appropriately reflex anticipated scope

4. Assessment and forecasting of historical spend

Green - Historical spend in relevant area has been assessed and appropriately applied in forecast calculation

Amber - Historical spend in similar area has been assessed and appropriately applied in forecast calculation

Red - No cost evidence available and/or inappropriately applied in forecast calculation

5. Other

Red - Not adhering to costing methodology, no costing evidence supplied or costs produced using obsolete estimating system