Dŵr Cymru
Welsh Water

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PR19: Water Quality

September 2018

Dŵr Cymru Welsh Water

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Executive summary

Driver for investment

Maintaining a high level of water quality remains one of our biggest challenges within the current and forthcoming AMPs. This is an historical challenge in Wales and one that is driven by the age, condition and performance of our assets; deterioration of raw water quality; changes in farming practices; climate change and changes to regulatory standards. We have seen an unprecedented challenge to treating raw water in recent years in response to these underlying root causes to ensure that water quality for key parameters including bacteriological, chemical, cryptosporidium, lead and disinfection by-products remains compliant at all times.

We have developed an industry-leading, long-term strategy to enable us to overcome these challenges. The "source to tap" approach we have now adopted, including our water quality programme, will tackle these root causes through catchments, water treatment works, service reservoirs, trunk mains and distribution systems. We have developed this approach alongside the Drinking Water Inspectorate, accepting performance improvement notices for several of our water treatment works and service reservoirs linked to improving water quality.

We strive for upper quartile performance in each water quality measure and have made significant progress with targeted investment in recent years to improve compliance. However, it is important not to become complacent, with significant changes to how water companies are regulated in terms of water quality as well as key changes to several parameters planned prior to the start of AMP7, we must ensure that the level of investment is right to overcome these challenges.

The investment

We propose to invest £46.91 million during AMP7 to deliver improvements (through a number of schemes to improve and maintain water quality compliance across the company. Building on the progress we have made during AMP6, our approach will improve water quality at water treatment works, within the distribution system and provide additional resilience across our operational area. The programme to be delivered in AMP7 is shown in Table 1 with the associated investment required.

Programme of work	Proposed programme total budget
Disinfection by-product Research & Development	£0.69 m
Disinfection by-product Improvements (Alaw WTW)	£0.77 m
Abandonment of Capel Curig WTW	£2.57 m
Felindre and Bryngwyn Sludge Improvements	£5.35 m
Contact Tank Bypasses	£11.19 m
Replacement of Lead Supply Pipes	£15.47 m
SEMD Enhancements	£10.87 m
Total programme (pre-efficiency)	**£46.91 m**
Total programme (post-efficiency challenge)	**£43.11 m**

Table 1 - Water Quality programme for AMP7

Delivering for our customers

This work will meet the following of our customer promises:

Clean, safe water for all: Improve the quality of the water provided to our customers.

Put things right when they go wrong: By proactively planning for future deterioration of raw water quality, regulatory changes and external factors we reduce the need for costly reactive maintenance

A better future for all our communities: A more resilient water service, providing all of our customers with compliant water quality irrespective of regulatory drivers or climate change.

Delivering for the future

In Welsh Water 2050, we identified future trends. Our proposed investment will ensure that our critical wastewater assets are resilient to the following trends:

Climate change: Climate change will result in more extreme rainfall events and prolonged dry periods increasing the risk of water quality events

Changes in customer expectations: Changing customer and societal expectations may require us to ensure that all customers have a minimum universal service standard.

Protecting essential infrastructure: Our ageing assets present significant issues with reliability and resilience.

Changes to the structure of the economy: The growth of the digital, knowledge based economy will create opportunities to provide services in more efficient ways. However, it could also have an impact on the nature of society, and present a challenge to continuing to meet the needs and expectations of our customer

Protecting public health: We will have a role to play in promoting healthier and more sustainable lifestyles for our customers.

Delivering our Strategic Responses

In Welsh Water 2050, we set out to deliver 18 Strategic Responses. This investment will contribute to the following:

Enough water for all: Improving water quality at our water treatment works and through our distribution network will ultimately increase resilience of supply for customers. By safeguarding water quality compliance it will ensure that there are fewer events and failures and therefore increasing resilience and security of supply for our customers.

Achieving acceptable water quality for all customers: Improving water quality for customers through a programme of source to tap interventions

Achieving our measures of success

In AMP7 we will continue to measure our performance against our Measures of Success (MoS). This investment will contribute to achieving the following MoS:

Measure of Success	End of AMP6	End of AMP7
Safe, clean water for all: Tap Water Quality Compliance Risk Index (Wt1) - The Compliance Risk Index (CRI) is a measure designed to illustrate the risk arising from treated water compliance failures, and it aligns with the current risk based approach to regulation of water supplies used by the Drinking Water Inspectorate (DWI).	-	0
Safe, clean water for all: Tap Water Quality Event Risk Index (Wt6) - The Event Risk Index (ERI) is a measure designed to illustrate the risk arising from water quality events, and it aligns with the current risk based approach to regulation of water supplies used by the Drinking Water Inspectorate (DWI).	-	Upper Quartile Position
Safe, clean water for all: Number of lead supply pipes replaced (Wt8) (cumulative over an AMP) - Replacement of lead service pipes for our most vulnerable customers.	1,800	7,000
Create a better future for all our communities: Asset Resilience (reservoirs) (Ft5) - Percentage of critical assets that are resilient against a set of criteria. Critical assets are those where failure would have a major impact on service to customers or on the environment.	92.2%	95.5%
Create a better future for all our communities: Asset Resilience (water network+ AGA) (Ft6) - Percentage of critical assets that are resilient against a set of criteria. Critical assets are those where failure would have a major impact on service to customers or on the environment.	84%	86.5%
Create a better future for all our communities: Asset Resilience (water network+ BGA) (Ft7) - Percentage of critical assets that are resilient against a set of criteria. Critical assets are those where failure would have a major impact on service to customers or on the environment.	47%	56%

1 Delivering our customer outcomes

Need for Investment

This investment is required to achieve our plans to deliver improvements to and maintain a high level of water quality to all customers - as outlined within our long-term strategy, Welsh Water 2050.

Maintaining the high quality of water that we supply is the most fundamental part of our water service provision. We are constantly reviewing risks that could threaten this and investment that will minimise the risk. In AMP 7, investment is required to minimise the risk of water quality problems for customers and maintain bacteriological, chemical and cryptosporidium compliance at water treatment works and throughout our distribution network. The programmes of work will enable a major step towards the achievement of our long term goal of achieving upper quartile performance for water quality to our customers and an improvement on our measures of success for water quality and asset resilience.

Our assessment has included a review of water quality data, recorded operational constraints, contact tank and service reservoir cleaning programmes along with current and projected changes to water regulations and industry best practice. In developing this business case we have undertaken a comprehensive review of water quality results, Drinking Water Safety Plans (DWSPs) and lessons learned following unplanned events. This approach has allowed us to identify a small number of priority problems to focus on. Our performance, reported to Ofwat on an annual basis, has been consistently stable for a number of years. Although performance will be reported differently from 2020, we will aim for upper quartile performance with the planned level of investment outlined as part of this programme. Regular monitoring of water quality performance at treatment works and in the distribution system allows us to target investigation and investment at poorly performing assets to prevent future failures and improve water quality compliance. Water quality data collected through our statutory sampling programme, online monitoring system, review of operational costs together with audits of unforeseen events and reactive operational costs all contribute towards the continuous appraisal of DWSPS and management of risks of water quality that may present a risk to public health.

Risks associated with water quality are recorded in DWSPs which adopt a straightforward risk matrix approach of impact and probability contributing to an overall risk score. We report any significant risk changes to the DWI on an annual basis. Level 5 risks are the most significant with a high impact and probability of occurring compared with Level 1 risks which are of negligible impact and unlikely to occur. A summary of our current number of risks per business area is illustrated in Table 2.

Table 2 - Summary of water quality risks managed through DWSPs

Water Quality Area	Residual Risk					
	1	2	3	4	5	Total
Catchments	371	625	227	49	0	**1272**
Treatment Works	2888	1960	300	34	2	**5184**
Service Reservoirs	2440	5352	447	4	0	**8243**
Network	2458	6621	563	28	0	**9670**
Total	**8157**	**14558**	**1537**	**115**	**2**	**24369**

Water Quality

Water quality risks are categorised according to their quality area; catchments, treatment works, service reservoirs and network. We presently have two Level 5 risks both attached to water treatment works and a further 115 Level 4 risks split across the four areas. We determine investment for Level 5 risks as requiring remedial action immediately and Level 4 risks as requiring action within the next 5 years along with additional monitoring and investigation to monitor the risk in the interim.

Current water quality performance is monitored using Mean Zonal Compliance (MZC) which although is providing us with an overall performance figure, is reliant on the number of failed samples and does not provide an early warning system as to where failures are likely to occur in the future. The current MZC system is also limited where each parameter is weighted equally and failures are disproportionally imbalanced towards zones with smaller populations.

From 2020, the existing Mean Zonal Compliance Index, Disinfection Index and other performance measures will be replaced by the Compliance Risk Index (CRI)[i] which will present a more risk based approach to compliance, where parameters and types of event will be weighted individually, producing a clearer and better understood metric where it will be more straightforward to be able to aim for upper quartile performance. In 2016, our CRI was calculated at 2.59 by the DWI compared with the national CRI calculated at 4.78 with upper quartile set at 1.6. CRI increased slightly for 2017 due to an increased number of additional zonal failures. We are currently within the 50th percentile for performance with a target at the start of AMP7 of being able to achieve an upper quartile position in AMP7.

Compliance Risk Index	2015	2016	2017
Dŵr Cymru	-	2.59	2.85
England & Wales Average	5.55	4.78	3.56

Table 3 - Compliance Risk Index scores for previous 3 years

Investment in water quality is closely linked with other investment programmes including asset maintenance (of treatment and network assets), Improving Customer Acceptability of Water and the Cwm Taf Water Supply Strategy project to maintain our current level of performance as well as improve the experience for customers in terms of quality, appearance and taste and odour of water.

The key benefits to investment for water quality will be directly measureable through existing and proposed water quality based metrics including water treatment works performance, mean zonal compliance and compliance risk index along with internal targets such as reducing operational cost. These metrics are all based on measurable parameters as identified in the Water Supply (Water Quality) Regulations where performance can not only be monitored on an annual basis but also compared with other water supply organisations as we strive to achieve upper quartile performance.

Our performance is constantly monitored by the DWI.

The proposed investment in this area will enhance the level of service currently provided to customers by meeting the following drivers:

- Improving water quality compliance and resilience of our water treatment assets and supply infrastructure in response to deterioration of raw water quality and changes to legislation; and
- Meeting our customer's expectations and delivering our aim to maintain consistent water service across our supply area by targeting customers that experience below average service and quality.

Views of our customers and stakeholders

We have undertaken extensive consultation with customers through our PR19 preparation programme, including our Welsh Water 2050 strategy consultation held in the summer of 2017, which engaged with 19,980 of our customers.

During our consultation for Welsh Water 2050, our customers ranked providing enough clean water to all amongst the most important aspects of our future plans, followed by providing reliability of

supply and water quality. Customers have stressed that they want stable water quality and reliability of supply, including resilience.

Benefit for our customers

Improvements to our MOS

We aim to improve our water quality compliance which, from 2020 will be measured under the new Compliance Risk and Event Risk Indices. We are not currently assessed against this new measure and the existing Mean Zonal Compliance measure will remain in place until the end of AMP6.

Our target position by the end of AMP7 is a 0 score for Compliance Risk Index and an upper quartile position for Event Risk Index.

We will also aim to increase the number of lead supply pipes replaced for our most vulnerable customers over the duration of the investment period with a total of 7,000 services replaced by 2025.

Enhancements to security will also contribute towards our overall asset resilience score for both Water Resources and Water Network+ sectors which will ultimately improve security of supply in terms of maintaining service and water quality.

Measure of Success	End of AMP6 Position	End of Investment Position
Clean, safe water for all:		
Compliance Risk Index	-	0
Event Risk Index	-	Upper Quartile Position
Number of lead supply pipes replaced (cumulative over an AMP)	1,800	7,000
Create a better future for all our communities:		
Asset Resilience (reservoirs)	92.2%	95.5%
Asset Resilience (water network+ AGA)	84%	86.5%
Asset Resilience (Water network+ BGA)	47%	56%

Table 4 - Forecast MOS end of AMP6 and end of AMP7

Affordability of bills

We understand the importance of balancing the need for this investment with the impact on the bills that our customers pay. To help ensure that our bills remain affordable, we have identified a range of efficiency savings within the proposed investment programme. These efficiencies will allow us to deliver the improvements that we know are important to customers, but at a lower overall cost.

2 Investing for now and in the long-term

Future challenges

Our Welsh Water 2050 strategy identifies significant trends over the next 30 years and how these will impact on us and our customers. The most significant trends in terms of water quality compliance are set out below.

Demographic change

An increasing population will inevitably increase demand for water and increase the pressure on our existing assets to supply potable and wholesome water as required by our customers.

Climate change

We expect climate change to have an influence on our catchments. This includes changes to the presence and development of algae and bacteria, and associated compounds such as Geosmin and 2-Methylioborneol (MIB). It will be increasingly important to ensure strong catchment management to control taste and odour issues.

A warmer, drier climate will lead to increased water demand particularly during peak periods in summer months. Similarly an increased frequency of extreme and prolonged rainfall events particularly when following dry spells will lead to a deterioration in raw water quality, increases in sediment loadings, and pesticide concentrations increasing demand on our treatment works.

Environmental change

Pesticide and fertiliser use is increasing in Wales is leading to increased nutrient loadings in reservoirs and rivers and therefore increased prolonged formation of algal blooms. There will be an increased need to install more advanced treatment processes to be able to remove these types of emerging contaminants.

Changes in customer expectations

Increased demand for water as well as expectations regarding acceptability will put increasing pressure on existing assets to be able to achieve current and future water quality targets.

Changes to the structure of the economy

A projected increase in tourism in Wales could see an increase in pressure on rural and coastal water supply networks and treatment works at peak times to meet demand. This investment will contribute to achieving the outputs required from our existing assets

Protecting essential infrastructure

A number of our assets are ageing and deteriorating and therefore have increased risk of those assets not being able to meet the standards of treatment required of them.

Policy and regulatory change

Uncertainty following the UK's decision to leave the European Union may lead to changes to water policy in many fields from abstraction to water quality. Our investment planning has considered this risk and its potential impact on customers

Protecting public health

Evidence is emerging of the impact on public health of additional contaminants not previously monitored. These could lead to changes to the Water Supply (Water Quality) Regulations in the future.

Legal duties

Our target to improve water quality performance and to a similar degree, interruptions and acceptability, is partly driven by improvement notices issued by the DWI. Our two major schemes to improve water quality in AMP6 were both driven by improvement notices generated following our PR14 submission for Water Quality.

Planning for the future

Long-term planning

This project links with our Water Resources Management Plan (WRMP) and our long-term strategy to improve the reliability of drinking water supply systems, protecting our critical water supply assets and achieving acceptable water quality for our customers.

The prediction of water quality is dependent upon a robust monitoring and sampling programme as well as collaboration with industry leading organisations in research and development. We are governed by existing regulations in terms of how we treat and manage water to the existing standards but not giving consideration to future changes in raw water quality as well as changes to the regulations would be unwise.

We are constantly broadening our water quality monitoring programme which provides not only online real time data but also data using laboratory analytical methods where such online technology does not currently exist. With more efficient analysis of this data we will be able to identify poorly performing assets and areas that were previously not considered, as well as prioritising assets for investment where emerging water quality parameters and standards require additional treatment.

Working with academic and research based organisations including APEM, Bangor and Cardiff Universities as well as WRc, we are developing several models which can be used to gain an understanding of current and future problems. Examples of current projects include raw water quality deterioration, the dynamics and movement of taste and odour causing compounds and conditions for bacteria growth in service reservoirs.

We are increasingly adopting a catchment management approach as a control measure to prevent water quality failures at treatment works and within the distribution system. By working with land owners, regulators and environmental organisations to minimise the impact of raw water quality on treatment works, the need for investment on expensive, advanced treatment processes may be less of a priority.

Focus on water quality is going to remain relevant during the remainder of the current and next AMP period. As asset age increases and the condition deteriorates there will be an increasing drive to prioritise specific sites for increased attention and investment. At the same time, there is increased scrutiny on the regulations with the inclusion of emerging contaminants such haloacetic acids in 2020 and amendment of existing standards such as Lead, on the agenda of the regulator as well as interested 3rd party research organisations.

Building on progress

Our proposals are not the start of our journey. We have made significant efforts in recent AMPs to improve our water quality compliance. Between AMP2 and AMP5 much of our investment has been targeted towards disinfection including bacteriological, cryptosporidium and turbidity compliance. Since the introduction of the Water Supply (Water Quality) Regulations in 2000 we have dramatically improved our performance for water quality, reducing the number of failures for turbidity and bacteria at treatment works from almost 100 per year in 1990 to 3 per year in 2017.

Historical Performance

Deterioration of Raw Water Quality

The deterioration of raw water quality is an issue faced in every drinking water catchment and water treatment works, which has the potential to impact on our customers. Although there are robust treatment stages at our water treatment works to be able to produce compliant water, a small number of works are approaching the limit of their treatment potential for particular parameters.

Cefn Dryscoed WTW is located in the Brecon Beacons National Park and presently serves 17,400 properties. There has been a deterioration in raw water quality in recent years which has put increasing pressure on downstream treatment processes, which currently comprises of only chemical coagulation and filtration. Year on year increases of organic matter in raw water have contributed towards a reduction in treatment performance, increasing the risk of solids and cryptosporidium breakthrough as well as manganese which has an impact on discolouration of water in the network. Figure 1 illustrates the trend of raw water colour increase at the raw water source for Cefn Dryscoed (Ystradfellte reservoir) from 2007 to 2017. During this time the annual average has increased from 18 to 33° Hazen. The final compliance limit for colour is 20° Hazen, so without treatment we would currently fail this limit.

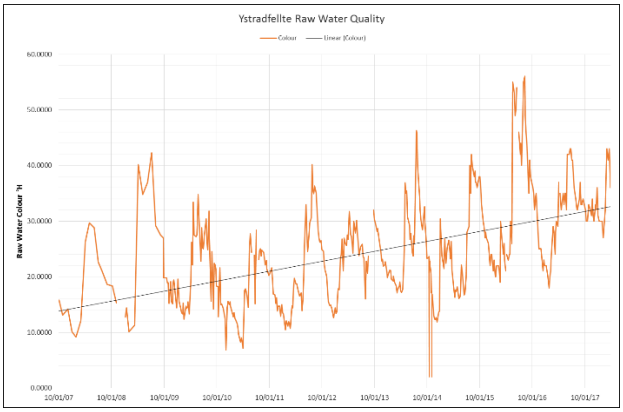

Figure 1 - Historic raw water colour loading at Cefn Dryscoed

Final water quality from Cefn Dryscoed is of general satisfactory quality, however, should raw water deteriorate on a similar level over the next 5 years, compliance may be put at risk.

Figure 2 illustrates the forecasted increase in solids loading on the existing filters. Solids loading is calculated from raw water turbidity and colour as well as chemical coagulant that is added to the water. Forecast models predict that by 2027, average suspended solids presented for filtration would have increased from a 95th percentile of 18 mg/l to more than 22 mg/l, which will be close to the limit in terms of industry best practice.

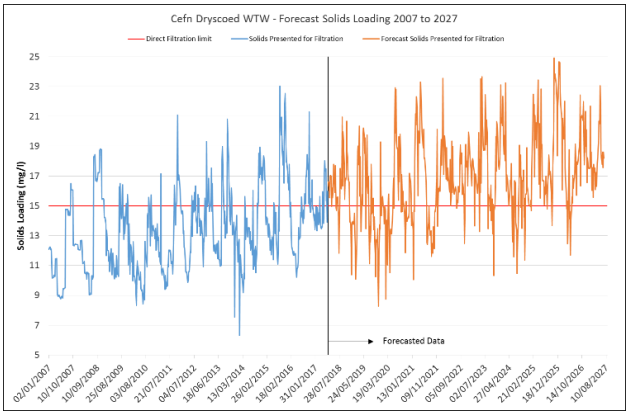

Figure 2 - Historical and forecast solids loading at Cefn Dryscoed WTW

Management of Pesticide Levels at Treatment Works

Following an increase in extreme rainfall events, coupled with more intense farming techniques, we have seen an increased number of positive pesticide samples in raw and final water in recent

years. Llechryd water treatment works in Ceredigion which presently serves 19,450 properties, has been particularly susceptible to such change.

There is currently no permanent treatment process dedicated to the removal of pesticides at Llechryd but a temporary powdered activated carbon (PAC) process has been used seasonally in recent years. A number of different pesticides have been detected at Llechryd but those amongst the most frequent include MCPA, 2-4, D and Glyphosate which are used as herbicides in this region. Table 5 shows the increasing frequency and concentration of pesticides being detected in the raw water at Llechryd.

Table 5 - Historic numbers of MCPA failures at Llechryd WTW

Year	No of MCPA Failures	Samples >50%ile of PCV
2007	0	0
2008	0	1
2009	0	1
2010	0	0
2011	0	0
2012	0	0
2013	1	1
2014	6	11
2015	2	7
2016	2	3
2017	1	2

Management of pesticide levels in the Llechryd catchment is currently partly reliant upon catchment management where a knowledge sharing programme, the use of innovative spraying techniques and incentives for land owners is trying to reduce the transportation of pesticides into the river Teifi (the raw water source for Llechryd). Together with management through the use of PAC, we have managed to avoid a final water quality failure. However, it is believed that such management techniques will only be successful to a certain extent and if rainfall events continue to become more intense and frequent then additional permanent treatment may be required.

Disinfection By-products

We continue to experience issues with the management of disinfection by-products in many of our supply areas. The challenge of treating and removing organic and other raw water precursors coupled with elevated contact time with chlorine has led to the production of several measurable by-products including trihalomethanes (THMs) and haloacetic acids (HAAs) within the distribution system. These types of disinfection by-products have been classified as possible carcinogens in elevated concentrations and although only THMs are specifically regulated, the regulations stipulate that the water undertaker must ***"design, operate and maintain the disinfection process so as to keep the presence of disinfection by-products as low as possible without compromising the effectiveness of the disinfection;"***

Although HAAs are not currently specifically regulated, we are anticipating a future inclusion for this parameter in the regulations from 2020.

Our most poorly performing areas in terms of by-products is the North West of the country in water supply zones Anglesey and Conwy. Figure 3 illustrates the ongoing challenge of THMs at Llanddonna service reservoir located on Anglesey where the average concentration for 2017 was 68 µg/l and 95th percentile was 85.7 µg/l. Although these concentrations of THMs are within compliance in terms of the current regulations we recognise that this is not an acceptable level of service for customers on such a continuous basis.

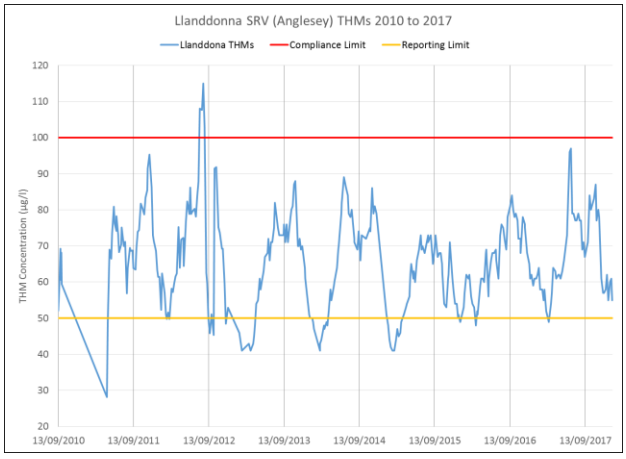

Figure 3 - Historic THM results from Llanddonna service reservoir

Figure 4 illustrates results for HAAs measured at the most poorly performing treatment works in 2017 where results approximately mirror those of THMs. There is an increasing drive to reduce concentrations further due to a potential higher toxicity and long term health impact than THMs. There is no current specific limit for HAAs but if proposed inclusion into the regulations in 2020 is implemented, the limit is highly likely to be set at 80 µg/l with a reporting limit set at 40 µg/l. At present, on a 95th percentile basis, we would fail the limit at two water treatment works and be subject to produce a management plan through DWSPs at a further 10 sites as shown in Figure 4.

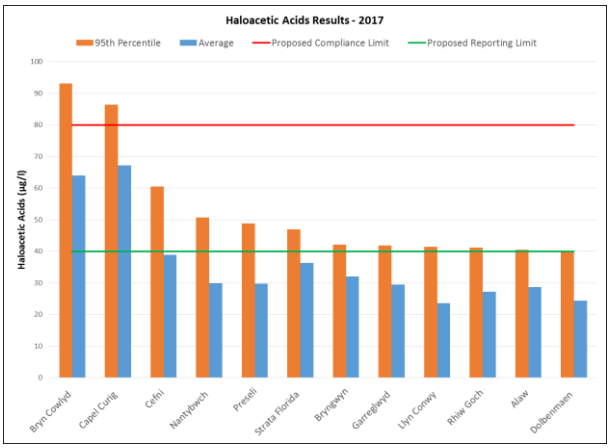

Figure 4 - Our worst performing water treatment works for HAAs

Capel Curig Water Treatment Works

Capel Curig is an aging asset that was originally constructed in 1960 that supplies approximately 200 people. By 2020, Capel Curig will be our last remaining uncoagulated surface water treatment works. It currently consists of two stage filtration along with ozone as its primary treatment process. Although water quality produced by the works is generally satisfactory and compliant, there is an increasing trend in some parameters which indicates that the existing treatment process is not sufficient or robust enough for the long term future supply of the area.

The use of ozone treatment at Capel Curig has been deemed an inefficient method of breaking down organic compounds in the raw water and is not in line with current industry best practice for removal of dissolved organics as a primary treatment process[ii]. Our own experience has illustrated that due to fluctuations in raw water colour together with inconsistent contact time, ozone has proved ineffective at reducing disinfection by-products at Capel Curig.

Figure 5 illustrates that THM formation at the treatment works since 2010 has been steadily rising over that period. Figure 5 shows that in recent years, predominantly during summer months, THMs have reached concentrations of 80 µg/l and have been steadily rising since 2015. Future projections indicate that raw water colour concentrations are set to rise over the next 10 years as indicated in Figure 6. Average colour is set to increase from 13 mg/l to over 23 mg/l by 2027 which will further increase the levels of THMs from a current average of 45 mg/l to 60 mg/l.

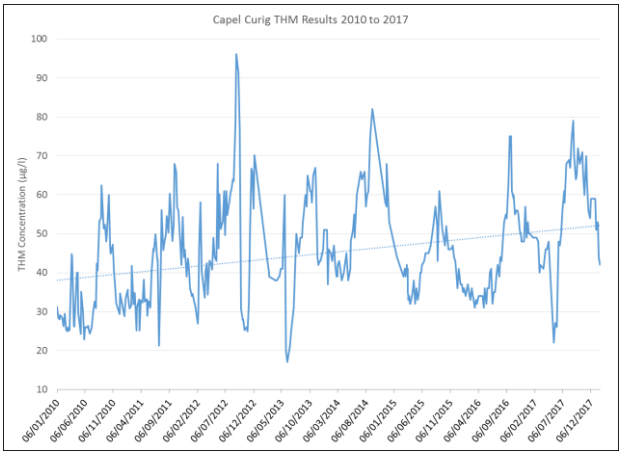

Figure 5 - Historical THM formation at Capel Curig WTW

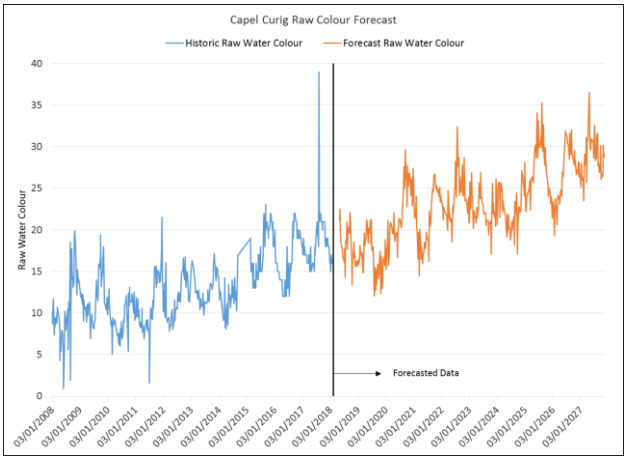

Figure 6 - Historical and forecast raw water colour at Capel Curig

Felindre & Bryngwyn Sludge Analysis

Felindre water treatment works is our largest, both in terms of volume output and number of customers supplied. Similarly, Bryngwyn is also of strategic importance to water supply in South West Wales. The volume of wastewater and liquid sludge produced by these works is amongst the highest in the company where currently treatment consists of only simple dewatering and sludge production. Coupled with a high operational cost linked with the disposal, producing such high volumes of sludge also has a detrimental impact on water quality produced for supply as well as the receiving environment. With limited space available on site to store wastewater, pressure is put on upstream treatment processes, primarily first and second stage filtration. Minimum run times of filters are

restricted to 20 hours, which during periods of poor raw water quality could restrict treated water output by as much as 20 Ml/d. Should there be a treatment failure at either works, which would call for runtimes on filters to be reduced, available space to process and store additional volumes of wastewater and processed sludge would soon be exhausted. Similarly, granular activated carbon regeneration at Felindre is restricted because of this issue therefore increasing the risk to water quality.

The ability to comprehensively process wastewater and treat sludge at treatment works should be a fundamental practice. If wastewater processing is not sufficient then it will have a detrimental impact on treatment from the inlet works through to disinfection and final water. With increasing extreme winter rainfall events and prolonged drier summers forecast for the future, contributing towards a deterioration in raw water quality and reduction of available water, it is imperative that wastewater processing is of sufficient capacity and optimised to required standards. Felindre and Bryngwyn are two critical treatment works in the South West, where failure of the works would have an impact on over 500,000 people in that area.

Contact Tank Performance

In line with industry best practice, it is expected that regular inspection, cleaning and sampling of tanks used for the disinfection and storage of water reduces the risk to water quality of a bacteriological failure. A number of contact tank assets, when originally constructed, were designed as single compartment tanks with poor access and without the facility to isolate while still maintaining supply. The supply network has seen unprecedented demand in recent years in response to population growth, climate change and challenges around leakage and has therefore further reduced the ability to remove additional tanks from service that was historically possible. Following an assessment we have identified 10 water treatment works contact tanks which fall into this category, and therefore carry an unacceptable elevated risk of bacteriological contamination.

Lead Supply Pipes

It is estimated that 25% of homes (380,000) in Wales have lead pipes, most of which are owned by the customer. Whilst customer supply pipes are not our legal responsibility, we have responsibility for water quality at customers' taps.

The Water Supply (Water Quality) Regulations are regularly updated and over the last 15 years the lead standard has reduced from 50 to 25 µg/l in 2007 and further again in 2013 to the existing standard of 10 µg/l. Our long term expectation is that the lead standard will continue to reduce to a target of 5 µg/l by 2030 which if implemented today would generate a further 5 failures per year. The Welsh Government has also recognised reducing lead in water supplies within its Water Strategy for Wales, which we have responded to by setting a target of a lead free Wales by 2050.

Although minimising the number of lead failures has been a challenge, particularly following a change in regulations in 2013, the number of lead failures has decreased over the last 15 years following implementation of phosphate dosing at water treatment works, an enhanced sampling programme and assistance with the replacement of lead supply pipes for our most vulnerable customers. Recent numbers of failures can be seen in Table 6.

Year	Limit (µg/l)	No of Failures
2011	25	3
2012	25	1
2013	25	0
2014	10	2
2015	10	2
2016	10	2
2017	10	1

Table 6 - Number of lead failures since 2011

SEMD (Security and Emergency Measures Direction)

During AMP5 and 6 the programme delivered security enhancements at dam structures, service reservoirs, boreholes, the highest at-risk water

treatment works and intakes, and sites with chemical storage and dosing sites.

We have a statutory obligation to deliver security enhancements as stated in the Water Industry Act 1991 and directed through the Security and Emergency Measures Direction (Water and Sewerage Undertakers) 1998.

The work we have already carried out in this area has ensured that any maintenance or enhancement activity at our highest risk sites will comply with SEMD as part of the site's design. It is important to maintain security at our highest priority sites to protect them against not only physical but cyber-attacks and unauthorised use. We currently have a number of sites in each category named above which require enhanced security based on their prioritised level.

AMP6 Progress

The current level of investment in AMP6 is approximately £59 million which has been split across four major areas which can be seen in Table 7;

Scheme	Scheme Cost	Customers Benefitted	Customer Benefit
Coagulation & Clarification Scheme – Bryn Cowlyd WTW	£29 million	90,000	Improvement in water quality and risk to public health through the reduction of disinfection by-products with more effective removal of organic material found in raw water as well as more effective removal of cryptosporidium with new treatment processes.
Coagulation & Clarification Scheme – Tynywaun WTW	£9 million	30,000	Increased reliability of supply and improved water quality through the introduction of a more robust treatment process able to treat deteriorating raw water that often results in increased levels of solids loading following periods of heavy rainfall.
Disinfection by-products research and development	£1.6 million	Up to 2.1 million	Strategic studies and pilot trials will provide a better understanding of the risks of disinfection by-products to public health. Future investment will be able to target a prioritised list of sites to reduce concentrations through optimisation and introduction of innovative solutions.
SEMD	£19.4 million	Up to 3.1 million	The strategy for this investment area is to address security risks on a prioritised basis with the highest risk assets first, across the water side of the business. For these assets our initial investment will ensure full compliance with SEMD standards.

Table 7 - Investment to address water quality in AMP6

All projects are on target to complete by the end of AMP6.

During preparation of the previous business plan in 2014 with the inclusion of proposed investment to improve Water Quality, DWI offered their support by issuing improvement notices at the two major sites that were included in our plans

By 2020 there will be a new coagulation and clarification process at Bryn Cowlyd replacing the existing ozone treatment to be able to overcome the challenge of treating highly coloured water with an elevated risk of cryptosporidium. The new treatment process will also reduce levels of disinfection by-products in the network (currently one of the worst performing zones for this parameter) as well as improve chlorine residuals and bacteriological compliance for up to 89,000 customers.

Tynywaun treatment works will also benefit from the addition of a new clarification process to be able to treat highly coloured raw water. The existing direct filtration process has struggled following intense rainfall events particularly given that there are many different sources for Tynywaun all of which behave differently where water quality make up is very different. Intervention at Tynywaun will benefit up to 28,500 customers.

There is also an ongoing research and development programme for disinfection by-products as well as an ion exchange pilot trial. This work will be developed further using the learning from some of our worst performing sites to develop solutions and pilot plants during the AMP7 investment period.

The proposed investment for AMP7 is crucial to ensure that we build on the progress made to date. Only through a step change in investment can we fully deliver the challenging improvements in service that our customers deserve.

3 Options

Background

In the optioneering phase of our programme development we considered all of the problem areas that had been identified and prioritised and undertook feasibility work to build costed options for each one. These options were then reviewed with the operational teams to decide which ones became part of the programme.

In determining the best approach to allocate investment for water quality, three high level options were considered:

- Option 1: do nothing and defer any interventions until AMP8 or later
- Option 2: develop programme to meet statutory obligations governed by the DWI but otherwise maintain current level of service
- Option 3: targeted improvements to enhance our water quality standing in line with industry best practice and internal drivers

Raw Water Deterioration Management

A number of options have been considered to manage the identified deterioration in raw water quality at Cefn Dryscoed WTW. The most significant of these options is the installation of new treatment processes to effectively remove increased levels of solids and dissolved organic compounds as well as an additional stage of filtration to manage levels of manganese in the final water. Other options include a do nothing option, continued base maintenance of the works and its assets together with improved optimisation of treatment processes and finally the installation of a de-stratification process to ensure raw water quality is of a more consistent composition to reduce the impact on treatment processes and final water quality.

Chosen Option: We have decided to adopt the “do nothing” option in AMP7 and delay any intervention and investment until AMP8 or later. We have decided on this course of action based on the current situation that even though raw water quality is of a deteriorating trend, final water quality is currently of generally satisfactory quality and unlikely to fail for any parameter previously discussed prior to 2025. However, Cefn Dryscoed is a site that has been targeted for investment under the Improving Customer Acceptability of Water business case from a discolouration perspective where investment will target general improvements and optimisation of the works as well as including a potential catchment and in reservoir solution of a de-stratification scheme that will also offer transferrable benefits to reducing the impact of deteriorating raw water quality.

Raw Water Pesticide Management

There are several options to manage concentrations of pesticides in final water at Llechryd WTW. These options include continuation of a catchment management approach, working with land owners and the farming community to raise awareness, adjust farming practices and minimise run off into water courses. More expensive options include a new permanent carbon treatment process at Llechryd

Chosen Option: We have decided to adopt the “do nothing” option in AMP7 and postpone any intervention and investment until AMP8 or later. This course of action has been chosen based on the current evidence that pesticide levels are being managed satisfactorily currently at Llechryd WTW. Although there have been a number of elevated pesticide results in the raw water, mainly for MCPA and Glyphosate, the existing treatment process has been effective in removing sufficient concentrations of pesticides preventing a failure on the final water. Cost of intervention for installing a permanent carbon filtration process would be in excess of £10 million which would not currently be cost beneficial. It is believed that due to early successes in the operation of catchment management solutions along with ongoing collaboration with landowners, the farming industry, Welsh Government and environmental organisations there may be opportunity to reduce pesticide runoff in this region further in the future.

Disinfection by-product Research and Development

The number of options in terms of research and development into disinfection by-products are limited. Because of the nature of this programme, options will include advancement of laboratory analysis, collaboration with external organisations including other water companies, purchase or hire of trial innovative treatment processes and research and development into optimisation of existing processes both at treatment works and network level.

Chosen Option: We have decided to adopt an option that is a continuation and progression of research completed in AMP6. We believe that this is the correct position to take where the focus is going to remain on disinfection by-products throughout AMP7 with forecast changes to regulatory drivers.

Disinfection by-product Improvements at Alaw WTW

There are a number of options to reduce overall disinfection by-products at Alaw WTW, one of our worst performing areas for this measure. Following successful trials of an innovative ion-exchange treatment process on Anglesey during AMP6, there is an opportunity to implement a full scale treatment process which would significantly reduce the formation of disinfection by-products. This treatment process effectively reduces dissolved organic matter from raw water, preventing by-products from being formed following the addition of chlorine.

Alternative options include building upon work already being performed in AMP6 including optimisation of the existing processes as well as the trial of other innovative treatment processes and techniques.

Chosen Option: The option we are planning to take forward into AMP7 will be a continuation of research and optimisation of the process and network to minimise disinfection by-products as much as possible. We have satisfactorily managed water quality in this area for a number of years and believe with planned process optimisation we can continue to manage throughout AMP7 without the need for developing new treatment processes.

Capel Curig WTW

The closure and abandonment of Capel Curig is one of a number of options available including ongoing maintenance of the treatment works, upgrade of existing treatment processes and a complete rebuild with modern processes able to treat current raw water quality. However, the 40 year cost of the latter 3 options will be significantly more expensive than closure of the WTW and would not necessarily offer an improved level of service to customers. An upgrade or replacement option would need to consist of at least a coagulation, clarification filtration and disinfection stages to ensure the sufficient removal of organic material and reduction of disinfection by-products. The raw water resource would be retained as part of all four options where it currently and will continue to supply Mynydd Llandegai treatment works. The benefits the chosen programme will offer include an improvement to water quality particularly with respect to trihalomethanes for customers currently served from Capel Curig following a change of supply to Llyn Conwy (post abandonment).

Chosen Option: We are planning to close and abandon Capel Curig WTW as the chosen option in AMP7. By taking this decision it we believe it will ultimately improve service for our customers in this area and increase resilience without the need for extensive maintenance or installation of new treatment processes at the treatment works. The benefits the chosen programme will offer include an improvement to water quality particularly with respect to disinfection by-products for customers currently served from Capel Curig following a change of supply to Llyn Conwy WTW (post abandonment).

Sludge Performance

The range of options to manage sludge production at Felindre and Bryngwyn include a do nothing option which would only lead to a continuation of the existing issues and increase the future risk to water quality. Increase in sludge tanker movements

was also considered to assist in the disposal of such high volumes of sludge production. However there is an increasing pressure to reduce tanker movements at Felindre and Bryngwyn due to the narrow roads leading to each treatment works which is currently causing disruption to local residents. We have made a commitment to residents to reduce transport movements through the villages which effectively eliminates this option.

Chosen Option: Considering the problems we currently face at these two sites, we will progress with the installation of advanced de-watering treatment processes. This option will not only allow the treatment works to operate with restriction on output but also improve capability of the process of adapting to changes in raw water quality. The chosen option, through more efficient sludge reduction, will produce an improvement to water quality at Bryngwyn and Felindre treatment works with increased control over upstream treatment processes during periods of raw water quality deterioration.

Contact Tank Performance

The range of options as part of this programme included do nothing and continue to perform remote live cleaning of tanks, the installation of additional tanks and installation of bypasses to allow tanks to be taken offline. However, the do nothing option would eventually resulted in higher bacteriological risk to customers, where the installation of new tanks would have reduced this risk, but would be at significantly higher cost. The installation of bypasses effectively produces a similar benefit of installing an additional tank where supply to customers can be maintained while also being able to perform a full inspection and clean of the existing tank. The installation of a bypass at our highest priority tanks will be a much cheaper option than a new tank and produce all of the same benefits.

Chosen Option: We will implement bypasses at all but one of our highest priority sites, with an additional tank at the remaining site. Such measures will allow us to perform full inspection and cleaning as per industry best practice to ultimately reduce the risk of bacteriological growth.

Replacement of Lead Supply Pipes

Options to manage lead failures in distribution include a continuation of reducing and managing plumbosolvency of the water through phosphate dosing at water treatment works as well as continuing to provide sampling support to customers who may have an issue with lead. Although we do not currently have a statutory obligation to replace lead supply pipes, options include assistance to customers to replace lead supply pipes on a shared cost basis, replacement of lead supply pipes on a reactive only basis only and replacement of lead supply pipes for our most vulnerable customers whether on a reactive or proactive basis.

Chosen Option: We will continue with a programme of replacement of lead supply pipes for our most vulnerable customers in anticipation of future changes to legislative standards. This option will not only improve water ability for customers but also improve our measures of success.

SEMD

We have considered several options to enhance security of our assets to ensure the preservation of water quality compliance. Security enhancement options include innovative and best practice implementation of measures at all of our raw water reservoirs, intakes, water treatment works, service reservoirs and pumping stations to prevent unauthorised access along with live monitoring and warning systems. There are many options around this level of investment where one option is to take a phased approach over the next 2 to 3 investment periods, implementing advanced security protection on a prioritised basis.

Chosen Option: We will continue with a programme of installing security enhancements at our highest priority sites across our water service. We believe that this essential to protect not only our assets but also our customers in a time with so much uncertainty of safeguarding supply.

4 Preferred option

Preferred option

Our preferred option will be to undertake our prioritised interventions for each of the nine programmes of work outlined. These programmes of work will be continually reviewed and updated taking into account operational performance, which may lead to reprioritisation of the interventions within or beyond the AMP7 period. With the exception of research of disinfection by-products the current plan is to complete the programmes of work by March 2025 with disinfection by-products research continuing beyond this date into AMP8.

Programme of work	Total Budget	Botex Element	Enhancement Element
Raw Water Deterioration (Cefn Dryscoed)	£0 m	£0 m	£0 m
Raw Water Pesticide Management (Llechryd)	£0 m	£0 m	£0 m
Disinfection by-product Research & Development	£0.69 m	£0 m	£0.69 m
Disinfection by-product Improvements (Alaw WTW)	£0.77 m	£0 m	£0.77 m
Abandonment of Capel Curig WTW	£2.57 m	£0 m	£2.57 m
Felindre and Bryngwyn Sludge Improvements	£5.35 m	£2.14 m	£3.21 m
Contact Tank Bypasses	£11.19 m	£0 m	£11.19 m
Replacement of Lead Supply Pipes	£15.47 m	£0 m	£15.47 m
SEMD Enhancements	£10.87 m	£0 m	£10.87 m
Total Programme	**£46.91 m**	**£2.14 m**	**£44.77 m**

Table 8 - Summary of proposed investment programme to address water quality in AMP7

Disinfection by-product Research & Development

We propose to spend £0.69 m on a programme based on research and development into disinfection by-products that will eventually have a benefit for customers supplied by the worst performing zones. In a continuation of research carried out during AMP6, investment will be used for a combination of individual schemes including the following –

- Collaboration with academic institutions and environmental consultancies;
- Production of environmental based modelling of raw water organic material and algae;
- Contribution towards innovative treatment and network optimisation;
- Purchase of equipment and development of laboratory analytical techniques;
- Contribution towards laboratory accreditation for analysis of disinfection by-products;
- Contribution towards the cost of the trial of innovative technology and methods including alternative coagulants and filter media;
- Costs have been determined from delivered run-rate of AMP6 where we feel that this is the correct level of investment period to continue detailed research in this area to build on success already achieved during the current investment period.

Disinfection by-product improvements at Alaw WTW

Although the trial of innovative ion-exchange treatment process in AMP6 produced positive results, implementation of a full scale plant would be in the region of £10 million. It was decided that at the current time due to proactive management of by-products at the treatment works and within the distribution network, such a treatment process should be delayed until AMP8 or later.

Improvements planned for Alaw will include process optimisation and the trial of alternative coagulant dosing points and potentially alternative coagulants. In an attempt to reduce trihalomethane precursors, initial laboratory work including the use of jar tests would be performed to investigate which alternative coagulants would be viable for trialling on a full treatment scale. Investment would include the cleaning of existing chemical dosing tanks and the purchase of usable volumes of alternative coagulants. Additional monitoring at the treatment works would offer a better understanding of not only disinfection by-product formation but also reduction or removal rates of any precursors including measures of dissolved organic content and chlorine residence time.

Costs have been determined from the delivered run-rate of AMP6 and we feel that this is the correct level of investment to continue detailed research in this area to build on success already achieved during the current investment period.

Abandonment of Capel Curig WTW

The proposed closure and abandonment of Capel Curig water treatment works will include laying new trunk and distribution mains to supply customers. The alternative treated water to supply existing customers will come from Llyn Conwy water treatment works where a new main will connect to the existing network at Betws-y-Coed. An assessment of requirements costed using our cost database indicates that the scheme will comprise of the following activities;

- Laying of 6.5 km of 150 mm (id) pipe using open cut technique (to take into account probable limestone rock geology) from Betws-y-Coed to Capel Curig.
- A 5.5 Kw water pumping station (including buildings) to overcome an altitude difference of 190 metres between the two villages.

The total cost for the completion of these two activities is £2.15 million. However due to uncertainties regarding ability to lay the water main due to geology, accessibility to the proposed route, power availability and other planning and environmental restrictions, an additional risk value of £0.42m has been added to the scheme cost which has uplifted the total to £2.57 million

Costing of the abandonment of Capel Curig WTW has been obtained through an up to date costing exercise of a previous scope of works that was designed in 2009. Costs have been put together using our Solution Target Pricing Tool which makes use of our Unit Cost Database.

Detailed costing can be found in Appendix A.

Felindre & Bryngwyn Sludge Improvements

The proposed schemes at Felindre and Bryngwyn will include the installation of advanced thickening processes for dewatering of existing wastewater reducing the total volume of liquid sludge produced. We propose to spend £5.35 million with the installation of an advanced centrifugal process to dewater current liquid sludge production with an aim to reduce high operational costs as well as improve water quality. The solution proposed includes a centrifuge dewatering plant, polymer dosing plant, thickened sludge holding tank, waste water pumps, thickened sludge pumps as well as all associated civil and electrical components.

The costs established with new advanced dewatering process were established by our Capital Alliance Partners; Arcadis. They have drawn up costs using expert judgement and knowledge using our Solution Target Pricing Tool.

Detailed costing can be found in Appendix B.

Contact Tank Bypasses

A summary of the proposed named contact tank bypass schemes are illustrated in Table 9. The planned intervention at each of these sites is to install additional pipework, valves, instrumentation, chemical dosing modifications as well as improved access to any existing tanks.

Table 9 - Summary of proposed contact tank bypasses

WTW	Cost (£m)
Builth Wells	£0.13 m
Elan Valley	£0.07 m
Felindre	£1.87 m
Maerdy	£0.3 m
Pendine	£0.13 m
Strata Florida	£0.15 m
Mynydd Llandegai	£6.0 m
Carryover + Other Improvements	£2.54 m
Total	**£11.19 m**

In addition to the six named bypass schemes there is also a proposed scheme to install an additional tank at Mynydd Llandegai to increase storage and provide the facility to perform a full inspection and cleaning operation at a cost of £6 million. Although the existing contact tank at Mynydd Llandegai is made up of two compartments, division is by a 1.4 metre high wall which is often submerged during normal operating conditions when the tank operates at a level of 4 metres. Consequently, inspection and cleaning of the contact tank must be carried out while the treatment works is offline resulting in the distribution area being difficult to supply from an alternative source.

Costs for each of the bypasses were established through an initial detailed study of requirements by our in house "Solution Development Team" made up of representatives from each of our Capital Alliance Partners. Once a detailed scope had been designed, each project was then costed using our Solution Target Pricing Tool.

The proposed new tank at Mynydd Llandegai was costed following a bacteriological failure in 2016 and subsequent identified further inadequacies of the existing tank. A detailed scope and cost was designed by our Capital Alliance Partner, Arcadis who have costed the scheme using the Solution Target Pricing Tool.

Detailed costing can be found in Appendix C.

Replacement of Lead Supply Pipes

We will target the replacement of lead supply pipes, where there would be a benefit to public health, replace communication and service pipes at properties which fail the lead standard, replacement of lead supply pipes when identified by meter installation and provide grants to our customers support the replacement of lead pipes

We will also focus on our most vulnerable customers so that homes with joint supplies which are lead are replaced and the level of lead in the customer's water supply is reduced. The budget will enable us to replace lead service pipes during AMP7 and is a continuation of a pilot programme which we have started in AMP6

The programme of lead service pipe replacement will replace around 7000 domestic service pipes at £3,000 each. The total programme of work will be £21 million. £15.5 m is included in this investment case, the remainder is included in our leakage investment case, as this will be a side benefit of our Project Cartref, tackling supply side leakage.

SEMD Enhancements

We propose to spend £10.87 million on SEMD enhancements at 78 priority sites in AMP7. A summary of the number and types of sites we propose to invest is summarised in Table 10 -

Asset Type	Number of Sites	Cost (£m)
WTW	24	£6.06 m
Intakes	19	£1.42 m
Valve Houses	13	£0.98 m
WPS	22	£2.42 m
Total	**78**	**£10.88 m**

Table 10 - Summary of proposed SEMD investment

We will target the highest prioritised sites each in each of these categories including sites deemed as “Critical National Infrastructure” or “National Infrastructure”. Measures that will be addressed include installation of security rated fencing, upgrades to doors and access systems and costs have been derived based on the costs of delivering the AMP6 SEMD programme. The programme of work has been costed using an average cost of a scheme at an asset type obtained from outturn costs at AMP6 multiplied by the number of locations.

5 Cost efficiency and innovation

Cost efficiency

We are proposing to deliver £3.8 m of cost efficiencies as part of this investment programme, as shown in Table 11.

We will deliver these savings by challenging our Alliance partners to improve efficiency and by maximising opportunities to innovate.

Table 11 - Summary of proposed cost efficiency challenge

Programme of work	Total Budget
Total programme (pre-efficiency)	**£46.91 m**
Total programme (post-efficiency challenge)	**£43.11 m**

Summary of innovation in this project

The approach we are adopting to improve water quality compliance is an example of how we like to think holistically to maximise the value of our investments. We are following a source-to-tap approach that looks beyond short-term reactive measures, to pursue investments that will benefit our customers for generations to come.

The approach that we are proposing is consistent with the strategy that we introduced in AMP6. Our intention is to build on our AMP6 progress, and further improve the planning and delivery of our AMP7 interventions.

An important part of this is exploiting opportunities to innovate. One of the areas we will seek to gain efficiencies is through the batching and timing of our investment programmes. We will work closely with our Alliance partners to optimise our delivery – for example by completing contact tank bypasses earlier in the AMP will allow inclusion into the cleaning programme to reduce their relative risk to bacteriological compliance.

We currently have **55** innovation projects delivering improvements across safety of drinking water, acceptability of water and reliability of supply that are either completed or currently still in progress.

We will look to exploit the opportunities presented by these projects throughout our AMP7 delivery. Some of our most recent innovative projects include:

- Investigating the effect of phosphate dosing on water quality and in particular the growth of biofilms in different types of mains, using research information from Sheffield University;
- Implementation of flow cytometry analysis at our Glaslyn Laboratories to give us a greater understanding of the microbiological make-up of our water from source to tap and to support optimum chlorine residuals within our network, supported by spatial mapping of chlorine in our network;
- Understanding the mechanisms of Geosmin and MIB production in our raw water sources through work with Natural Environment Research Council (NERC) placement Dr Rupert Perkins from Cardiff University. We have started to ascertain the growth and stress factors associated with cyanobacteria which will in future enable us to better control nutrients in catchments to prevent or reduce the production of these compounds that affect the taste and odour of raw water;
- The Aquavalens project is a European Funded research project, whose aim is to develop new methods and technologies for monitoring the microbiological quality of drinking water and water used in food preparation. It is hoped that the knowledge gained from the work will allow water companies to assess the robustness of water treatment in terms of the microbiological quality of drinking water, and identify which catchments and activities pose the greatest risks. The project will work towards an increased understanding of the relationship between climate events and pathogen numbers in water supplies;
- Working in collaboration with our Hereford operational team to install an acoustic cleaner

on to a lime silo to maintain consistent lime dosing and reduce operational call outs;

- Predictive modelling to highlight areas at risk of water quality failures by our in-house data scientists;
- Trialling of Resmix Vital at Betws yn Rhos service reservoir to ensure that chlorine levels are consistent leaving the tank; and
- Participation in a research programme to reduce dissolved organic carbon-DOC2C alongside partners in Belgium, the Netherlands, France and the UK.
- Importantly, we will continue to share best practice across the industry from conference attendance and the Innovation Forum.

Partnering and co-creation

Working closing with our partners is essential to the way we plan to work in the future. Our 2050 strategy highlights this through identifying partners for each of our programmes of future work.

We aim to undertake this work in partnership with customers and communities, the Customer Challenge Group and crucially, the Drinking Water Inspectorate. We have well-defined reporting points for each DWI notice – including completion milestones and setting of performance targets.

6 Value for money and affordability

Impact on customer bills

We understand the importance of balancing the need for investment with the affordability of our bills. We believe the investment will help to deliver the level of service our customers and regulators expect, and represents an optimal approach for sustained long term improvement.

Value for money

We recognise the need to demonstrate value for money in everything that we do. In arriving at the proposed investment, we have closely considered the costs and benefits of different approaches to make sure that the investment represents long term value to our customers.

The programmes of work have been developed so that they are delivered in conjunction with other levels of investment. For example, the abandonment of Capel Curig WTW project has been developed in conjunction with the Water Treatment Maintenance programme to ensure the performance of the water treatment works due to replace Capel Curig is satisfactory.

As outlined in the previous section of this document, we will also seek to ensure value for money by promoting innovation throughout delivery, by learning lessons from the work we have delivered to date, and by working closely with our partners to encourage best practice and incentivise efficiency.

In addition to these investments, and funded separately, improving the customer acceptability of water, water treatment works & network maintenance as well as the Cwm Taf Water Supply Strategy project will provide further improvements to water quality across the company to improve compliance to future challenges in terms of raw water deterioration, climate change and changes in regulation.

7 Delivery

Procurement

We have undertaken an assessment of the applicability of direct procurement for these projects. The nature of these projects is such that we consider a direct procurement approach would not be in the best interests of customers.

The various projects will be managed by our Water Assets team throughout AMP7 with scope and programme adjustments being made to meet current operational and other issues. We will monitor performance month by month so that we can respond quickly to emerging signs if we are not getting the benefits we have projected.

Programme

A prioritised programme of work has been produced linked to the investments, costs and associated benefits of the assessment programme. Interventions to target improvements in Water Quality will be targeted for completion during the first 2 years of the investment period to ensure we see the benefits towards the end of the AMP where we have set targets for Compliance and Event Risk Indices.

These programmes of work will be continually updated following review of water quality and compliance data as well as annual reviews of Drinking Water Safety Plans. This programme will be optimised early in year five of AMP6 based on this up-to-date performance data. This may lead to reprioritisation of the interventions undertaken during the AMP7 period. Currently we plan to frontload the manganese treatment investment as it will also help us to reduce the amount of chlorine treatment at our treatment works.

Our plan will be to continue with each of the investment programmes beyond March 2025 with the latest study, cost, performance and benefits data used to prioritise the interventions for each periodic review starting with PR24.

We have currently only set out a five year AMP7 programme. Our plans and associated programmes for further AMPs will be based on our continuous review of water quality during AMP7.

Risk mitigation and customer protection

We will deliver our programme in a modular fashion so that the benefits of lower cost assets, for example valves, can be seen in terms of their effect on reducing the number of burst mains before going ahead with the replacement of a main. This approach will be used for the worst- served customers in particular.

The largest uncertainty regarding improvements to acceptability is the level of service benefits in terms of contacts that will be achieved. A methodology has been used to calculate the benefits including factoring in where our performance levels will be at the end of AMP6. However, each zone is different and there is an inherent risk that the benefits achieved may be greater than or less than the calculated value. There is also uncertainty related to the occurrence of bursts and the impact this might have on performance.

We have developed an Outcome Delivery Incentive (ODIs) for water quality, which will provide protection for our customers in the event that we do not deliver our planned outcomes.

8 Assurance

Governance

Our current water quality investment programme is supported by the Water Quality Steering Group. The team meets on a monthly basis and is chaired by the Head of Water Quality. This helps to ensure that the full focus of the business is directed at this investment.

Water quality performance is also targeted in monthly meetings chaired by the Managing Director of Water Services. These meetings are attended by key stakeholders including, operational teams, the Water Services Science team and Water Assets team.

On a daily basis our current performance is shared internally to ensure that emerging trends and problem areas are targeted quickly. There is also strong awareness of our commitment to improve our water quality performance following company-wide stand-downs to ensure that quality issues are front of mind for all colleagues across our business.

Our investments to improve water quality is also reported to our Quality and Environment Committee (QEC) on a six-monthly basis. QEC checks the improvement progress against our Strategic Objectives and is provided with the key risks and mitigation measures.

We will continue to apply these effective governance systems for our proposed AMP7 investment programme. The board will carry out a final review of this investment in detail prior to the submission of the business plan in September.

Cost assurance

We have undertaken a high-level feasibility study to enable the high-level scope of work and cost benefit of the options to be assessed.

Costs of the water quality improvements are based on a similar level to the costs from AMP6 with 10% improvement on the delivered costs through efficiencies. These efficiencies are outlined in the 'Cost efficiency and innovation' section.

A number of our costs were developed using our in house Solution Target Pricing model and Unit Cost Database. The model is updated annually and externally benchmarked every five years to make sure that costs remain current.

Customer consultation assurance

Our customers have indicated that investments to reduce interruptions to improve the appearance, taste and odour of our water is key and would be concerned if poor water acceptability were a recurrent problem.

Measures of Success

We are continuing with our measure of success (MOS) to monitor the benefits that our water quality interventions bring the 'Safety of Drinking Water' MOS. Our target for improvement to this MOS over AMP7 as a result of our proposed investment is shown in Table 12.

Measure of Success	End of AMP6 Position	End of Investment Position
Clean, safe water for all:		
Compliance Risk Index	-	0
Event Risk Index	-	Upper Quartile Position
Number of lead supply pipes replaced (cumulative over an AMP)	1,800	7,000
Create a better future for all our communities:		
Asset Resilience (Reservoirs)	92.2%	95.5%
Asset Resilience (water network+ AGA)	84%	86.5%
Asset Resilience (water network+ BGA)	47%	56%

Table 12 - Summary of improvements to MOS

Future assurance

We have strong governance procedures for the planning and delivery of our capital investment.

Our Board will continue to provide the high level overview and governance to ensure that we deliver these much-needed improvements in the interests of our customers.

Supporting Document (available on request)

Supporting Document A – Costing of Capel Curig abandonment

Supporting Document B – Costing of Felindre & Bryngwyn sludge improvements

Supporting Document C – Costing of contact tank by-passes

References

[i] DWI Compliance Risk Index: Definition December 2017

[ii] Twort's Water Supply, Brandt MJ et al 2017