

Ref 5.8I PR19: Acceptability of Water Service Improvement

September 2018





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Executive summary

Driver for investment

Acceptability of water is our biggest customer performance challenge within the current and forthcoming AMPs. This is an historic challenge in Wales and one that is now understood to be driven by both raw water characteristics and the prevalence of unlined iron trunk mains. In previous investment cycles we have targeted areas with iron sample failures, and whilst in many cases this effectively treated the downstream symptoms and led to a sustained improvement in our iron compliance, there remains a need to address the upstream root causes of discolouration, taste and odour.

We have developed an industry-leading, long-term strategy to do this. The "source to tap" approach we have now adopted, including our zonal study programme, will tackle these root causes from water catchments, through water treatment works, to trunk main and distribution systems. We have developed this approach alongside the DWI, accepting performance improvement notices for many of our zones.

We are already measuring the benefits from our investments made in this AMP period - we have reduced acceptability of water contacts from customers from 3.3 to 2.7 contacts per 1,000 population served. This has been achieved by targeting our investment cost-effectively to maximise our improvement, for example, making operational improvements. However, our historic performance for acceptability of water has been consistently near the bottom of the UK water industry and over AMP7 we will need to tackle some of the more challenging causes of our poor performance.

We want to build on the progress we have made to date in this AMP period but recognise the significant investment required to achieve the step change in performance.

The investment

We propose to invest £159.7 million during AMP7 to deliver acceptability of water improvements across the company. Building on the progress we have made during AMP6, our holistic approach will use zonal studies to inform our interventions. We will target improvements in manganese performance at water treatment works (WTW), and will include significant improvements to our water distribution system. The programme to be delivered in AMP7 is shown in Table 1 with the associated investment required.

Programme of work	Proposed programme total budget	Proposed cost adjustment claim
Zonal study reports and hydraulic modelling	£4.63 m	£2.32 m
Zonal study interventions	£131.83 m	£107.62 m
WTW manganese improvements	£20.14 m	£20.14 m
Worst served customers (Acceptability of Water)	£3.09 m	£3.09 m
Total programme (pre-efficiency)	£159.69 m	£133.17 m
Total programme (post-efficiency)	£144.12 m	£118.07 m

Table 1: Integrated intervention programme with enhancement for AMP7



We are currently developing 44 innovation projects focusing on improving acceptability of water. We will look to integrate these innovative practices to deliver these improvements to our customers at the lowest possible cost.

Need for cost adjustment

We have included this investment as a cost adjustment in our PR19 business plan submission because it is a significant programme to meet an area of poor performance:

- we need a significant improvement in our performance to prevent Drinking Water Inspectorate enforcements;
- we do not believe these costs will be accounted for in the econometric and unit cost models; and
- it includes a cost adjustment claim of £133.17 million



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: Reduce the need for reactive maintenance through a zonal approach that proactively targets the areas we know, or predict, will be a problem.



A better future for all our communities: Reduce water discolouration and provide all our customers with acceptable water, bringing our water quality back in the line with industry averages.

Delivering for the future

In Welsh Water 2050, we identified future trends. The requirement for this investment is driven by the following trends:



Climate change: More extreme temperatures will increase the likelihood of burst pipes in the future and may contribute to higher concentrations of naturally occurring compounds in our raw water that are associated with taste and odour problems.



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 and cast-iron water mains present significant issues with reliability and water discolouration.

Delivering our Strategic Responses

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



Achieving acceptable water quality for all customers: Improving AoW, including discolouration, taste and odour, through a targeted programme of source-to-tap interventions.



Addressing our worst served customers: Undertaking interventions to enable minimum service standards to be delivered to all customers.

Achieving our measures of success

For PR19, we will measure our performance based on measures of success (MoS). This investment will contribute to achieving the following MoS:

Measure of Success	End of AMP6 Position	End of Investment Position
Customer Acceptability (Drinking Water) - The number of contacts received from customers in the calendar year regarding the appearance, taste or odour of drinking water per 1,000 population served	2.4	2.0



1 Delivering our customer outcomes

Need for investment

This investment is required to achieve our plans to deliver acceptable water quality to all customers as outlined within our long-term strategy, Welsh Water 2050.

Our historic performance for Acceptability of Water (AoW) has been consistently worse than the industry average across England and Wales, as illustrated in Figure 1 below.

Figure 1: Welsh Water AoW performance



Most of our customer contacts relate to discolouration, with about 15% being taste and odour complaints. Our comparatively poor performance is attributed to the prevalence of unlined iron mains across our distribution network and the characteristics of our raw water. The nature of our region's geology means that our raw water is typically soft, and high in naturally occurring manganese. Levels of manganese in the water leaving treatment works, well within the regulatory requirements, can lead to discolouration events when flows rapidly increase following a burst main. We have been at the forefront of research in this area over recent years with our contributions to the PODDS research work ongoing at Sheffield University

The researchⁱ has shown that discolouration events are strongly linked to the removal of biofilms from the surface of pipes. These biofilms can acquire 'colour' from both manganese and particulates that result from the soft water corrosion of unlined cast iron mains. Figure 2 shows an example of one of our corroded iron mains.

Approximately 11,000km of our water mains are made of cast iron, which amounts to 40% of our entire mains network. These pipes also have reliability issues, and on average experience 30 bursts per 1,000km for cast iron pipes, compared to 6 bursts per 1,000km for plastic pipes.

Figure 2: Iron pipe corrosion ©Welsh Water



The decline of industry in some of our supply areas has led to parts of our network being oversized for today's demand requirement. This exacerbates problems with discolouration, taste and odour, as water travels at sub-optimal velocities through the network, inhibiting effective turnover and the selfcleansing of pipes.

Due to the coastal boundary of our region and the influx of tourism this attracts in summer months, our network can also experience large seasonal flow variations. Some of these variations are in excess of 200MI/d and increase the risk of discolouration introduced by the distribution network.

In 2016, we were the worst performing company across the industry for the appearance of our water. The majority (around 70%) of the contacts we received for appearance were linked to discolouration resulting from burst main events,



transient flow during periods of peak demand and network flow reversals.

The remaining 30% of our contacts were caused by third party use of our network – much of it illegal – and we are working hard to reduce this through the use of locking hydrant caps and an externally managed hydrant hire and enforcement scheme.

With respect to taste and odour our performance is in the lower quartile compared with the industry as a whole. Many of our customer complaints regarding taste and odour are linked to fluctuating levels of chlorine.

Through cleansing and replacing old cast iron mains, as part of our strategy, we will be able to control our levels of chlorine more consistently throughout our distribution system, leading to a reduction in complaints.

Our poor performance has been monitored by the Drinking Water Inspectorate (DWI). During AMP6 we worked with the DWI to improve this performance, resulting in the DWI issuing improvement notices for 32 of our 83 water quality zones. The notices are provided in Supporting document 5.81.3.

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

- Improving the acceptability of water performance - we have received high levels of customer complaints for acceptability compared with other water companies; 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^{ii,iii.} Customers have stressed that they want stable water quality and reliability of supply, including resilience.

We have consulted with our customers and stakeholders regarding their service expectations for acceptability of water. While many of our customers are generally happy with the current levels of appearance^{iv}, customers have also told us that discoloured water is hugely off-putting, and is considered unhygienic. Many customers said they would avoid drinking it, and would instead purchase bottled water^v. Our customers have also told us that water with poor taste or smell is key to address and that it would be concerning if it were a recurrent problem^{vi}.

We have spoken with our customers to better understand their willingness to pay (WTP) for improvements to the acceptability of water. Table 2 provides a summary of what our customers would be willing to pay per affected property, demonstrating that our customers consider acceptability of water to be an important area of investment.

Table 2: Summary of stakeholder feedback and proposed willingness to pay (WTP)

Customer feedback measure	WTP per property
Taste and smell not ideal	£1,567
Discoloured water	£1,162

We will continue to work closely with the DWI, and have provided a detailed report outlining our acceptability of water investment proposals for PR19^{vii}. We have used our discussions with the DWI to help shape and target our investment.

Benefit for our customers

Acceptable water

We aim to improve the appearance, taste and odour of our water.

Table 3 shows both our historic customer contact performance (as also illustrated in Figure 1) and our forecast performance for the remainder of AMP6 and through AMP7. The figures are based on our proposed level of acceptability of water investment and include the benefits of our proposed interventions.

Our forecast position by the end of AMP6 is 2.4 contacts per 1000 customers and following our proposed investment this will fall to 2 contacts per 1000 customers by the end of AMP7.

Table 3: Actual and forecast customer contacts per year

АМР	Year	Source	No of contacts / 1000 population
	2012-13	Actual	3.36
AMP5	2013-14	Actual	3.53
	2014-15	Actual	3.29
	2015-16	Actual	2.91
	2016-17	Actual	2.88
AMP6	2017-18	Actual	2.79
	2018-19	Forecast	2.55
	2019-20	Forecast	2.40
	2020-21	Forecast	2.32
	2021-22	Forecast	2.24
AMP7	2022-23	Forecast	2.15
	2023-24	Forecast	2.08
	2024-25	Forecast	2.00

Reliability of supply

Our AoW proposals are also expected to provide wider benefits to the reliability of our supply. For example, our proposed investment in mains renewals to address discolouration may also help to reduce the number of leaks and bursts on our network.

Affordability of bills

We understand the importance of balancing the need for this investment with the impact on the bills that our customer 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.



Wider benefits for Customers

The tools we have put in place and will continue to develop have a wider benefit to our customers. Having more of our network covered by all mains hydraulic models means that we can respond more quickly to questions on how the system works – this has brought benefits in two areas in particular. Firstly our Developer Services team are now able to respond much more quickly to requests from developers to connect to our network and we are frequently top of the industry in customer satisfaction for this. Secondly our operational teams can assess both planned and emergency work more effectively, risk assessing the impacts to the network in real time and minimising or eliminating impacts to customers.



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 our acceptability of water performance are set out below.

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 Methyl-Isoborneol (MIB). It will be increasingly important to ensure strong catchment management to control taste and odour issues.

Changes in customer expectations

Changing customer and societal expectations may require us to ensure that all customers have a minimum universal service standard. This will mean that the service we provide our worst served customers will need to improve.

Protecting essential infrastructure

Industrialisation and urbanisation in parts of our region led to the rapid construction of water supply infrastructure in the late 19th and early 20th century. A growing number of physical assets constructed during this period are expected to reach or exceed their design life within the next 30 years.

Our ageing iron water mains, some of which are unlined, pose a risk of iron deposits entering supply and causing turbidity and the discolouration of water.

High levels of manganese are naturally occurring in our soft upland water sources. This has been particularly challenging at some of our water treatment works where on average, raw water manganese has increased from 50 μ g/l in 2007 to over 80 μ g/l in 2016. It is important that our treatment works can adequately process these higher levels of manganese. They must also be able to reduce concentrations of manganese to increasingly low levels before entry into the distribution system.

Land use change

Deindustrialisation in some of our supply areas means that our network is now oversized in places. This can exacerbate problems with discolouration, taste and odour because water travels at suboptimal velocities through the network, inhibiting effective turnover and the self-cleansing of pipes.

Legal duties

Our target to improve acceptability of water performance is partly driven by notices from the DWI to make improvements in 32 specific water supply zones. These were issued between 2015 and 2017 and are included as supporting document 5.8I.3.

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.

Building on progress

Our proposals are not the start of our journey. We have made significant efforts in recent AMPs to improve the quality of our water. Between AMP2 and AMP5 much of our investment targeted iron compliance. Since 1995 we have dramatically improved our performance relating to iron sample non-compliance, as illustrated below in Figure 3. This has resulted in a reduction from circa 124 to <15 sample failures per year over 20 years.



Figure 3: Iron Non-Compliance



AMP6 Progress

More recently, our focus has centred on acceptability of water and its upstream root causes, including the increasing discolouration risk we face due to high levels of manganese in our raw water.

In 2014-15, we proactively developed a long term acceptability of water strategy to guide our improvements in this area. Our strategy adopts a two-pronged approach to maximise the improvements that can be made.

The first aspect relates to improvements in operational practices. We have implemented a range of changes to how we manage the risk of discolouration in our network, including:

• Improved modelling and risk assessment before works are undertaken;

- Extensive valve training for internal and thirdparty operators;
- City & Guild training for Technicians to better understand hydraulic data and root cause analysis;
- Application of trickle caps;
- Application of in line filters;
- Low-velocity flushing; and
- A new third-party partnership for standpipe management.

The second aspect of our long term strategy to improve acceptability of water is the implementation of zonal studies. The studies include holistic analysis of key performance parameters for a given zone.

The level of performance for acceptability of water has been assessed across all of our 83 water

distribution zones. Of these, the worst performing 38 zones were chosen for further assessment during AMP6.

In order to prioritise these zones for intervention, we used defined criteria, primarily based on appearance, taste, and odour customer complaints received over the preceding five-year period. Our criteria also considered notices and undertakings issued by the DWI and our open dialogue with them.

Of the 38 distribution zones where studies have been undertaken, the worst performing 16 had the solution outputs promised and selected for completion during AMP6.

The studies combine hydraulic modelling, statistical analysis, and capture the experience of local operations to identify the root cause of performance issues. The outputs from the studies are evidential, auditable and quantitative. This allows for targeted investment within the zone to most appropriately improve long and short term performance for the benefit of our customers.

The zonal studies are a tool that help to streamline our capital gateway process and provide a joinedup, strategic approach to investment.

To date, four zones have been completed -Holywell/ Mold, Malpas/ Caerleon, Whitbourne, and Llechryd. The zones are currently in their stabilisation period, however early indications of performance improvements are encouraging. Figure 4 overleaf provides a summary of the results for Whitbourne and the downward trend in complaints.

A fifth zone, Flint Connah's Quay is nearing completion but is also already demonstrating improvements in performance. Works have also now progressed into Bolton Hill (Pembrokeshire), Anglesey North, Abergele Rhyl, Maerdy and Hereford North.

Table 4 provides a summary of the network improvements we have made to date. It shows that we have cleansed more than 182km of our mains and replaced a further 143km of mains.



Table 4: Summary of outputs

Intervention	2016-17	2017-18 to date	Cumulative Total
Total length cleansed (km)	341.76	556.89	898.65
Total length renewed (km)	111.97	97.12	209.09

In addition to network-based improvements, during AMP6 we have introduced a Manganese Management Strategy.

The strategy aims to improve AoW by reducing levels of manganese being supplied into the distribution system from water treatment works. We are on a 'Journey to 2' – reducing the total manganese in the final water at our water treatment works to a value of $2\mu g/I$. Whilst there is evidence to suggest that discolouration contacts could be reduced still further with concentrations below $2 \mu g/I$, we have set the target at this level due to the increased degree of difficulty in reducing manganese further than this.

To achieve this, we are targeting investment towards treatment, catchment and in-reservoir management. Work undertaken since 2015 includes enhancement of the manganese sampling regime to enable us to better understand treatment effectiveness, optimising existing processes to maximise removal capability of our existing assets, and more effective tracking of performance to enable future investments to be better targeted. To date good progress has been made to reduce average manganese output from WTWs but we know that we need to do more.

Ofwat set us a target of 1.23 contacts per 1000 by 2019-2020 but despite investing £130 million in AMP6, we will not meet the Ofwat target. Our forecast is that we will improve service to 2.40 contacts per 1000.

Initially, the total available budget for zonal study interventions in AMP6 was £70 million. This fund was agglomerated from a number of related



investment cases to attempt to drive an improvement in performance. It quickly became apparent that this amount was not enough to deliver the improvements expected and further money would be needed. Support was gained from the Board resulting in an additional £60 million being released through our Customer Distribution plan. Support for this was also gained from customers through our consultation process.



In AMP6, £95.2 million has been approved to target discolouration in nine distribution zones, with a further £34.8 million to be spent across the remaining seven distribution zones.

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.



Figure 4: Customer acceptability in the Whitbourne zone

3 Options

Background

Our historic performance for acceptability of water has been consistently worse than the industry average across England and Wales. We are committed to improving our performance in this area, and have made significant efforts in AMP6 to develop an innovative approach that will allow us to do so.

To achieve this our Zonal Study approach has been developed over the last three years to ensure we get the best value from our investments to improve AoW performance.

What is a Zonal Study?

A Zonal Study is a holistic, Source to Tap investigation into the factors influencing performance at a Water Quality Zone level. Through the utilisation of all mains hydraulic modelling, statistical analysis and by capturing the experience and knowledge of local operations the Zonal Study is able to identify the root cause of poor performance within the Water Quality Zone in an integrated approach. All the outputs from the Zonal Studies are evidential, auditable and quantitative. It therefore allows for targeted investment within the zone to the most appropriate long and short term solutions for the benefit of our customers and the business. Zonal Studies are a collaborative and integrated "business as usual" tool that acts as a streamlining tool through the capital gateway process and gives a joined up strategic approach to investment.

The methodology follows the four-step asset management process:

- Plan target areas of poor performance;
- Do full data and hydraulic model performance review to identify root cause;
- Check operational review of options, select most cost beneficial; and
- Act/Review- deliver schemes and measure benefit



This process is cyclical and is part of our businessas-usual delivery. The process document is included as supporting document 5.81.1.

Plan

Performance for the company is measured at Water Quality Zone level, a water quality zone is an area that receives similar water, on which we report to the DWI. We currently have 82 such zones. Data for each zone is gathered for a three year period and the zones are ranked according to their relative performance. Early in the planning period it was noted that 75% of our complaints were generated in 20 of zones. These worst performing zones were selected for a full Zonal Study.

Do

A full hydraulic model is built and calibrated for each zone. This model is then interrogated against performance data to highlight problem areas. Software tools are then used to identify the root cause of problems, for example areas of high or low pressure and high or low velocity. The tools can also trace customer complaints back upstream to a common point of failure. This method has identified problems with trunk mains that have not been addressed in past investment programmes. This phase also takes into account performance at Water Treatment Works and other assets including Service Reservoirs and Pumping Stations.

Check

In this phase root cause solutions are reviewed with the front line operational teams to ensure they match with known issues in the area and are targeting the right interventions. This is also a final check that there is not an operational solution available that would defer investment. Following this workshop the cost benefit of each scheme is evaluated and the most beneficial schemes selected to go forward for investment. The methodology used for cost benefit is also attached for review. In short the Cost Benefit review utilises either the Service Measures Framework Cost of Consequence table or a surrogate Social Benefits measure based on customer research Willingness to Pay figures. Worked examples are shown in the

attached Methodology. The monetised output of these reviews is compared against scheme cost and those selected as beneficial are moved forward to the next phase. At this point a performance target for the improvements is agreed with the DWI.

Act/Review

The delivery of schemes is managed through the Capital Delivery Gateway Process. Following delivery, the benefit of the schemes are monitored against the target for 12 months after a 6 month stabilisation period. At this point the legal notice with the DWI will be signed off if performance is acceptable. A Care Plan will then be put into pace to maintain performance into the future.

AMP6 zonal studies

As outlined earlier in this document, the level of performance for acceptability of water has been assessed across all of our 83 water distribution zones. Of these, the worst performing 38 zones were chosen for further assessment during AMP6.

Of the 38 distribution zones where studies have been undertaken, the worst performing 16 had the solution outputs selected for completion during AMP6

AMP7 zonal studies

From the remaining 22 zones, the worst performing 17 zones were prioritised for the recommended interventions to be undertaken during AMP7.

Customer Engagement

During our investment in AMP6 we have been careful to ensure that our customers are fully aware of planned work that may impact them. To that end we have put in place a customer communications strategy with levels of engagement dependent on the type of work that was ongoing. This has proved successful with many positive comments and few complaints about the work.

To inform customers of the benefit of planned work while mitigating risk of contacts linked to discoloured water / interruption of supply a range of communication techniques are used:

Direct mail;



- Face to face;
- Social media;
- Website / animation;
- Local advertising, e.g. bus adverts;
- Site branding;
- Media relations; and
- Local school engagement.

Around 200,000 customers have been reached, with a low negative customer contact rate linked to the work undertaken. We have also received positive media coverage despite the planned work having the potential to cause significant disruption in some communities.

For example – our Customer Contact Van, and media and social media examples are shown in Figures 5, 6 and 7 below.



Figure 5: Customer contact van





£5m work on water main in Llechryd and Cilgerran



Work has begun to replace a water main in Pembrokeshire after thousands of people were left without supplies last year.

Figure 6: Raising awareness in the media



We'll be cleansing the water pipes in Cemaes Bay, Anglesey tonight. Want to know more? Becky is in Maes Capel today until 4pm. Pop by!



Figure 7: Raising awareness though social media

Worst served customers

We have analysed the geographical locations of our worst served customers. This has helped to ensure that we also capture worst-served customers who are not located in our zonal studies. In many instances there is a single worst-served customer whose property is fed at the end of a long distribution main with poor turnover.

Analysis of future needs

Our zonal studies have been supported by hydraulic modelling, data analysis and operational intelligence from a range of teams across our business. We have also made use of deterioration models to predict the pipeline failures and to understand the network maintenance programme that might be needed in the future, for example pipeline replacement or cleansing.

This combination of deterioration modelling and detailed desktop network assessment has enabled us to build up a prediction of maintenance needs over the next five to ten years. And we are now beginning the investigations that will lead to investment identification for AMP8.

Option Review

Options have been developed around the key areas for investment including water treatment, distribution and customers.

High-level options appraisal

Four high-level options were considered in the development of this investment case:

- Option 1: Do nothing;
- Option 2: Deliver improvements through separate programmes;
- Option 3: Maintain the current level of service and meet legal obligations; and
- Option 4: Integrated intervention programme with enhancement

Further detail on these options is provided below:

Option 1 - Do nothing: do nothing in AMP7 and defer any interventions until AMP8 or later.



Option 2 - Deliver improvements through separate programmes: undertake separate programmes of work to deliver improvements for AoW through multiple business cases including Catchments, Network Maintenance, Leakage and Water Quality.

Option 3 - Maintain the current level of service and meet legal obligations: develop an integrated programme of interventions to meet statutory obligations governed by DWI and maintain the current level of service in other areas. This option would include targeting the most cost beneficial distribution zones with approximately 30% of the total proposed budget as well as only 50% of the proposed additional zonal studies for intervention in later investment periods. There would be no investment at WTW to manage manganese and no investment to resolve persistent issues for our worst served customers.

Option 4 - Integrated intervention programme with enhancement: develop an integrated programme of interventions with:

- an extension to zonal studies, asset condition assessments;
- implementation of an enhanced zonal study interventions programme;
- deliver enhanced resilience with improvements to manganese concentrations at WTW;
- addressing our worst served customers;
- delivered alongside the base maintenance required to maintain the current level of service.

We recognise that there are overlaps between the different intervention options and their impact on performance drivers. We have therefore developed this as an integrated investment case that considers all problems together to generate an optimal programme of work.

Assessment

Our performance for AoW is already well below our target, the industry average and the DWI have issued notices for improvements to water quality. Our worst performing water distribution zones are at risk of continual deterioration without further investment in AMP7. This means that "option 1 – Do nothing" is not tenable.

Option 4 is the preferred option to take forward for more detailed definition. This is because it was the most effective way to deliver multiple benefits and improve our service standards for our customers during AMP7.

Considering integrated interventions can provide multifaceted benefits for example, a scheme to replace a poor condition iron main is likely to improve the risk of burst failures and reduce the risk of problems with discolouration. This option is considered to achieve more effective and efficient results than options 2 or 3.

The main benefit of our chosen solution is that it achieves an improvement for each of the investment areas at the lowest total expenditure (totex) option to meet our water quality needs. It will also improve the customer experience for our worst served customers.

The next stage of work is to develop fully prioritised programmes of interventions so that the cost, scope of work and benefits are fully understood.

The four programmes, described in the next section, that form part of our preferred option are:

- Zonal study reports and hydraulic modelling;
- Zonal study interventions;
- WTW manganese improvement; and
- Worst served customers.



4 Preferred option

Preferred option

Four programmes of work have been defined against option 4, 'Integrated intervention programme with enhancement'. The overall programme, base total expenditure (botex) and cost adjustment claim element can be seen in Table 5.

Table 5: Summary of proposed budget for customer AoW programme

Programme of work	Proposed programm e total budget	Botex Budget	Cost adjustment claim
Zonal study reports and hydraulic modelling	£4.64 m	£2.32 m	£2.32 m
Zonal study intervention s	£131.83 m	£24.2 m	£107.62 m
WTW manganese improvemen ts	£20.14 m	£0 m	£20.14 m
Worst served customers (AoW)	£3.09 m	£0 m	£3.09 m
Total programme	£159.7 m	£26.5 m	£133.2 m

zonal study interventions. It comprises hydraulic modelling, deterioration modelling, desktop assessments of zonal information, and customer complaints for each zone. It allows the current and predicted performance of our network to be assessed.

Zonal study interventions

Evaluation of the benefits delivered by network improvements undertaken during AMP5 and AMP6 has shown that mains replacement and mains cleansing are the most effective forms of intervention. These two interventions provide the most effective improvements for the long term and will provide sustainable solutions for the next 40 years.

From our zonal studies we have prioritised 17 zones for interventions during AMP7. They have been prioritised because of the need to deliver acceptability of water improvements to achieve the requirements of the DWI notices in these distribution zones.

The proposed high-level interventions associated with the zonal studies programme and other investments to improve customer acceptability can be seen in Table 6 below.

Zonal study reports and hydraulic modelling

This investment includes the work required to make sure that we identify the most appropriate

 Table 6: Breakdown of budget for zonal study

 interventions and strategy programme

Zonal studies intervention programme	Budget
Mains abandonment	£0.62 m
Mains cleaning	£24.21 m
Mains renewal	£95.28 m
Management fees (vehicles, communications and salaries	£6.37 m
Zonal study outputs subtotal	£126.48 m
Hydrant capping (urban 10,000)	£0.14 m
Dead end cleansing (top ten zones care plans @ £300k)	£3.18 m
Mains conditioning (~ five locations)	£1.71 m
Customer information on domestic plumbing and taste and odour issues	£0.32 m
Strategy subtotal	£5.35 m
Zonal study interventions total	£131.83 m

Cost Benefit Assessment

The high level interventions above are built bottom up from individual schemes in each Zonal Study, and are selected through our Cost Benefit methodology.

The studies identify all possible schemes within a zone but not all will be beneficial, also we want to ensure that with a limited budget only the most beneficial schemes across the company are delivered. To achieve this our cost benefit methodology converts the benefit derived from each scheme into a financial value, this value can then be compared against the cost of delivery. A benchmark level of £1 benefit from £1 spent was used to select schemes for a zone. With the same methodology applied across all zones, we can be sure that the money is spent in the right areas. This methodology attached as supporting document 5.81.2.



Mains abandonment

Mains abandonment will target the identification and eventual removal of redundant sections of water main. Whilst these sections may not directly feed customers, they can be the source of sediment build up which is disturbed when flow velocities change in the network.

The removal of these sections will prevent sediment build up, reduce the risk of discolouration and improve service for customers. The abandonment of dead-end sections of main will also help to ensure that all our customers receive consistent water quality, reducing the risk of increased chlorine degradation and potential lower bacteriological compliance.

Mains cleaning

The mains cleansing programme has been developed to target our strategic mains in the highest priority areas with minimal impact to customers.

Investment for cleansing will focus on the use of ice pigging techniques as well as exploring more innovative and new methods such as air scouring to reduce the disruption of cleansing.

Mains renewal

The mains renewals programme has the highest proportion of planned investment. It will focus on the replacement of ageing cast iron mains which have corroded due to the aggressive nature of the water and environment they were originally laid in. They will be replaced with plastic water mains that allow for a more consistent and high quality of water to be supplied to customers. Plastic water mains are at a much less susceptible to bursts caused by changing environmental and operating conditions.

Management fees

These fees cover investment related to the management and logistics of implementing both the zonal interventions and zonal studies during AMP7, including the costs for our customer communication plans.



Hydrant caps

The approach for hydrant caps has been to target urban locations where there is evidence of illegal use. Inappropriate use of our hydrants has been the root cause of many discolouration incidents. The purchase of 37,500 caps will allow approximately 30% of our hydrants to be protected. We have tailored the scope of this programme to account for the ability of our operational teams to install the caps.

Care plans: dead-end cleansing

The source to tap approach aims to minimise the build-up of iron, manganese and other solids across the network.

Care plans have been developed from the zonal studies. These detail suitable aftercare methods to enable ongoing operational maintenance of the network to be undertaken in addition to the prioritised capital schemes.

The care plans' scope of work will be the installation of new assets including:

- Additional isolation valves;
- Air valves and hydrants to enable the ends of the network to be flushed and turned over reducing the level of discolouration; and
- Extensive valve training for internal and thirdparty operators.

This will help to improve AoW and reduce the risk of burst mains.

Mains conditioning

Mains conditioning will focus on the implementation of automated and proactive flow and velocity changes within trunk mains. This will allow the operation of trunk mains at maximum flow, bi-directionally and enable the flushing of sediment in a controlled way. It will reduce the risk of increased turbidity and discolouration.

The investment will be used to actuate existing valves, as well as improvements to turbidity and flow monitoring to keep trunk mains in a conditioned state.

Customer information on domestic plumbing and taste and odour issues

We will supply information notifying customers of the most common domestic plumbing issues and options of how to proactively resolve them prior to contacting us.

We receive a number of customer contacts each year for plumbing issues including black slime from taps, blue/green water from the corrosion of internal copper pipe. We also receive contacts relating to taste issues stemming from water draining from washing machines back into the customer's potable supply. The majority of these issues are readily resolved by customers themselves for little or no cost.

Our investment in customer information will also target customers to inform them of unplanned events and planned maintenance or emergency works that may have an impact on their supply. By gaining support from customers for our network improvements it reduces the chance of them contacting us when there is a problem.

Table 7 provides a summary of the 17 zones that we will target in AMP7 and the expected impact our interventions will have on the number of customer contacts we will receive.



Table 7: Summary of proposed Zonal Study interventions and associated benefit

Water quality zone	Customers supplied in zone	Proposed budget (£m)	Customer acceptability benefit (contacts/1000 customers)	Proposed reduction in customer contacts
G28 - Bryngwyn	61,526	2.99	0.053	162
B04 - Bangor Caernarfon	65,197	8.70	0.012	36
B14 - Lleyn Peninsula	27,297	4.57	0.003	8
D10 – Bontgoch	19,689	1.55	0.005	15
D12 - Aberystwyth	14,453	4.58	0.021	64
G19 - Port Talbot	39,770	15.99	0.027	84
G25 - Bridgend Porthcawl	86,095	3.85	0.020	62
G27 - Bridgend Pencoed	71,573	13.77	0.022	67
G15 - Sketty / Gower	72,484	3.91	0.007	21
N10 - Merthyr Abercynon	80,417	27.04	0.0341	105
N51 - Cardiff Ely Radyr	89,348	6.21	0.0079	24
N48 - Cardiff Heath and Llanishen	93,824	2.66	0.0137	42
N15 - Cardiff East	53,290	4.17	0.0060	18
L51 - Newport Risca	52,680	2.11	0.0033	10
L45 - Rassau Sirhowy	41,632	7.69	0.0378	116
H12 - Hereford South	41,250	0.57	0.0009	3
H24 - Llyswen	10,018	8.61	0.0287	88
Totals	920,543	118.97	0.3024	925

WTW manganese improvements

The improvements at water treatment works will provide a long-term solution that will enable us to achieve and continue to achieve our long-term target of $2\mu g/I$ manganese at our WTW. This will reduce customer contacts which are attributed to elevated manganese concentrations. The proposed named WTW manganese schemes at six sites can be seen in Table 8. High level feasibility assessment reports for these sites can be found as separate appendices in this document.

Costs have been generated using our Unit Cost Database (UCD) model. The model uses our own historic capital cost data to provide a bottom-up cost estimates based on different assets and their characteristics, such as type, size, and length. A

strength of this approach is that the costs draw on the actual costs we have encountered across a range of capital projects.

wtw	Zonal discolouration	~Customers served	Average final manganese –	Benefit (contacts/1000	Proposed investment
Cefn Llan	39	10,300	3.7	0.001 7	5.11
Alwen	343	125,00 0	4	0.014 8	0.97
Alaw	366	40,000	4.1	0.020 2	4.09
Penycefn	43	5,000	2.9	0.001 9	0.39
Cefn Dryscoed	327	39,000	5.8	0.018 0	2.04
Pendine 8		10,600	4.2	0.000 3	3.89
General im	3.65				
Total net benefit and proposed 0.06 investment					20.14

Table 8: Summary of proposed investment and benefit to improve manganese at 6 primary chosen sites

The installation of additional treatment equipment and processes at Alaw, Alwen, Cefn Dryscoed, Cefn Llan, Pendine and Penycefn for manganese removal will enable us to treat deteriorating raw water to a higher standard. The installation of reservoir management at Alwen to improve raw water quality will enable us to provide our customers with an improved level of service.

In addition to the £16.5 million programme of work at these sites, there will be a £3.6 million programme of work at a further nine of our WTW.



The planned interventions include additional assets to enable more effective pH control through lime dosing, monitoring and control equipment to optimise chemical dosing, and through works performance. This will reduce manganese levels in the final water.

The projected benefit of our interventions at the nine WTW is summarised in Table 9. The total benefit of improving manganese concentrations across our WTW will be an improvement in our AoW score of 0.11 contacts per 1000 customers served.

WTW	Zonal discolouration contacts – 2016	~Customers served	Average final manganese – 2016 (ug/l)	Potential benefit (contacts/1000 customers)
Felindre	1372	480,000	1.29	0.0216
Pontsticill	562	210,000	1.09	0.0088
Sluvad	428	344,000	1.69	0.0067
Nantybwch	306	50,000	1.11	0.0048
Cefni	168	32,000	1.38	0.0026
Broomy Hill	137	114,000	1.25	0.0022
Whitbourne	137	18,000	1.18	0.0022
Llwynon	112	176,000	1.08	0.0018
Capel Dewi	61	24,000	1.09	0.0010
Total benefit	0.05			

Table 9: Summary of nine further sites and thebenefits of reduction of manganese

Worst served customers

The worst served customer programme has been designed to offer improvements to customers who have repeat problems, those who have complained at least six times over the last three years.

We have undertaken cluster analysis to identify customers with the same postcode and who have complained about the same issues. Often the

resolution of worst-served customer issues is not cost beneficial, however we understand the significant detrimental impact repeat problems can have on our customers. We have therefore identified the top ten worst-served clusters for



acceptability of water and developed a programme of work to resolve these issues.



5 Cost efficiency and innovation

Cost efficiency

We are proposing to deliver £15.57 m of cost efficiencies as part of this investment programme, as shown in Table 10 below.

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

Table 10: Proposed cost efficiency

Programme of work	Proposed programme total budget
Zonal study reports and hydraulic modelling	£4.63 m
Zonal study interventions	£131.83 m
WTW manganese improvements	£20.14 m
Worst served customers (AoW)	£3.09 m
Total programme (pre-efficiency)	£159.69 m
Total programme (post-efficiency)	£144.12 m

Summary of innovation in this project

The zonal approach we are adopting to improve the acceptability of our water 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 scheduling our WTW manganese removal schemes in advance of local network improvements to reduce the risk of downstream issues. We currently have 52 innovation projects delivering improvements to the acceptability of water that are either completed or started.

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

- Implementing learning from Sheffield University and 'PODDS' to install turbidity monitoring on the Taff Trunk mains, Talybont Trunk Mains and Crai Trunk Mains to enable safe and reliable operation of the system without causing discolouration;
- Investigating the effect of phosphate dosing on water quality and in particular the growth of biofilms in different types of mains, (including iron and metal) and the associated discolouration risks, again using research information from Sheffield University;
- Implementation of flow cytometry analysis at our Glaslyn Laboratories to inform us of the optimal chlorine residual that is needed within our networks, 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;
- Predictive modelling to highlight areas at risk of discolouration 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.

There are also a range of other innovative approaches that we will consider during AMP7, including:

- The use of parametric (strap-on) meters to avoid the operational issues associated with shutting down mains.
- Develop more cost-effective methods of pipe replacement including new reinstatement technologies (including 'no dig' techniques), new more efficient materials, ecological assessments, and jointing methods;
- Research new pipe cleaning techniques (including self-cleaning); and
- We will work with our supply chain to achieve cost effective and less disruptive pipe replacement.

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 confirmation of zonal study completion and setting of performance targets. We have also presented our zonal approach to the DWI on numerous occasions and have been invited to share the best practice elements of our work with DWI Inspectors nationally.



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 programmes of work. For instance, the WTW manganese programme has been developed in conjunction with the maintenance programme to enable dosing and other upstream processes to be optimised prior to the commissioning of the new manganese removal assets.

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, the Cwm Taf Water Supply Strategy will provide further improvements to the taste and odour of water for our customers, removing up to 200 acceptability of water contacts per year.



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, 16 of which will be completed in AMP6 and a further 17 are planned for completion in AMP7. We have created a programme of priority zones, which are currently performing poorly.

These programmes of work will be continually updated following additional zonal studies, performance and customer data. 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 only the five year AMP7 programme as programmes for further AMPs will be based on our continuous review 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 AoW, which will provide protection for our customers in the event that we do not deliver our planned outcomes.



8 Assurance

Governance

Our current AoW investment programme is supported by a Zonal Studies Steering Group. The group meets on a monthly basis and is chaired by the Managing Director of Water Services. This helps to ensure that the full focus of the business is directed at this investment.

Acceptability of water performance is also targeted in the monthly Water Quality meetings chaired by the Head of Distribution. These meetings are attended by key stakeholders including 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 AoW performance following two companywide stand-downs to ensure that AoW issues are front of mind for all colleagues across our business.

Our investments to improve the acceptability of water 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 zonal studies and network improvements are based on the costs from AMP6 with a 6% improvement on the delivered costs through efficiencies. These efficiencies are outlined in the 'Cost efficiency and innovation' section.

The costs of the manganese improvements were created using our UCD model. 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 viii,ix.

Measures of Success

We are continuing with our measure of success (MOS) to monitor the benefits that our AoW interventions bring – the 'Customer Acceptability' MOS. Our target for improvement to this MOS over AMP7 as a result of our proposed investment is shown in Table 11.

Table 11: AoW MOS improvement predicted.

Measure of Success	End of AMP6 Position	End of Investmen t Position
Customer Acceptability (Drinking Water) - The number of contacts received from customers in the calendar year regarding the appearance, taste or odour of drinking water per 1,000 population served	2.4	2.0

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 Documents

- 5.8I.1 Zonal Studies process
- 5.8I.2 Zonal Studies cost benefit process
- 5.8I.3 DWI notices
- 5.8I.4 Acceptability of drinking water cost-adjustment summary form

References

ii WW2050 Qualitative Debrief, 2017- engaging with 108 customers

iii Summer Consultation, Welsh Water 2050,2017

^{iv} Performance targets qualitative, Welsh Water consultation, June 2017

 $^{\rm v}$ WTP Qualitative research, Welsh Water consultation, August 2016

^{vi} WTP Qualitative research, Welsh Water consultation, August 2016

vii DWI Annex A submission. Welsh Water, 2018

viii WTP Qualitative research, Welsh Water consultation, August 2016

^{ix} WTP Qualitative research, Welsh Water consultation, August 2016

¹ Multivariate data mining for estimating the rate of discolouration material accumulation in drinking water systems, Mounce et al, 2014