

## **Appendix 2.6**

# **LONG TERM WATER QUALITY PLAN**

**September 2018**

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### INTRODUCTION

This strategy document represents a summary of Northumbrian Water Limited's (NWL) long term plans for water quality, stating goals and associated actions across a 25 -30 year horizon from source to tap. It is intended to meet the requirements of the DWIs Guidance note on the 'Long term planning for the quality of drinking water supplies'.

It contains a number of committed activities to enhance water quality in addition to some key enabling work packages which we believe are critical for the development of both our long term asset plan and NWLs readiness for detailed assessment by DWI in 2020.

Through this document, we will provide an overview of the work currently being undertaken to reduce and mitigate water quality risk across NWL in the short term, and from this we will demonstrate continuity with plans for PR19 and beyond through to 2050.

### Vision

Our vision is to become the national leader in the provision of water and wastewater services. This long term water quality strategy will achieve a number of stated goals to ensure NWL supplies the highest quality of water to our customers. We will:

- Achieve 100% compliance at water treatment works (WTW) and service reservoirs (SR) by 2025 and sustain this level of performance in the long term, ensuring regulatory changes are accommodated and our assets operate effectively at a level that goes beyond national standards;
- Achieve 100% compliance at the customer tap by 2045 through water network improvement and control, water fittings advice and consumer education;
- Deliver best performance in discolouration contacts compared to upland water companies, and upper quartile against the rest of the industry;
- Contribute to leading CMEX performance. Our customers will believe that NWL provides a reliable and consistent water supply that tastes good and will have a preference for tap water over bottled;
- Deliver an effective asset health framework, creating an industry leading intelligent asset management system, revised asset standards and a defined asset replacement approach. Through this work, we will ensure that supply is never chosen over quality and we will significantly reduce the number of customers reliant on a single source of supply;
- Ensure our people will have the skills, competency and awareness to achieve expected performance and can flex to business need and priority.

### Scope

We believe that exceptional water quality performance cannot be achieved in isolation and needs to be aligned with a number of other strategic aims. This long term plan therefore considers the needs of the following areas as part of an integrated approach to water quality:

- Water Resources;
- Asset management;
- Resilience;
- Unplanned Outage;
- Our Customers;
- Our People.

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As part of water safety planning, we have risk assessed potential future areas of non-compliance and set ourselves demanding targets to further enhance our compliance under the Compliance Risk Index and Events Risk Index, whilst maintaining progress around consumer acceptability. However, we believe that creating strategic alignment of the multiple risk factors listed above will allow better decisions to be made around asset needs, maintenance and replacement in conjunction with water quality improvement.

The strategy will also highlight how people and processes are critical to delivery of leading water quality. Within the document we will provide description of transformational change within NWL and how this will promote future asset health. We will also demonstrate the importance of building knowledge and competency within our current and future workforce and how this will impact on leading water quality.

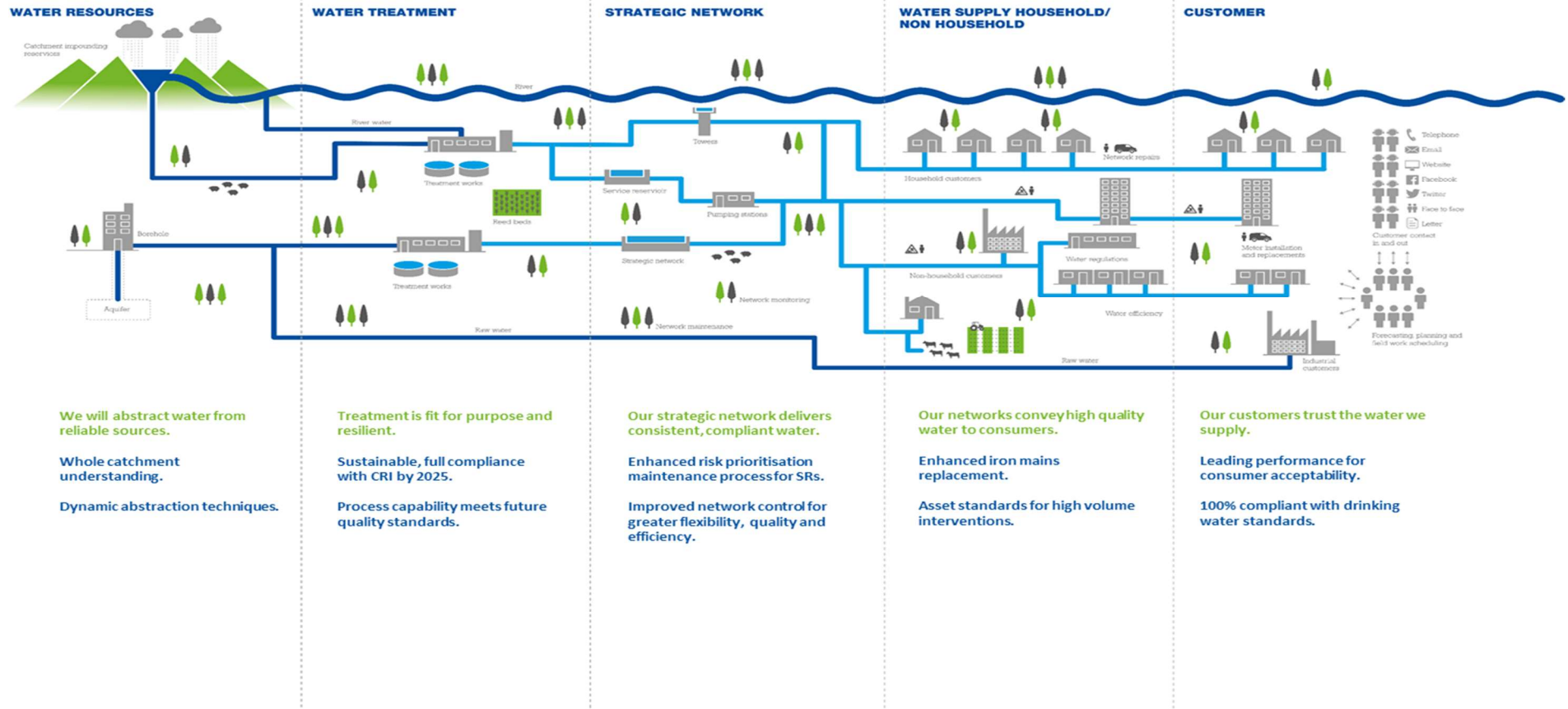
The document takes a source to tap approach in highlighting the significant new future risk mitigation measures which we intend to provide for. It will illustrate our short, medium and long term plans for water quality and is intended to demonstrate a clear thread and rationale around water quality planning and performance, phasing of which is both risk-based and proportionate.

In the context of this strategy, short term is considered up to year 2025. Medium term will represent plans to 2035 and long term extends to 2045 and beyond. The key elements of our plan are summarised below:

- The creation of a dynamic and intelligent abstraction management process for source waters;
- Implementation of zonal studies across all NWL water supply systems to create a blueprint for efficient, resilient and reliable customer supplies. The work will inform a water treatment works replacement programme and also highlight integrated strategic network design opportunities. The outputs will form an asset plan over many AMP periods;
- Commitment to a service reservoir replacement programme based on zonal study outputs, asset capability and rationalization;
- Build upon current Aquadapt software within our Regional Control Centre to create a smart network of data capture and real-time control;
- A significant uplift in non-strategic mains renewal over the 25 year horizon for unlined cast-iron mains to remove the risk to compliance at the customer tap;
- A service pipe replacement programme for lead with the intention of being lead-free by 2050;
- Creation of new asset / design standards from both complex projects through to high network volume interventions;
- Implementation of an Intelligent Asset Management transformation programme across NWL to provide the data, capabilities and cultural change to make quicker, better decisions on asset maintenance and investment;
- Continued focus on people competency and continuous improvement based on learning from various industry sectors.

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#### OUR SOURCE TO TAP APPROACH

##### Catchment – ‘We will abstract water from reliable sources’

##### Water resources

The first element of any water service plan is the resilience of our water resources. NWL operates in the North East and East Anglia both of which have historically forecast supply deficits due to increasing customer demand. However, as reported in our draft Water Resources Management Plans (WRMP), all six of our Water Resource Zones are resilient to a drought with a return period of 1 in 200 years.

- I. Northumbrian Water (NW) - In the North East, construction of Kielder Water (a 200,000 MI reservoir) was completed in 1981 to meet an expected rise in demand for water from industry. However, there was a subsequent decline of traditional heavy industry in the North East which has provided the region with a significant supply surplus;
- II. Essex & Suffolk Water (ESW) - In the 1990s, the demand for water in our Essex supply area, a water stressed area, was forecast to increase by around 6% over a period of 25 years, almost entirely due to an increase in population. There was therefore a need to make available a long term and sustainable increase in water resources. We have since invested £150 million in the Abberton reservoir scheme to provide security of supply in the area.

#### Long term sustainability of abstraction

We have a forecast supply surplus in each of our water resource zones, so we are not promoting any new supply schemes in our Water Resources Management Plan (WRMP).

Alongside this, we are setting tough leakage targets: 17.5% reduction for ESW and 15% reduction for NW. Reducing leakage along with an enhanced water efficiency programme will maintain a supply surplus / resilient supplies across the full 40 year planning period.

Although not highlighted within the WRMP, we are promoting a resilience scheme within PR19 which will construct an Abberton to Hanningfield Pipeline scheme. This will ensure we can balance storage in both of these raw water reservoirs to maintain our water resource zone deployable output.

#### Raw water reservoirs and mains, reservoir act compliance

We have a rolling programme of reservoir bathymetric surveys which confirm the rate of sedimentation. Surveys completed to date have shown that there does not appear to have been a significant reduction in reservoir capacity due to sedimentation. We have an agreed programme of Section 10 and Section 12 inspections that covers all of NWLs reservoirs. The Section 12 inspections are completed through a combination of in-house and consultancy resource. All deformation monitoring is completed in house.

NWL has a region-wide wells and boreholes strategy which defines a rolling inspection programme for all wells and boreholes. The inspections confirm the condition of the source structures and identifies the need for maintenance or complete replacement.

The internal Water Resources team have drafted a wider raw water asset strategy which covers the condition survey, maintenance and operation of all of our raw water assets e.g. raw water aqueducts. This draft will be consulted on prior to September 2018 and once approved, projects will be agreed with inspections and minor works being fulfilled through an investment programme.

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### Catchment knowledge

We are fully committed to catchment management and our work particularly in the Essex area has been highly innovative and engaging.

Understanding the quality of our river waters is essential to ensure consistent quality of water is taken onto our treatment works, which protects against elevated turbidity, cryptosporidium, nitrates, manganese, sulphate and pesticides. We know that understanding catchment usage, pollution risks and other external factors is key to better raw water and more complete risk assessments, so we will be investing further in our already well developed catchment management approach.

Improving understanding of raw water quality with upstream monitoring allows us to have warning of poor quality water. This will allow us to operate a more dynamic abstraction management approach using upstream data to target optimum abstraction reducing risk of quality failures and also maximising abstraction to provide for resilient water supply.

### Catchment management

The DWI confirms in its guidance note “Long term planning for the quality of drinking water supplies” that it expects that water companies will always plan to meet their statutory obligations for drinking water quality. Our overall drinking water quality compliance confirms that this is not always achieved, with pesticides (such as metaldehyde) and cryptosporidium being a risk.

It is extremely difficult to remove some pesticides such as metaldehyde from water without new, very expensive treatment processes. For NWL, this means we have to maintain monitoring programmes both at our intakes and within the wider catchments, engaging with farmers to ensure they are aware of the problem and understand how they can reduce the diffuse agricultural pollutants from their farms.

For NWL, we have pesticide undertakings in place for the Rivers Stour, Chelmer, Blackwater, Waveney, Bure and Coquet and for the Whittle Dene reservoirs. 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. Given the risk posed by agricultural pollutants and Ofwat and DWI's expectations, we have developed our PR19 Catchment Management schemes, all of which are included in WINEP.

In the short-term, we plan to replace our AMP6 “Pesti-wise” scheme with a new scheme that will consider a wider range of diffuse pollutants and measures supported by the development of a new grant delivery system. This will allow other stakeholders to contribute funding for other ecosystem service improvements that are not a priority to NWL. The PR19 schemes will provide advice, subsidised “low risk” slug pellets and capital grants to land managers to implement measures that will reduce the loss of diffuse pollutants from their farm yards and land. We have also allowed for two additional catchment advisors so that we will have dedicated Catchment Advisors for each of our main river catchments across our Northumbrian Water and Essex & Suffolk operating areas.

Our existing Essex & Suffolk catchment partnerships will be re-launched in AMP7 and we will create similar partnerships and delivery groups for all of the Northumbrian Water catchments. We will also continue to support peat land restoration which in time we believe will reduce DOC at our intakes and the need for expensive chemical dosing. We intend to pilot a new web based platform developed by EnTrade that will facilitate subsidising the use of low risk slug pellets. We will apply learning from this pilot to delivery of our main schemes in AMP7.

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In addition to the above, there are a number of specific elements of catchment management which NWL aims to develop or promote in the short to medium term to support our overall water quality strategy. These are:

- **Continued support of successful catchment agri-advice partnerships**  
We will continue to work with external stakeholders through a Catchment Partnership approach, developing joint projects that bring together expertise, funding opportunities and manpower to deliver multi-benefit schemes that align with aims in the government's '25 Year Environment Plan' *'to leave our environment in a better state than we found it'*. This aspect will depend on the future British Agricultural Policy (BAP) post-Brexit;
- **Dedicated Catchment Advisors**  
These will be provided for all problem river and groundwater catchments. Our objective will be to build a positive, empathetic relationship with farmers and landowners through ongoing engagement and support from dedicated Catchment Advisors;
- **Financial support**  
NWL will look to provide the means to deliver improvements on the ground, be that through direct grant funding or through signposting to other support options such as government funded stewardship schemes. Where government support is insufficient, inappropriate or incompatible with our aims, objectives and/or our priority areas, NWL will attempt to 'plug the gap' and provide support through grant funding to ensure affordability is not a barrier to delivery:
  - We will support precision farming and use of GPS and remote sensing;
  - We will develop and use our own reverse auction platform to avoid excessive fees of external platforms in order to financially support farmers to reduce loss of agri-inputs from farm to water.
- **Research and innovation at industry level**  
We will focus on targeted research that, for example, looks into products that could reliably bind phosphorus and trial any promising innovations.
- **Rainfall Runoff models**  
We will increase the level of certainty around pollution loading from tributaries rather than rely on spot concentrations. This work is currently in development.

Precision agriculture is certainly the way forward and will reduce inputs (nitrates and pesticides). However, technology in this area is moving forward at a very fast pace. NWLs long term plan for Catchment Management will therefore consider these uncertainties and ensure that regardless of future government policy we have the funds, partnerships and capacity to continue to develop our catchment programme in a flexible and responsive way.

#### Consistent product

Many of the challenges our treatment works face comes from the variability of the raw water entering the works. There would be benefits and reduced risks from creating a more stable and consistent raw water product. This can be done by further development of our catchment work focusing on all hazards rather than more specific risks such as pesticides or sediment. In the short term, we will look to more real-time online monitoring throughout the catchment and specifically upstream of abstraction points would better inform any abstraction management options. This should lead to intelligent abstraction management where the quality of water entering bankside storage reservoirs or treatment works is controlled automatically. Such in-reservoir measures would include:

- Telemetered real time in-reservoir water level measurement for all reservoirs;
- Telemetered real time reservoir flow measurement for all inflows / outflows for all reservoirs;



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- Telemetered multi-parameter water quality monitoring on all inflows / outflows and mixing zones for all reservoirs;
- Mass balance models with real time data feeds (from ii) and iii) above) and forecasts;
- Reservoir mixing facilities to maintain mixing and reduce algal blooms;
- Bathymetric surveys to understand sedimentation rates;
- Fully automated abstraction management (see below).

For in-reservoir telemetry monitoring, we have already begun to apply this techniques. On abstraction management, we intend to apply the following measures:

- Manual sampling rounds to be replaced by in-river monitoring along rivers providing telemetered real time data for range of pollutants (pesticides, nutrients, TOC, turbidity);
- Monitoring data from the above will be developed to feed directly into Aquadapt which would be further developed to limit need for human intervention so that abstraction management is fully automated.

A review of raw water assets that could support this aim will be carried out. This would include current asset condition assessments but also may include building of further raw water storage, bankside reservoirs and a more integrated raw water network allowing movement and blending of raw water to take place to increase resilience and improve variations in raw water quality.

### Treatment – ‘Our treatment is fit for purpose, reliable and resilient’

#### Standards

Our short term aim is to achieve 100% water quality compliance at our WTWs by 2025 which in turn will help NWL attain upper quartile performance within the industry for CRI by the end of AMP7. The longer term horizon will be aimed at sustaining this level of performance and ensuring our treatment works are capable of meeting internal standards which can naturally absorb future regulatory change.

### Short term plan for water treatment works maintenance and enhancement

A number of our WTW assets are now at the limit of their capability and have reached the maximum quality attainable with the existing process technology and raw water quality, some are also approaching the limit of their asset life. We have now moved into a different phase of asset maintenance where retrofit or additional processes to achieve compliance with defined parameters are not required but entire new WTW assets are. In the 2015-20 period we are replacing a number of WTW assets entirely, these are not process modifications but brand new entire treatment processes. The WTWs being replaced are not subject to any Undertakings or legal instruments requiring the replacement to occur. They are:

- Horsley WTW which is being rebuilt with a new process stream incorporating Actiflo clarification, a new rapid gravity filtration with enhanced manganese removal, and a revised disinfection and treated water storage regime which will eliminate an inoperable tank. The new process will meet both supply and quality demands for the next 25 years.
- Byrness, Rochester and Otterburn rural treatment sites which are to be fully replaced with new treatment units pre-built off site during 2018/19. This will increase their operability and reliability.

In addition, the works at Murton (and Fowberry) will be replaced by 2019/20 as the existing processes supporting the various boreholes in the Berwick region are no longer fit for purpose. This scheme will mitigate the issues experienced in three incidents alone in 2017, as well recommendations from a DWI technical audit.

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We have also assessed the immediate risks to CRI within the short term plan, and recognise that turbidity, coliforms, cryptosporidium and manganese remain a concern. In the period 2018-2025, we will also be investing in further treatment process upgrades to mitigate or remove these risks altogether. These schemes include the following:

- A filter management refurbishment programme to help manage changing turbidity and cryptosporidium risks.
- Filter units will be installed at Sunderland groundwater stations to mitigate final (treated) water turbidity risk from borehole particulates.
- Chlorine contact tanks will be built at Gunnerton and Honey Hill water treatment works to meet the requirements of our disinfection policy and ensure increase operability of treated water storage tanks.
- The Dissolved Air Flotation (DAF) unit at Lartington is being upgraded which will ensure water presented to filtration is more reliable and of a much higher quality. The DAF unit provides up to 70 Mld of water per day from the site.
- Manganese removal at Whittle Dene and Warkworth which are due to be delivered in late 2018. These will ensure optimum control of the metal in final waters leaving each site, which in turn will protect the legacies of trunk mains cleaning over three AMPS in Tyneside and Northumberland. This work will then extend into other medium risk northern sites and Suffolk.
- We have observed an increased risk from algae in Abberton impounding reservoir which can impact on the output from the receiving Layer WTW. In response, we intend to install additional treatment to condition the raw water at Layer WTW and so improve treatability.

One aspect which differentiates northern treatment works from others in the sector is our difficulty to contain or manage non-compliant water when unexpected events occur, particularly on gravity treatment works. This is the reason we have previously experienced a high number of registered DWI events against water supply. The water quality plan is therefore reliant on outputs from a current run-to-waste feasibility study being delivered as part of a phased programme of work which we expect will cover a number AMP periods starting in 2020. The objective of the project will be to ensure all our treatment works operate resiliently and with the principle that only compliant water will ever leave a water treatment works.

### Compliance with proposed new Water Directive 0.3NTU Turbidity Standard

Our asset management system assesses the risk of quality failures on our performance and prioritises investment in our assets to protect supplies. We are investing in improving turbidity performance on our treatment works in AMP6 & AMP7. Aligned to this we have developed operational continuous improvement processes to operate and control our assets in the best way possible.

In order to understand the impact of the proposed new drinking water directive, we will carry out an analysis of the performance of our treatment works against the new standard, identify gaps in performance and update our operational and investment plans to ensure compliance.

The majority of our Water Treatment works were not designed to produce water to these standards, we understand this and will work continuously to improve, substantially upgrade or replace assets to maintain and reduce Water Safety Plan risks.

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### Consistent product

We have a long term vision of producing final waters that are conditioned across a number of parameters so as to minimise asset deterioration, maximise positive customer perception and be interchangeable within a region, so as to maximise our flexibility of resource management, facilitate maintenance interventions without customers being aware of our activities.

Remineralisation is the process of addition of carbon dioxide during water treatment process and then adding lime slurry, the overall result is to increase the alkalinity of the final water. The resulting higher alkalinity water requires less change in pH to achieve a stable pHs, that minimises scale formation and the potential to dissolve scale and therefore inhibit or encourage corrosion. This is in addition to our established water conditioning of phosphate addition and careful control of pHs.

In the short term, we are planning to start the use of remineralisation at our low alkalinity northern treatment sites in order to improve pH stability throughout the network and reduce the pHs of some of our upland sourced water supplies.

As well as reducing the corrosive nature of our upland sourced waters, our long term vision is that overall delivery will allow us to freely move water supplies between our operational areas in each region, without any noticeable aesthetic changes to customers. This will allow us to take full advantage of another long term vision of a potable water grid for much of our Northumbrian and Suffolk operating areas.

### Medium / long term treatment plan and design standards

To promote consistency and give guidance on water quality matters to the teams involved in operating, managing, maintaining and renewing our WTW assets we developed a document called the Treatment Management Guidelines (TMG). The TMG contains three things; the water quality specification already described, guidance on troubleshooting for site operators to refine; restart processes that require bringing on line or back into optimal range; and treatment processes and some essential requirements for these to operate effectively.

To continue to innovate and drive improvement, the water quality specification will be taken from the TMG and will become part of our design standards for treatment. All new WTW assets or processes will have to be able to deliver this water quality specification, but the processes employed to do so will be at the choice of the supply chain. We envisage, for example, that all future water treatment designs should be dual stream depending on their size and interdependency with other strategic assets and network storage. We would also look for secondary filtration units to become standard for enhanced multiple particulate removal.

We can also foresee a future where reliance on chemical treatment becomes increasingly difficult. One example is the difficulty in disposing of Water Treatment Works sludge. While we see our immediate and medium term future served by conventional treatment, we will maintain a watching brief on new developments that reduce reliance on chemical treatments for the types of raw water risks seen in our sources. This is particularly important for the high chemical usage treatment works in the Northumbrian region. We will look to work with Universities and experts in this field with the intention of becoming lead innovators in the treatment of upland water.

Based on the above, we intend to replace or significantly upgrade one of our large water treatment works every AMP from 2025 onwards in an ongoing programme in line with water quality risk management, TMG requirements and strategic network optimisation.

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#### Strategic Network- 'Our network delivers consistent, compliant water'

##### Standards

Our aim for strategic networks is to ensure that the quality of the water leaving our treatment works treatment works is sustained and suffers no detrimental impact on public health standards or acceptability to consumers.

This will be achieved by robust maintenance regimes and the creation of calm, controlled and flexible networks which can maintain consumer supplies during known outages.

The aim will be supported by the creation of asset standards for the network which will be aligned to industry best practice, ensuring that when we refurbish or rebuild our assets they are able to deliver leading levels of performance and service.

Similar to treatment, we will have Network Management Guidelines which will specify water quality expectations and design standards and we will invest to achieve these both proactively and opportunistically. This will include standard service reservoir designs to manage age of water and residency as well as air valves and materials used in high volume / low design work such as service connections.

##### Network studies – Re-shaping our networks for the future

The ambition is to review the layout of our existing strategic network infrastructure to optimise both quality and resilience. From a quality aspect we will be looking at areas such as chlorine optimisation, age of water, mains velocities and service reservoir turnover. From a network resilience perspective we will be aiming to deliver a flexible network that can cope with future "incident scenarios". The approach will be risk-based, with drinking water quality safety planning playing a central role through-out.

This work has already commenced. In 2017, we completed a study across Teesside and a similar one in North Suffolk (2015), which has identified a number of network interventions and investment requirements that will reshape the network for the future. This has provided a clear vision for this network going forward and the aim would be to apply this approach across all our regions.

The Teesside Strategic Network Study was derived from three separate parts. Firstly, new hydraulic models were built by contactors. This involved both fieldwork and office based tasks and took 6 months to complete. A key task of this stage was to gather knowledge and understand current network functionality, known issues, and GIS discrepancies. These models would be used later in the study to test and analyse scenarios and potential future network configurations.

In parallel with this work, demand forecast and deployable outputs reviews were completed to understand future demands on the network and available treatment capacity in the region. These numbers would be fed into the hydraulic model and helped to contextualise it.

The hydraulic modelling phase was a creative process focused on transferring water between two points. The approach was to strip back the network to the point where the water transfer between these points collapsed. We then built from this point, looking for ways to reduce know risks either by removing redundant assets or looking for ways to improving overall network control.

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The outputs of this study have formed a key part of our AMP7 plan. The first stage for Tees is the laying of a 37km replacement section of strategic (or trunk) main from Lartington WTW to Teesside to manage both discolouration and asset deterioration which has received a letter of support from DWI as part of the PR19 process and will be delivered under a Regulation 28(4) notice. The new main will be an enabler for three AMPs worth of schemes to enhance the Teesside system (Appendix A).

A similar exercise in North Suffolk is mid-way through implementation (Appendix B), and a key activity in AMP7 will be the construction of a new service reservoir and pumping station at Barsham to support network resilience.

The cost of the Tees zonal study was approximately £320k and we intend to replicate it across the northern systems of Central, Tyne, Northumberland and Berwick, and then followed by South Suffolk and Essex. This will allow decisions to be made on treatment rationalisation and / or upgrade and ensure networks are designed to be integrated and resilient.

It would be inappropriate to look at individual systems in isolation as part of long term planning as this would generate a different set of answers to the same questions. We believe this work is critical to the development of a water quality / asset planning strategy and we will commission these studies with immediate effect to understand individual and cross-system dependencies. The outputs from the respective studies will form a key part of discussion with DWI during detailed assessment of the long term plan in year 2020. The work will identify the optimum number and locations of our Water Supply asset base and influence future replacement policy. It will also illustrate opportunities for strategic network re-design to make them fit for the future with respect to flexibility, resilience and rationalisation. It is anticipated that the collective zonal studies will help set water service investment programme agenda over at least five future AMP periods.

This is where our major 'lumpy' schemes will be signposted.

#### Strategic network control

The design, operation and maintenance of our strategic network systems will be a key factor in our ability to deliver leading levels of water quality to our customers in the future. The strategic network asset base we manage is big, aging and will require significant levels of investment in future years. All these factors present challenges to us in maintaining the quality of our drinking water from when it leaves our treatment works to the point of delivery to our customers taps.

To address these risks we acknowledged a number of years ago of a need to move away from the traditional approach to operating and maintaining the strategic networks to one that moved us into the digital age and a shift towards automated system control. The enablers to achieving our goals meant we needed to improve both the reliability, functionality and resilience of our strategic network asset base. A number of steps have already been taken towards our goals including:

- Improved system monitoring and control functionality;
- Successful implementation of the Aquadapt control system in 2011 across our NW and Essex operating areas meaning around 90% of our strategic systems are monitored and controlled in real time by optimisation software. This has delivered a reduction in reportable water quality events by delivering calmer but controlled networks, improved reservoir operation and turnover and improved operational efficiency;
- Improvements to the way we monitor and respond to issues on our network assets to ensure we manage and remove risks to water quality as much as possible, e.g. our process and approach to service reservoir performance monitoring, inspection and repair

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Going forward we will deliver a number of further initiatives across our strategic networks to maintain the momentum. This includes:

- The adoption of asset design standards aligned to industry best practice which ensures when we refurbish or rebuild our assets they are able to deliver leading levels of performance and service aligning to our digital ambition and shift towards fully automated system control;
- Improving the way we will monitor the performance of our assets, ensuring a proactive maintenance approach to reduce the risk of strategic network asset failures impacting water quality and improve the overall service delivered to our customers;
- Improve our analysis capability by improving the tools available to our people, including to our field workers. This will improve both our day to day operation and planning capability, reducing the impact of our activities on water quality as well as improving our respond and recovery capability during any future events;
- Continuing to provide adequate training and awareness to those who work across our network ensuring we only allow competent operators on our networks.

#### Air valves

We will develop a standard on what we expect of an air valve and then rationalise our stock to minimise risk of ingress or mains failure. We will enhance our maintenance of air valves and chambers.

#### Mains conditioning

The technique of mains conditioning involves taking an established trunk mains network through a designed stepped increase in flow with careful turbidity monitoring. This, sometimes protracted process, results in a main or system that is conditioned to carrying a particular flow, without deterioration in water quality. This conditioning is sustained for a period of months and we then condition again.

Unconditioned mains pose a risk to customer acceptability due to the potential for sediment and biofilm disturbance. By actively maintaining and improving resilience of the strategic and distribution networks, this will ensure that regeneration of material within the mains causes no noticeable impact to customers during planned interventions or unplanned events.

The company has invested in network management and automating management controls, supported by a network optimisation tool which allows mains conditioning. At present 25% of the strategic network is managed in this way, with most conditioning operations being carried out automatically once they have been proved and risk assessed. We believe this approach is industry leading within the UK.

We will continue to invest in valves, monitoring and control to achieve the company ambition to maximise the strategic mains conditioning coverage of the strategic network. In the short-term to 2025, this will require the installation of about 90 new strategic valves and or meters to which in turn will allow pipeline management to be applied to all mains where conditioning is appropriate. This work has received a letter of support from DWI as part of the PR19 process and will be delivered under a Regulation 28(4) notice.

#### Preferred materials

We will develop our approach to non-preferred materials of trunk mains or linings. In particular look at sections of unlined cast iron and bitumen lined mains that exist in specific locations.

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#### **Service Reservoirs**

Service Reservoirs are often the subject of competing objectives: turnover vs resilience and quality, maintenance and availability. We want a better long term visibility of their ageing process and its implication on the water quality and the civil structure, to anticipate and plan for their replacement.

To replace the existing set of service reservoirs over say a 100 year period, the cost to NWL would be approximately £140m per AMP. This is unlikely to be affordable. We do recognise however that our existing rate of replacement for service reservoirs is inadequate and that the current age profile of these assets is predominately 80+ years. There is a need to create more informed tendency tree analyses to determine the service reservoir inspection frequency rate, and where engineering assessments signal significant asset deterioration within a 5-10 year period, we would plan to replace or abandon. Other principles which form part of the strategy include:

- All fill and draw tanks will be re-engineered to remove this type of operation;
- All tanks constructed from brick or masonry will be removed from service and replaced;
- Age profile will be considered within the tendency tree assessment, with an option for a cut-off point agreed dependent on construction material;
- Age of water from source to customer to be assessed across a system and not just isolated to design residency in single tanks.

The sensitivity behind any risk prioritisation process is dependent on the quality of data around asset condition and performance. We will therefore enhance our current service reservoir risk models by embedding the latest industry's thinking and combine it with CFD modelling and our own innovative techniques such as flow cytometry. The latter provides a risk index for any given tank from sampling data which in turn provides an indication of the likelihood of a coliform failure. This ground-breaking application of a traditional technique is forcing NWL to think more readily about how we can run systems optimally to keep the water fresh for customers and protect those tanks at the end of any given system from potential biofilm growth.

Within the AMP7 plan, we will also be adding to the existing service reservoir asset base. As well as the new tank construction at Barsham in Suffolk, we are also constructing a new service reservoir in the Central area at Springwell to improve resilience, water quality compliance whilst reducing risk of outages. The 62MI storage tank will bridge storage deficits in the area and will be sited on the Washington leg from Mosswood WTW. DWI has provided this scheme a PR19 'commend for support' for inclusion in our final business plan, and the £17m project will also include duplication of the outlet main to provide opportunity to link supplies from Carr Hill on the Tyneside system.

Both reservoirs will be designed to meet the requirements of our Network Management Guidelines.

#### **Inset Appointments and Bulk Transfers**

We will support our customers and enhance assets in these areas as we do with all our other assets. We will work with the incumbent suppliers of our bulk supplies of potable water to encourage levels of risk assessment, risk mitigation and asset investment and equal to our own.

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#### DISTRIBUTION – ‘Our networks convey high quality water to customers’

##### Distribution Operation Maintenance and Strategy (DOMS)

Our Distribution Operation and Maintenance Strategy (DOMS) is a required document by the DWI to document how NWL is proactively operating and maintaining its potable water network to achieve consistent or improving water quality to customers in a cost-effective way. The revised NWL DOMS document continues to be primarily an umbrella document detailing business processes and the performance management systems around them. Specific policies and strategies are listed and referenced but not fully detailed.

##### WILCO Model

The SEAMs WILCO product was chosen to deliver our top down analysis. The product:

- Analyses and extrapolates the performance of our non-strategic distribution pipelines with regard to its impact on serviceability (bursts & customer interruptions);
- It is capable of analysing and extrapolating the minor work interventions – valve replacements, chamber rebuilds etc;
- We maintain models for each of the Company’s 29 potable water system zones to identify the investment required to maintain pipeline serviceability at its current level and identify likely spend on minor works.

This is being replaced with an updated SEAMs product EDA for Water.

We will develop further our pipe deterioration models to quantify how our assets are deteriorating structurally and the impact this has on water quality either directly (corrosion, plumbosolvency, chlorine residual) or indirectly (bursts, discolouration, negative pressures). Tighter integration of asset modelling and water quality deterioration will broaden the scope of our decision support process leading to a better assessment of customers’ benefits and greater understanding of whole life cost of our asset investment strategy (treatment vs replacement).

##### Iron compliance and discoloured water

Water quality compliance and consumer acceptability in NWL has been significantly affected over many years by the presence of iron mains degradation and sedimentation. Since 2015, we have invested heavily on water conditioning and pH correction schemes at four water treatment works to mitigate the risk of aggressive water and iron mains corrosion, and compliance has improved as a result. This is

In AMP7, we are expecting to deliver 30km of ring-fenced iron mains replacement per annum in the Northumbrian Water operating region where the biggest risk from corrosion and deterioration exists. Benefits in iron compliance will also be seen through our leakage and bursts reduction programmes across the whole of NWL.

Unlined cast-iron however will continue to be a significant risk until a more significant step change is created beyond that planned for the short term. There is currently over 4800km of unlined cast or spun iron main across NW and ESW, and a cost analysis has been carried out to determine the appropriate ambition based on affordability. Table1 (below) details that analysis and the rate of replacement based on an annual committed spend. Sustaining the AMP7 rate of around 30km per annum in the NW region alone would take until 2095 to remove all unlined cast iron.



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Table 1: Iron mains replacement rates

NWL (£128 per m)	30km / yr	40km / yr	50km / yr	60km / yr	70km / yr	80km / yr
AMP Cost (5yr cost)	£19m	£26m	£32m	£38m	£44m	£51m
Zero unlined iron date	2095	2075	2065	2055	2050	2045

ESW (£200 per m)	30km / yr	40km / yr	50km / yr	60km / yr	70km / yr	80km / yr
AMP Cost (5yr cost)	£30m	£40m	£50m	£60m	£70m	£80m
Zero unlined iron date	2095	2075	2065	2055	2050	2045

Our ultimate aim will be to replace all unlined iron mains although the uplift in activity will be significant in order to achieve this within a 25-30 year timeframe. We do however expect to achieve 100% compliance with standards at the customer tap by 2045. The long term strategy will therefore look to remove the risk from unlined cast iron non-strategic mains within this timeframe across the two operating regions. In this programme, we will further uplift current and proposed spend post-2025 in order to remove all unlined cast iron by 2065 in the Northumbrian operating region. For ESW, our asset modelling and prioritisation tools will be modified to reflect iron compliance more readily alongside other key drivers for mitigation, whilst accepting that leakage and burst mains strategy will together deliver significant meterage of iron mains replacement.

The section 19 programme of non-strategic mains relining and renewal is now almost 20 years old in places and where lining techniques were applied, this material is coming to the end of its asset life. The long term strategy would therefore include the re-introduction of pre and post rehabilitation assessments (PPRA) to determine (alongside un-lined cast iron mains) the areas of greatest risk to non-compliance and iron pick up and so help to prioritise a forward programme of works.

## OUR PEOPLE

We will continue to make people competency a key strategic objective and tools and techniques will be allowed to evolve in line with best practice taken from across various industry sectors.

We are pursuing a programme of continual improvement across all those teams that interact with the source to tap journey of our water. This involves initial training and mentoring for new starters as well as periodic training and development for existing employees.

Within our competent operator framework for Water Supply, all new starters will do doing an accredited Level 3 diploma against the Trailblazer standards. Existing operators are being assessed through the Occupational Competence Gateway (OCG) which requires determines knowledge and competency against a series of baseline questions. This is allowing us to understand gaps in process knowledge per area and site, which we can then fill with targeted training, coaching and support. This technique will move into networks as part of our competency strategy.

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Our food factory vision in Water Supply makes sure everyone understands what they are producing on a daily basis and re-enforces our right first time principles. We have embedded techniques such as Kaizan, Go to Gemba and 5'S' into the Water Supply teams and have created a framework for performance and behavioural conversation around site scorecards to ensure everyone has line of sight to company targets. Importantly, people are at the core of this philosophy.

We are currently developing an internal e-learning module which will be mandatory for anyone working in or influencing our water service, including supply chain partners. The material will cover drinking water regulation, risk management, decision making source to tap and customer engagement to make sure our teams deliver leading drinking water quality and customer service through their awareness and interactions.

We are also aware of a skills gap that will be required to blend data science from outside the organisation with detailed water treatment and distribution knowledge. We are also committed to providing the information technology required to support these new developments to allow people and technology to deliver a step change in performance.

The goals set in the water quality strategy (and other similar sector ambitions) will put new demands on our people and we will support cultural change and learning of existing employees wherever possible. We do monitor employee engagement and actively manage this. Our current company engagement score through survey is 80%+ and this is helping us move towards our ultimate ambition to become a three star company within the Time's Best Companies ratings. We believe this high level of employee engagement is important and will ensure our people are motivated and have the skills, knowledge and development tools to succeed.

### CUSTOMER – 'Our customers trust the water we supply'

#### Lead

Our approach to lead continues to evolve and focuses on public health, compliance and availability of natural resources.

We are enhancing our current lead policy for communication pipe replacement and using this opportunity to replace the customer's supply pipe to mitigate risk now and for the future. We are currently doing pilot work in the Southend area of supply to build up data intelligence around the approach and to understand customer behaviour towards free supply pipe replacement.

In the short term we want more robust plumbosolvency control to achieve improved protection for our customers and we are doing this through detailed analytics and modelling to understand individual property lead risk. Optimisation of control measures will be assessed by maintaining a stretch compliance target of 40% of the regulatory standard, taking us beyond regulatory obligations. This has the additional benefit of preparedness for the potential future tightening of the regulatory lead standard from 10µg/l to an anticipated 5µg/l.

For AMP7 and 8, our primary objective will be to target service pipe replacement in public buildings frequented by children, the age group most susceptible to the ingestion of lead. To support an environmental sustainable strategy we will reduce our phosphate dependency through full lead service pipe replacement in six discrete rural areas enabling the removal of phosphate dosing in those areas. In addition, we will continue with lead hot-spot replacement schemes where identified. The combined costs for this package of work have been determined to be in the region of £14m. It has been supported by DWI through a Regulation 28(4) notice as part of PR19.

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Our customer research highlighted the most significant barrier to supply pipe replacement was cost. Through our strategy of full lead service pipe replacement we are removing that barrier, supporting our customers and safeguarding health. This will allow us to achieve our long term strategy which aligns with the ambition of Water UK to be lead free by 2050. Our ongoing programme of work will be risk prioritised, targeting first properties with the highest risk to non-compliance. To support this ambition, we would welcome a debate on supply pipe adoption as we see this as a key financial enabler for higher rates of service pipe replacement activity.

#### Discolouration (appearance)

Historical improvement in contacts since 2010 have varied, with an average improvement of 10%. These improvements have followed water supply improvements, trunk main cleaning works and associated communication campaign in the Tyneside area, pipeline management and adoption of uni directional flushing.

Reduction to 2000 contacts by end of 2024 has been chosen as the target to allow the company to continue to improve on discolouration contacts. This is equivalent of reduction of 76 contacts per year from 2018 onwards.

We have a comprehensive source to tap discoloured water strategy. We work to minimise iron and manganese carryover from treatment processes and are committed to distribution network flushing using industry best practice and trunk mains conditioning. We believe all of these are ongoing activities and have built them into our business model.

Our ultimate aim is to achieve zero complaints for discolouration. There is currently no end date to achieving this ambition, however we will continue to work with Universities and sector experts to understand best practice opportunities and innovations on this topic.

#### Taste and Odour

In 2017 we had our best performance to date, with a final year end figure of 978 contacts. To build on this, maintain momentum and deliver continuous improvements year by year, we are proposing an annual reduction of approximately 1.7% applied from 2017 onwards. This would see contact numbers reduce to 860 by the final year of AMP 7.

Investment requirements have been identified across a range of asset type's aimed at improving quality, consistency and to reduce the likelihood of future Taste and Odour issues.

Firstly, we will be looking to gain a better understanding in the T&O risk associated with our source waters and changes in blend. We will do this through increased sampling, monitoring and analysis.

With water treatment and processing we will be looking to optimise our disinfection processes at all sites across the Northern Operating area. We will also be increasing the use of PAC dosing and process unit cleaning activities.

Across the strategic network the investment targets increased network monitoring, providing the tools and resources to optimise quality and consistency.

There will also be investment around the customer experience, and the ability to deliver unrivalled customer service, through our people and social media outlets.

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Interventions currently proposed will allow us to meet to proposed target of 860 contacts per annum by the end of AMP 7.

In addition, we will create asset standards for service connections to ensure only standard materials are used during planned and reactive work. This will offer benefits in the long term to our T&O ambition by removing the potential for non-standard materials to influence consumer perception of the water supply.

#### Customer education

We understand the power of customer communication and relationships. We are a trusted water supplier and aim for the highest possible customer service. In achieving this we have built up a considerable internal understanding of customer communications which we intend to maintain and enhance. During PR19, we have driven a leading communications strategy which has seen us interact with up to 2 million of our customers to help inform our business plan. This has been supported by our community engagement vehicle 'Flo', which allows us to speak openly with customers about the service we offer and the value they perceive in it.

Refill is City to Sea's campaign to promote and encourage free tap-water 'Refill Stations' to be made available in cafes, bars and shops on every high street and transport hub across the UK. As an Ethical company we really support this campaign, which not only encourages people to drink our clean, clear and great tasting water, it will also help reduce the amount of plastic waste. We have some big plans as to how we as a company can radically reduce plastic waste, and stop the flow of plastic into the ocean, whilst also offering lots of our great water to people to drink for free. We have started our partnership with Refill by encouraging businesses in the County Durham area to become a refill station and add them to the refill app. The general public can then download the app and find somewhere to fill their reusable water bottles with our clean, clear and great tasting water. So far we have encouraged over 300 business to sign up for Refill in Durham and we are have recently expanded the campaign by encouraging a further 200 to sign up in Newcastle City Centre. As well as tackling plastic pollution, Refill should help to positively influence the perception of tap water.

Building on the perception theme, we have recently run an award winning campaign to create improved brand awareness for tap water under the theme of taste and odour. 'It's in your water' has encouraged consumers to understand the wider benefits of tap water in terms of health and its impact on local economy, and we have linked this to the issue of branded glassware to local restaurants to encourage customers to drink free tap as an accompaniment to their food. We believe that these initiatives help us to build a stronger affiliation for tap water quality and the NWL brand within our customer base.

The risks associated with the pipes and fittings within customer house can have a big impact on health and compliance. Research has shown that three-quarters of shops and on-line retailers are failing to let customers know if their internal plumbing products like kitchen taps are tested, fit for purpose and safe to use. These products can make customers vulnerable to water quality issues in their home and the plumbing products can put the public water supply at risk. We are leading a national campaign with the Water Regulations Advisor Scheme (WRAS) to increase awareness of this issue to customers and make sure manufacturers and retailers only sell properly tested products which display clear information on whether products comply with water fitting regulations.

We will continue to innovate in the field of customer engagement and awareness and we have drinking water quality as a key theme within our corporate responsibility and marketing strategies.

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#### **Digital ambition**

Our Digital ambition programme will present opportunities to enhance customer understanding of the risks to water quality and provide information about self-resolution.

#### **Asset Health**

#### **Intelligent Asset Management (iAM) Transformation Programme**

The way in which we manage and maintain our assets plays a key role in our ability to provide an unrivalled customer experience. We are embarking on a major transformation programme, with investment of £25 million, across the business to introduce intelligent asset management.

The programme is a key assumption within the water quality plan and will enable NWL to address any inconsistencies in processes across our two regions and between business functions. In doing so, iAM will provide us with better quality, more reliable and readily available data so that we can make better, faster, more proactive decisions about asset maintenance and investment.

iAM will also allow us to make the most of the immense knowledge base of our people and of new technology.

The programme will involve employees across the business and aligns closely with our new customer experience programme. Together both initiatives will provide us the information we need to act efficiently, provide a better service and, ultimately, deliver more for less. Our Water safety planning will be fully aligned with risk prioritisation within the iAM programme.

The outcomes from the iAM will be a new Target Operating Model within NWL with an associated organisational design based on capability and functional needs. This design and associated technology are core elements within the long term water quality plan and this transformation programme is due to be completed by 2019-20.

To further enhance our asset knowledge and decision points, we are introducing Building Information Modelling (BIM), a national framework which describes how to deliver projects efficiently. Embracing BIM will allow NWL to deliver more effective projects for our internal customers and better value for our external customers. Fundamentally, BIM will enable operations and maintenance to optimise their actions, resulting in a greater whole life value from our asset base. The application of the BIM process also offers the following advantages:

- Gives high quality digital data about our assets, and sets digital output requirements at the beginning of any new project;
- Provides meaningful analysis to help maintain and manage the assets efficiently;
- Ensures we leave the right data legacy for future generations to enable them to deliver unrivalled customer service;
- Provides a classification system which allows us to understand and share asset information across industries;
- An ability to undertake whole life cycle asset management decisions;
- Predictive analytics – understand our assets better;
- Alignment to internationally recognised process and best practice (ISO standard coming).

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# LONG TERM WATER QUALITY PLAN

## SUMMARY

Our short, medium and long term plans for water quality cover all aspects of the water service and aim to protect consumer health, demonstrate ambition against regulatory comparisons and also recognise asset needs in line with consumer and regulatory expectations. The plan has water safety plans at its heart, identifying risk and requiring systematic risk reduction. The plan confronts each of our key measures around CRI, ERI and consumer acceptability and aims to ensure that NWL is seen as a trusted, innovative and high performing company.

Key long term deliverables within the plan will include:

- Investment in water treatment to meet our revised treatment standards. Our ambition is for one replacement works per AMP from 2025 onwards;
- Development and implementation of a smart network programme to build on our SCADA and Aquadapt historical development. We hope to pursue a national approach with a standard for smart networks in the UK being developed by a national body;
- Strategic networks which are fit for the future. This will be a rationalisation AND development programme to improve flexibility and resilience;
- A replacement programme for service reservoirs and strategic networks, aging asset base that overall requires a rolling replacement programme;
- Unlined Iron and non-standard distribution main replacement including lined mains. This to be targeted by a revised PPRA programme;
- Alignment with the Water UK ambition to be lead-free by 2050 which in turn will support environmental considerations around phosphate dosing;
- A continuation of our successful discolouration and taste & odour strategies to improve the consumer experience.

We believe the plan is coherent and offers service-wide benefits. It will provide strategic intent to asset planning and the iAM transformation programme for both asset maintenance and enhancement, and it offers opportunities for long term resource planning within our investment framework.

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#### Appendix A - Tees Zonal Study Outputs

Date	Action	Capex
<b>AMP7 (2020-2025)</b>	New pipe from Lartington WTW to Longnewton SR	£37,500,000
	New pipe from Whorley Hill SR to Shildon SR	£15,600,000
	New outlet main from Maltby Grange SR to Conduit 67	£6,000,000
	Commence a programme of pipe line condition assessments	£500,000
	Separate Conduit 53 and Conduit 67	Nominal
	Move Nunthorpe PS onto Ormesby SR Outlet	Nominal
<b>AMP8 (2025-2030)</b>	Reline Conduit 5	£3,500,000
	Reline Conduit 46 Abandon Conduit 56	£2,450,000
	Continue programme of pipe line condition assessments	£500,000
	Abandon South Lackenby SR	£100,000
	Abandon Broken Scar WTW to Longnewton SR (via Fighting Cocks)	£100,000
	Abandon Longnewton SR	£100,000
	Abandon Uplands WPS	Nominal
<b>AMP9 (2030-2035)</b>	Continue programme of pipe line condition assessments	£500,000
<b>AMP10 (2035-2040)</b>		
		£66,850,000

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#### Appendix B – North Suffolk Supply Strategy Outputs

Scheme	Description	Driver	Priority
Caister Res No.1 Valve	Install actuated valve to allow Res No.2 to be fully utilised	Efficiency	Medium
Lound to Bradwell Main	3.5km x 600mm main – possibly via Beacon Park development + 1.3km x 450mm main	Supply/Demand Balance Resilience	High
Lound to Gorleston Pumping Plant	Duty / Standby plant – nominal duty 18 Ml/day @ approx. 45m lift (needs to derive outlet head of 55m)	Supply/Demand Balance Resilience	High
Gorleston Reservoir to Beacon Park Main	Clean existing 18" CI main	SIM	Med
Caister Pumping Plant	Replacement (Duty / Standby) Pumping plant – nominal duty 52l/s @ 30m lift	Efficiency	Med
Caister Site	Cross connection between Pump outlets and PRV head main	Efficiency	Low
Ormesby Site	Cross connection between 24" HL pumping main and 15" PRV head main	Efficiency	Low
North Cove to Carlton	3.75km x 600mm extension to existing main	Resilience	High



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South Lowestoft Reinforcement	0.6km x 450mm extension to existing main	Resilience	High
Lowestoft Harbour Crossing	Reinstatement of damaged crossing	Resilience	High
Barsham Groundwater Treatment Plant	Replacement of existing plant	Quality	High
Lound Treatment Plant	Replacement of existing plant	Quality	Med
Barsham Reservoir and Pumping Station	New 20 MI Reservoir and replacement of all pumping plant	Resilience	Med
Ellough Pumping Station	New facility to pump directly to Ellough (link to new Barsham pumping station)	Efficiency	Med
New High Level link between Lound and Hollingsworth Road	Re-designation of existing main or construction of new main + decommission of Rectory / Corton Boosters + new HL pumps at Lound	Efficiency and DG2	Med
Shadingfield to Alder Carr	10.4km x 300mm duplicate main	Supply/Demand Balance	High
Barsham to Shadingfield	5.5km x 300mm duplicate main	Resilience and ALFA	Low
Barsham to Bungay St.Margarets	8.5km x 300mm new main – if Broome not sustainable	ALFA	High (if Broome unavailable)
Replacement Barsham to Bungay Pumping plant	Replacement pumps within new Barsham pumping station	Efficiency	Med

This collection of schemes are less defined in terms of timescale than Tees Zone. That saying, a number have already been delivered within the existing capital plan and it will be NWL's intention to state a revised timeline to DWI during the more detailed plan to be submitted to DWI in 2020.