Dŵr Cymru
Welsh Water

Ref 2.1

PR19 Water Resources Business Plan

September 2018

Contents

List of abbreviations

CCW	Consumer Council for Water
CNI	Critical national infrastructure
CUS	Conjunctive Use System
DP	Drought Plan
DWI	Drinking Water Inspectorate
EU	European Union
GAC	Granular activated carbon
INNS	Invasive non-native species
LoS	Level of Service
MIB	2-Methylisoborneol
MoS	Measure of Success
MCPA	2-Methyl-4-Chlorophenoxyacetic Acid
NERC	Natural Environment Research Council
NRW	Natural Resources Wales
RARs	Risk Assessment for Reservoir Safety
SCADA	Supervisory control and data acquisition
SEMD	Security and Emergency Measures Directive
SEWCUS	South East Wales Conjunctive Use System
SGZ	Safeguard Zone
SMNR	Sustainable Management of Natural Resources
THM	Total Trihalomethanes
WFD	Water Framework Directive
WRMP	Water Resource Management Plan
WPS	Water Pumping Station
WRZ	Water Resource Zone
WTW	Water treatment works
WWF	Wales Water Forum

Executive summary

Introduction and purpose

This document supports our PR19 water resources price control submission for the next asset management period, 2020-2025 (AMP7). It details our plans to deliver our customer promises in AMP7 and the contribution of our AMP7 plan to meeting our Welsh Water 2050 aims.

The scope of this document is all the activity that sits within the water resources price control. That is, our activity in the catchments that supply water to our treatment works, the management of water resources in general, and the physical assets required to manage the quantity and quality of raw water supplies such as intakes, source water pumping stations, boreholes and dams. It does not include assets that are under the 'Network Plus' price control including water treatment works (WTWs), raw water transport mains and pumping stations, potable pumping stations and water supply networks. Water Resources is covered separately to reflect Ofwat's requirements for price control separation. However, our business is highly integrated, and therefore many of the programmes discussed in this document also provide benefits across other areas of the business.

Customer views

Our vision is "*to earn the trust of our customers, everyday*". As a customer-driven business, our customers' views, preferences and priorities are the foundation of our business plans.

The delivery of clean, safe and reliable drinking water is taken as a given by customers, and we need to continue to do this to maintain their trust. The majority of our customers rarely or never experience supply interruptions. However, the rapid resolution of problems when they do occur is seen as a top priority. Responding to droughts is also one of their 'top of mind' threats.

Acceptability of drinking water (including colour, taste and odour) is currently a high cause of customer contacts. We recognise that, to become an industry leader, there is a need to improve our performance in this area and our customers fully support the need for improvements.

Moreover, we know that a small number of our customers still experience unacceptable levels of disruption to supply, which they expect us to address as a matter of urgency.

Customers are very clear that they consider the current levels of leakage across the sector to be unacceptable, and that it undermines their trust and confidence in the industry. They understand that the cost of leakage repairs are a limiting factor in our ability to improve our current levels of leakage. However, they expect that more should be done.

Welsh Water 2050

In response to the long-term trends that we are facing, globally and locally, we have developed a strategy, Welsh Water 2050. This sets out the challenges that we expect to face over the next 30 years, and the 18 strategic responses that will be required to address them. The primary strategic responses relevant to this business plan are:

- **Strategic Response 1: Safeguarding clean drinking water through catchment management** - Faced with increasing raw water challenges due to the intensification of agriculture and greater intensity of storms, we will co-create an extensive, innovative programme of catchment management with landowners and partners to improve raw water quality and reliability.

- **Strategic Response 2: Enough water for all -** Confronted with an increasing water supply demand gap from population growth and drier summers due to climate change, we will review the water supply balance to 2050 through our Water Resources Management Plan. We propose to implement demand management measures and leakage reduction and water efficiency programmes as well as supply side measures to address any deficits.
- **Strategic Response 4: Protecting our critical water supply assets** – With increasing risks of disruption and limited customer tolerance of supply interruptions, we will improve the resilience of critical water assets which have high consequences of failure.
- **Strategic Response 13: Smart water system management** – With the opportunity to capitalise on technological advances, we will improve the service performance and resilience of our assets through remote sensing, data analysis and automation; solving problems before they impact on our business, our customers, or the environment.
- **Strategic Response 14: Supporting ecosystems and biodiversity** – In the face of habitat loss and more extreme weather, we will look for ways to help nature, enhance biodiversity and promote ecosystem resilience while we carry out our water and sewerage activities.

We intend to start delivering on these long-term commitments in AMP7. The development of Welsh Water 2050 into incremental strategic area investment plans are an integral part of this development process and brings together these strategies and combines them with other long-term plans such as long-term asset management planning, water resources management plans and drought plans.

AMP6 progress

We are delivering against each of our objectives from PR14. We have:

- Implemented a risk-based approach to asset management through our resilience scorecards;
- Improved our Drinking Water Safety Plans by aligning these plans from source to tap in preparation for accredited status;
- Established WaterSource as a brand to communicate our evidence-based collaborative approach to catchment management;
- Developed the Brecon Beacons Mega Catchment concept by founding a steering group which includes regulators, third sector and local land managers, drawing on best practice exchanges with the New York Water Corporation;
- Improved our understanding of our catchments characteristics through long-term investigations, innovative trials and extensive research;
- Delivered both flow and quality benefits to the environment through our support of the National Environment Programme;
- Delivered two strategic plans – the draft Water Resources Management Plan (WRMP) and Drought Plan (DP);
- Delivered the schemes identified within the previous WRMP as required;
- Delivered environmental assessments to support the Drought Plan;
- Introduced a new process to provide long-term risk assessment and prioritise investment at our dams (Portfolio Risk Assessment – PRA) which will be implemented during AMP7 and future AMP periods; and
- Carried out unprecedented upgrades and repairs to our large dams.

Strategic Responses and Measures of Success

Our Measures of Success (performance commitments) for water resources for AMP7 are presented in Table 1 below grouped with the related Strategic Response from Welsh Water 2050. For each the table shows the performance as at 2017/18, the target for the end of AMP6, and the target for 2024-25. The remaining Strategic Responses are covered within supporting documents 2.2 (Water network plus business plan). Our PR19 plan also includes targets for 2030 and each AMP period out to 2050.

Strategic Response	Measures of success (MoS)	Narrative	2017/18 Outturn	2019/20 target	2024/25 target
1. Safeguarding clean drinking water	Wt7: Water catchments improved	The number of our WTWs with catchments designated as requiring Safeguard Zones	1	23	18
2. Enough water for all	Ft1: Risk of severe restrictions in a drought	Percentage of the population that would experience severe restrictions in a 1-in-200 year drought	4%	4%	0%
4. Protecting our critical water supply assets	Ft5: Asset Resilience (Impounding Reservoirs)	Percentage of critical assets that are resilient against a set of criteria	-	92.2%	95.5%
13. Smart water business	Wt5: Water process unplanned outages	Total unplanned outage as a proportion of the company's total production capacity (%).	1.57%	-	0% change from 2019-2020
14. Supporting ecosystems and biodiversity	Wt7: Water catchments improved	The number of our WTWs with catchments designated as requiring Safeguard Zones	1	23	18
	En6: km river improved	The length (in km) of river improved as a result of Welsh Water action (cumulative within an AMP).	36	562	418

Table 1: Measures of success

AMP7 drivers and investment

Our investment plan is focused on delivering sustainable, high-quality water supplies to our customers over the long-term. The WRMP is one of our long-term strategies for the company and takes account of the challenges arising from a changing environment. The five-year asset management plan (AMP) investment programme supports the delivery of this strategy.

Our activities will include:

- Catchment management campaigns such as PestSmart, NutriSmart and Animal Health;
- Improving our understanding of our catchments through greater use of 'smart' technology-smart technology in terms of water resources are further explained within chapter 5 e.g. use of drone technology;
- Further flow and quality improvements as part of the National Environment Programme;
- Development of opportunities to trade water resources with other companies;
- Delivery of our WRMP and Drought Plan;
- WRMP schemes to achieve positive supply-demand positions across our area whilst enhancing our resilience to more extreme drought events;
- Major upgrades and repairs to meet new legal obligations on us, reducing the risks from our most critical dams in the face of climate change; and
- Reductions in leakage and per capita consumption. (This is discussed in our supporting document 2.2 (Water network business plan) but is an assumption that underpins our demand forecast position.)

The investment cases and the related drivers are presented in Table 2.

Table 2: Summary of investments in AMP7

Strategic Response	Investment Cases	Operational Strategies	Key drivers	Also contributes to:	AMP7 Enhancement Totex
1. Safeguarding clean drinking water	Water Resources	Brecon Beacons Mega Catchment Strategy Welsh Water Catchment Strategy DWI Submission: Long-term planning for the quality of drinking water supplies	Stop decline in water quality in catchments contributing to Acceptability of Water contacts	SR2 – Enough water for all, SR3 – Reliability of supply systems, SR4 – Protecting assets SR5 – Acceptable Water Quality for all SR8 - Affordability SR10 – Smart systems	£25.30m
2. Enough water for all	Impounding Reservoirs Water Resources	Water Demand and Leakage Strategy	Manage the water supply-demand balance in the context of more extreme weather events due to climate change and changing demographics.	SR3 Reliability of supply systems SR4 Protecting assets SR6 Towards a lead-free Wales SR13 Smart water system management	£20.04m
4. Protecting our critical water supply assets	Cost Adjustment Claim - Impounding Reservoirs	Dam Safety Annual Report Resilience and Security Business Plan Resilience Scorecards	Identify and mitigate risks including flooding, cyber-attack, physical security, asset failure at our critical assets including reservoirs, WTW, pumping stations, and critical section of trunk main.	SR1 – catchment management SR2 – Enough water for all SR3 – Reliability of supply systems SR8 - Affordability SR13 Smart water system management	£79.23m

13. Smart water business		Water Network Maintenance Cross Service	Welsh Water Smart Strategy	Capitalise on technological advances to improve the service performance and resilience of our assets through remote sensing, data analysis and automation; solving problems before they impact on our business, our customers, or the environment.	SR1 – Catchment management SR2 – Enough water for all SR3 – Reliability of supply systems SR4 – Protecting our critical water supply assets SR5 – Acceptable water quality for all SR8 - Affordability	£4.17m
14. Supporting ecosystems and biodiversity		Water Resources	Making time for nature, Welsh Water	Enhance biodiversity and promote ecosystem resilience while we carry out our water and sewerage activities in the face of habitat loss and habitat fragmentation and changing climate. Welsh Water has a duty under the Environment (Wales) Act (2016) to enhance biodiversity and promote the resilience of ecosystems in the exercise of our functions.	SR1 – Catchment management SR2 – Enough Water for all	£6.43m

Our total investment as indicated in Table 2 £135.17m. The table describes the relevant investment to support the strategic responses listed.

1 Introduction

1.1 Wider context

Our customers expect that we will deliver clean, safe and reliable drinking water. This is essential for maintaining their trust.

To do this we capture and store raw water from our catchment areas in reservoirs and, along with some river water, treat this to potable standards in our water treatment works (WTWs), store the potable water in service reservoirs, before distributing this through our networks to our customers. This process must be resilient and sustainable if we are to continue meeting customer expectations.

Our focus within this document is on our water resources, drinking water catchments and dams. It should however be noted that our business is highly integrated and many of the programmes we discuss in this document will provide benefits across other business plans and our strategic responses.

1.2 Key challenges

Key challenges for our water supply services in the AMP7 are outlined in Figure 1.

Figure 1: Key challenges for AMP7

In order to respond to these, we need to move beyond our traditional service delivery models and innovate to meet future challenges. Therefore, our responses will include harnessing innovative technologies, working in partnership with our customers and communities, and transitioning towards becoming a holistically sustainable business. We have also learnt from recent events, such

as Storm Emma and the 2018 period of dry weather, about how we can further strengthen resilience[1].

1.3 Purpose and scope of document

The purpose of this document is to support our submission for PR19 with respect to the Water Resources price control for the next asset management period from 1 April 2020 to 31 March 2025 (AMP7). This document outlines the plans for our water resources and how these plans will deliver improvements in service for our customers and contribute to our long-term strategy, Welsh Water 2050.

This document provides an outline of:

- Our customers' priorities for AMP7 as reflected in the results of customer engagement;
- Our approach to delivering on these priorities in the face of future challenges;
- Our **progress during the current asset management period 2015-2020 (AMP6)** and how our AMP7 plans will build-on this progress, including both successes and lessons learnt;
- Our **plans for AMP7** and how these plans deliver improvements to our customers in line with their priorities and contribute to our long-term strategy, Welsh Water 2050;
- Our longer-term plans for the next asset management periods 2025-2030 (AMP8) and beyond; and
- How we will **assess our progress** in AMP7 using our measures of success.

This plan will help us to meet our six customer promises, which also form the customer outcomes for PR19:

- Clean, safe drinking water for all;
- Safeguard our environment for future generations;
- Personal service that's right for you;
- Fair bills for everyone;
- Put things right if they go wrong; and
- A better future for all our communities.

1.4 Relationship to wider PR19 business plan

This Water Resources Business Plan forms part of our overall PR19 Business Plan which also covers customer and stakeholder engagement, how we propose delivering outcomes in AMP7 and beyond, the levels of service we will provide, financial implications and the impact on customer bills.

The management of raw water transport, treatment and potable water distribution will be subject to a separate price control from 2020. However, supplying raw water is critical to the delivery of safe reliable drinking water to customers at the tap, and therefore our supporting document 2.2 (Water network plus business plan) is referenced repeatedly in this document.

This plan has been produced in alignment with Ofwat's methodology for the PR19 price review.

This document reinforces how our business plan links to other strategic documents that are produced separately but which also support the business plan such as the Water Resources Management Plan; the Drought plan, the National Environmental Programme and our Trading and Procurement Code.

1.5 Background

Welsh Water is the sixth largest of the ten regulated water and sewerage companies in England and Wales in terms of customers, but the third largest in area. We operate 63 water treatment works supplied from 128 sources. These sources are 74% supplied from impounding reservoirs, 21% from intakes on rivers, and 4% from groundwater and bulk supplies. Our biggest responsibility is to provide a safe and reliable drinking water supply to customers while maintaining the integrity of the environment that we abstract from, and ensuring our service meets the needs of today and those of future generations.

1.6 Our customers

We are a company without shareholders, run solely for the benefit of our customers. We therefore have a unique position in responding to their priorities.

We have engaged with our customers in the development of Welsh Water 2050 and through the WRMP consultation process. These consultation responses include

- Draft WRMP statement of Response (2018)
- Welsh Water 2050 “Have your say” consultation 2017
- Welsh Water 2050 response to long-term strategy (2017)
- PR19 Willingness to Pay (2017)

These consultation responses allow us to tailor plans and programme to delivery to meet our customers specific needs, wants and desires.

1.7 Welsh Water 2050: Purpose and content

In March 2018, we published our final “Welsh Water 2050” document[2,] which sets out our long-term vision for a truly resilient water business, to help us respond to the many challenges and opportunities that lie ahead — from climate and demographic change to the pace of technological progress and increasing customer expectations.

1.8 Welsh Water 2050: Future trends

Significant future trends that are likely to impact on our clean water business are:

Change in customer expectations – What our customers expect from their drinking water, in terms of quality and availability, and their acceptance of outages, and their impression of drought measures is likely to change.

Protecting essential infrastructure – Ageing water supply infrastructure, and physical and cyber security risks, could limit our ability to maintain a reliable supply into the future.

Demographic change – Demand for drinking water will change across our network and more of our customers are likely to be considered vulnerable in the future.

Changes to the structure of the economy – The growth of the digital, knowledge based economy could allow us to realise significant efficiencies in our water supply business, and will also present challenges.

Policy and regulatory change – Policy and regulation around water supply could change, especially after the UK's departure from the European Union, and quality criteria could progressively tighten.

Climate change – Drier, hotter summers will increase the risk of supply deficits and increase peak demand.

Environmental change – Raw water quality could come under increased pressure due to land use change in our catchments.

Protecting public health – Regulatory standards to protect drinking water quality are likely to tighten in the future, and emerging contaminants will present at increased risk to public health.

1.9 Welsh Water 2050: Relevant Strategic Responses

Our Welsh Water 2050 strategic responses include a long-term direction of travel for how we will mitigate the challenges and harness the opportunities, which will be continually reviewed and revised over time. Relevant strategic responses for our water resources, catchments and dams include:

Strategic Response 1: Safeguarding clean drinking water through catchment management – Management at catchment level to improve raw water quality and reliability.

Strategic Response 2: Enough water for all – Managing how we treat and supply drinking water, along with customer demand, in order to mitigate expected future water supply deficits.

Strategic Response 4: Protecting our critical water supply assets – Protecting our water supply assets against physical and cyber threats to their operations.

Strategic Response 13: Smart water system management – Using technology to monitor and control our assets, and predict and respond to failures before they impact on the service to our customers.

Strategic Response 14: Supporting ecosystems and biodiversity – Promoting ecosystem resilience and enhancing biodiversity while carrying out our water and sewerage activities.

1.10 Structure of the water resource business plan and supporting documentation

The water resource business plan is structured by Strategic Response in alignment with our long-term strategy, Welsh Water 2050. For each Strategic Response, we set out:

- Introduction
- Drivers
- Customer and stakeholder priorities;
- Our approach;
- AMP6 progress;
- AMP7 plan;
- Longer term plan: AMP8 and beyond.

Where a Strategic Response covers more than one price control, we have discussed the information relevant to water resources only in this document.

This business plan is supported by additional submission documents. The key supporting documents for this area of the business are:

Document title	Reference	Description
Past Performance Report	5.4	Description of our AMP6 performance against PR14 Measures of Success.
PR19 Performance Commitments	5.2	Description of how our Measures of Success and commitments have been developed
PR19 Water Networks Plus Business Plan	2.4	Description of our bioresources price control plans.
Welsh Water 2050	1.4	Our long-term strategy, outlining future trends for our business, and how we will harness the opportunities and mitigate the challenges we will face up to 2050.
Investment cases		
Document title	**Reference**	
Wastewater Networks Maintenance	5.8M	
Wastewater Networks Plus Enhancement	5.8N	
Llanelli and Gowerton	5.8O	
Wastewater NEP	5.8P	
Wastewater Network Plus Growth	5.8Q	
Wastewater Treatment Maintenance	5.8R	

A list of additional documents available on requested is provided as Annex A.

2 Strategic Response 1 - Safeguarding clean drinking water through catchment management

Figure 2 the catchment of a reservoir

2.1 Catchment management

Working across our catchments is vital for maintaining a resilient service. We abstract raw water from more than 100 topographically discrete catchments covering a combined area of around 11,000km^2. 95% of all treated water in our operating area is surface derived^3. We collect every day almost half of that water from the Brecon Beacons.

Our area faces a great deal of uncertainty from challenges such as intensification of agriculture, urbanisation, climate change, enviornmental change and policy change. Some raw water quality challenges are already becoming aparent in our region: there has been an increase in organic matter, 2-Methylisoborneol (MIB) and geosmin in raw water causing colour, taste and odour issues as well as landslips causing turbidity issues. Uncontrolled, these challenges will present a risk to raw water sources, presenting challenges for our water treatment works in the future. These issues within the Brecon Beacons Mega Catchment (see below) provide an opportunity to look at multi-issue landscape scale approach to raw water improvments.

We have developed a WaterSource approach to catchment management; as a new way of working to look after the land around our rivers, reservoirs and groundwater to protect drinking water both now and for years to come.

Principles of the WaterSource approach

. The key activities the group will undertake are:

- Inclusive
- Collaborative
- Recognises multi benefits
- Polluter pays as a minimum
- Right for our customers
- Prevention not cure
- Underpinned by evidence

2.2 Drivers

In AMP7, and going forward towards 2050, we are expecting that increased levels of pesticides, fertilisers, nutrients, pathogen loadings and turbidity will put pressure on the quality of the raw water that we abstract – in part due to intensification of agriculture, more extreme weather events and other environmental change.

Catchment management is our 'first line of defence' - a well-managed catchment, producing raw water of an expected, consistent and manageable quality, will build resilience into our water supply systems. Strong catchment management helps to reduce problems around taste, odour and discolouration, and facilitates more efficient treatment at water treatment works. This allows us to reduce operational costs and may allow us to delay capital investment to upgrade treatment processes and in some case remove the need for treatment.

A major element of our work has been to develop different land management techniques, such as providing information, influencing and incentivising, and collaborative work with a range of partners from government, regulators, environmental lobbyists and individual land managers. Our work has been to understand the catchments that we take our supplies from and we will continue to carry out risk mapping of our catchments as a key element to managing the catchments in future. Partnership working will be key, as we have limited land holdings across our catchment and hence little control of land activities.

Drinking water safeguard zones (SGZs) are designated areas in which the use of certain substances must be carefully managed to prevent pollution of raw water sources. Our WTWs may have more than one catchment and more than one Safeguard Zone. The DWI approach via drinking water safety plans (DWSP) is used to track the risks associated with raw water quality and is also managed by our catchment team.

Our adoption of a co-operative and catchment-based approach to solving society's potential issues aligns with the approach set out in the Environment Act (Wales) 2016 and could make a significant contribution towards delivering the environmental improvements discussed in the first State of Natural Resources Report (published by Natural Resources Wales in 2016).

2.3 Customer and stakeholder priorities

Safe drinking water is consistently referred to by customers as their highest priority out of the services we provide[4], and it is a core outcome for us as a business. Moreover 9 in 10 respondents in our 2017 consultation on Welsh Water 2050 said that it is important that Welsh Water 'works with

nature to improve water quality'[5]. Customers support preventing pollution at source, recognise that such solutions are better for nature and wildlife[6], and believe that raising awareness and working with landowners and other stakeholders should form a key part of managing safe drinking water, in addition to boosting research in treatment processes that use fewer chemicals.

Our customers recognise the wider co-benefits of catchment management, and they feel it is important to protect the countryside and rivers in order to support tourism, recreation, wildlife and the wider health and well-being of Wales and the parts of England that we serve.

The Brecon Beacons National Park Authority, is strongly supportive of us engaging with rural areas in the upper catchment and welcome our approach of using catchments as a first line of defence. They recognise the need for partnership working and believe that the strategy for the Brecon Beacons can be developed to have a strong influence on public understanding of where finite water supplies come from and how conserving them is a collective, civic responsibility. The Royal Society for the Protection of Birds (RSPB) Cymru, The Wildlife Trust Wales and Salmon & Trout Conservation UK are also supportive of our approach to catchment management partnerships and have highlighted the importance of taking a view of the multiple benefits of catchment management when planning schemes.

2.4 Our approach

We are shifting our approach to water quality management upstream into our catchments as well as building resilience into our water treatment works. In 2011, we established our in-house catchment team, with responsibility for identifying risks and developing and delivering catchment solutions to meet our current and future challenges to raw water quality. During AMP6, through catchment characterisation, we have identified candidate Safeguard Zones. These are catchments at risk of raw water quality deterioration that, without intervention, would result in the need for additional treatment. We will measure the overall success of our catchment management measures against our ability to reduce the number of candidate Safeguard Zones, and hence bring value to our customers by avoiding additional treatment processes. The Drinking Water Inspectorate (DWI) has offered its support for our approach to catchment management[7].

We have the support of our customers to protect and enhance the environment we take our supplies from. This is analogous with Article 7 of the Water Framework Directive; to prevent further deterioration in raw water quality due to anthropogenic sources of pollution. Our approach considers this principle and goes further to consider sustainability of the ecosystems and improve biodiversity.

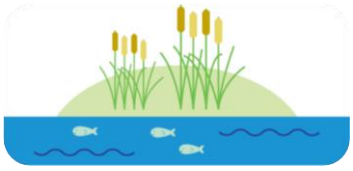
The approach so far is the start of the journey that takes the company to a place where we maintain the diversity of our catchments, protecting the catchment as an asset and enhancing the environment to provide a sustainable landscape to provide a more consistent supply of raw water.

Protecting the resource ensures a more consistent product is delivered to our treatment works which in turn reduces our reliance on chemicals for treatment. In our approach to improve raw water quality, reduce the number of candidate Safeguard Zones and bring long-term value for our customers, we have developed WaterSource - our evidence-based, collaborative approach to catchment management. This approach is the foundation and the first building block has been added during AMP6 further building blocks will be developed and added and form the AMP7 plan.

Innovation and collaboration: PestSmart and Weed Wiper Partnership

Within our WaterSource approach we have two initiatives (Weed Wiper Partnership and PestSmart) that tackle the rising levels of pesticides in our catchments and water sources, in collaboration with land owners and users.

Both projects use an integrated and collaborative approach to reducing pesticides entering the water cycle, improving water quality and reducing our impact on the environment.



The Weed Wiper Partnership promotes alternative methods of eradicating rushes and other grassland weeds that have less impact on the environment. The project supplies information on best practices and offers land managers free hire of 'weed wipers' that apply herbicides directly to the plants, using less chemicals and reducing spray drift. It addition it uses Glyphosate instead of 2-Methyl-4-Chlorophenoxyacetic Acid (MCPA), which has less impact on water quality as it breaks down quicker.

PestSmart is a campaign that works across the pesticide supply chain to reduce the impact of all pesticides on water, wildlife and people. The campaign encourages the use of best practice, focusing on smart storage, use and disposal of pesticides, as well as promoting alternative, non-chemical methods of pest control. The project also runs a free and confidential disposal scheme, allowing users to safely dispose unwanted, expired or unlicensed pesticides.

The Brecon Beacons Mega Catchment

In our 2050 strategy we recognised the importance of working with others to achieve society's wider goals, and this is reflected in our Brecon Beacons Mega Catchment Strategy. We collect almost half the water that we use every day from the Brecon Beacons, yet we own just 3.9% of the land area within the Brecon Beacons. The Brecon Beacons Mega Catchment Strategy will bring together all stakeholders to co-create a long-term, unified vision for future management, recognising all the ecosystem services the area provides and its important economic role in water provision, agriculture, tourism and timber production, and will establish an effective form of governance.

Our first Mega Catchment workshop attracted 40 attendees, representing all our key stakeholders. We have formed a Steering Group to continue development of the strategy and provide the secretariat of the group. Best practice lessons have been learned through exchanges with the New York Water Department.

2.5 AMP6 performance

	PR14 Measure of Success	Narrative	2014/15 Performance	2017/18 Performance	2020 target (current forecast)
	A1 Safety of drinking water	% overall compliance for all tests taken at our WTW, service reservoirs or customer taps that have met regulatory	99.98%	99.98%	99.98%

Table 3 SR1 PR14 measure of success

Table 3 shows the PR14 measures of success relating to this strategic response and provides the starting position during 2015/16 our current position as reported during 2017/2018, and the latest forecast of where we predict we will be at the end of AMP6.

During AMP6, we have focussed our approach on upstream water quality in our catchments. Our AMP6 catchment investigations programme is currently producing a catchment characterisation assessment of all our catchment areas. For each investigation this includes risk mapping, groundwater modelling, raw water quality assessments, geology and soil assessments, and land use management assessments. From this work, we identified that we collect almost half the water we use every day from the Brecon Beacons, and have put a special emphasis on this area through our 'Brecon Beacons Mega Catchment' strategy[8]. This strategy captures existing challenges to water quality, key land owners, hazard mapping and a water treatment vulnerability assessment and will be used to drive new interventions in AMP7 and has become a programme of work in its own right.

In order to improve our monitoring, and move towards a more predictive approach, we have developed WaterSource, our evidence-based, collaborative approach to catchment management. Through this programme we have developed strong relationships with stakeholders, which have resulted in early notification of pollution incidents that could have threatened our raw water quality. More widely, we are also developing our in-house spatial risk mapping and modelling capability to ensure we can better understand future trends and the viability of potential catchment solutions.

Interventions within our catchments during this period include our Weed Wiper trial, dissemination of good practice for pesticide use and management through our PestSmart programme, peatland restoration, fenland restoration, tree planting and the installation of stock exclusion fences.

An emerging risk within our catchments relates to the use of Metaldehyde. This compound cannot be removed with conventional carbon treatment and therefore we are putting in place a number of catchment initiatives to help reduce the levels seen in our catchments, such as farm surveys, and promoting awareness to landowners. We will continue to map the use of this substance and meet with landowners to influence its continued use.

Our strategy continues to focus on minimising the formation of disinfection by-products which are produced by the reaction of free chlorine with organic content in the raw water. We have worked with the University of Bangor over a number of years to monitor and study an increase in colour and dissolved organic carbon (DOC) in our raw water, which reflects changing climate patterns, and we are working to mitigate this in our catchments where we can. The water quality parameter required to be measured by the regulations is Total Trihalomethanes (THM). We have employed aeration and

ion exchange techniques at our treatment works to eliminate some of the difficult to remove organics at key service reservoirs in our operating area, and have introduced ultrasound units at Plas Uchaf reservoir to reduce algal growth in the abstracted raw water. We have also introduced reservoir mixing (Resmix) at Pontsticill and Llandegfedd Reservoirs in order to improve oxidation to remove manganese[9].

Research and innovation have been fundamental to our approach in AMP6. For example, we are working closely with academia to drive the new research required to better understand our catchment hazards, and the risk they pose to raw water quality, along with the risk posed by future stresses such as climate change. This has included two fellowship positions with the Natural Environment Research Council (NERC) within the catchment team, funded PhD research programmes and membership of other joint industry initiatives. These will form the basis of catchment management plans to drive activities in the future.

PestSmart and the Weep Wiper Partnership

Programmes that form part of WaterSource include our pesticide and herbicide disposal scheme PestSmart, and the Weed Wiper Partnership aimed at reducing the amount of pesticides used for weed control.

During AMP6, we trialled our Weep Wiper Partnership in three catchments. Through this trial, we estimate that we have helped to avoid 4048 litres of the herbicide MCPA from being used. This has allowed us to delay an investment of £10 million for additional granular activated carbon treatment (GAC) at Llechryd treatment works, and hence contribute to lower bills for our customers.

Our PestSmart programme has already attracted £1 million of external funding. This demonstrates the value of working in partnership to achieve greater impacts, and will allow us to extend the scheme across our area towards the end of AMP6. Through this programme we have also developed strong relationships with stakeholders, which has resulted in early notification of other pollution incidents that could have threatened our raw water quality.

Peatland and fenland restoration

Targeted restoration of peatland and fenland can contribute to improved water quality in our reservoirs. We have worked in partnership with key stakeholders to restore peatland around two of our reservoirs, Llyn Conwy and Alwen in North Wales. We are also part of the £5 million Anglesey Fens project, towards which we have contributed £200k.

Collaboration: The Anglesey and Llŷn Fens LIFE Project

The Anglesey and Llŷn Fens have suffered from dereliction, artificial drainage and pollution in recent years. Using EC Life+ funding, we have been working with NRW and the Welsh Government to restore the fens to their natural state. This includes working with landowners to ensure over 200ha of land are maintained in a mutually beneficial way. The project includes the restoration of Cors Erddreiniog, the largest part of the catchment for Llyn Cefni reservoir, which will improve raw water quality and reduce our treatment costs for years to come.

Pesticide and herbicide disposal scheme

As part of our PestSmart campaign, we ran a free and confidential disposal scheme for farmers, growers, foresters and land managers to safely dispose of any unwanted, out of date or now unlicensed pesticides and herbicides which are difficult or expensive to dispose of.

By providing this disposal scheme in targeted catchment areas, we aimed to work with land managers to safeguard raw water quality before it reaches our water treatment works by minimising the risk of unintended losses into water or wider environment

Reservoir initiatives

The presence of manganese and disinfection by-products can reduce the acceptability of water for our customers. In many cases, in-reservoir interventions such as reservoir mixing (resmix), aeration, ion exchange and ultrasound units can mitigate manganese and reduce the levels of taste and odour forming compounds before they enter our WTWs.

We have improved our understanding of how manganese contributes to customer acceptability, and established a target of 2µg/litre. To help meet this target, we have installed reservoir mixing (resmix) to improve oxidisation to remove manganese at Pontsticill and Llandegfedd reservoirs before they enter our WTWs[10]. At key reservoirs, we have employed aeration to reduce algal growth and taste and odour forming compounds in the abstracted raw water.

Collaboration and research

The mechanisms behind the production of certain pollutants in our catchments, such as manganese, is poorly understood at present. Moreover, future challenges such as climate change and land use change could have an impact on the significance of these pollutants going forwards. Our approach is therefore to work closely with academia and other research councils/organisations to continuously build our understanding of these issues and how best to address them. We are also building our monitoring and modelling capability to understand the effectiveness of catchment interventions.

Research and innovation have been fundamental to our approach in AMP6. We are working closely with academia to drive the new research required to better understand our catchment hazards. This has included two fellowship positions with NERC within the catchment team and funded several PhD research programmes, forming the basis of our catchment management plans to drive activities in the future.

As part of our programme to build our internal capability in catchment management, we hosted a team from New York to learn about their ‘Catskills Watershed Corporation’ programme. This is a not-for-profit corporation, formed to assist the Department for Environmental Protection with the implementation of watershed management programmes, a model which we take inspiration from when implementing catchment solutions in the Brecon Beacons and beyond. We are continuing to learn from them and have a return visit planned later in 2018.

Innovation: Taste and Odour Working Group

As part of our commitment to partnership working, we founded the UK Water Industry Taste and Odour Working Group in 2017. By working in partnership with other companies who face similar concerns, it will help us better understand the drivers behind taste and odour production in our raw waters, including emerging pressures in our catchments, and allow us to make viable assessments of the most appropriate solutions to mitigate these risks.

The Brecon Beacons Mega Catchment

The key activities the group will undertake are:

- Baseline current activities and develop a shared evidence base;
- Identify catchment activities, costs and effectives;
- Identify and secure funding sources;
- Deliver catchment activities;
- Monitor and evaluate their effectiveness and share learning.

Brecon Beacons Mega Catchment

A key component of our WaterSource approach is our Brecon Beacon Mega Catchment strategy. The Brecon Beacons Mega Catchment proposal represents a pioneering, new way of working to deliver landscape scale management to safeguard our water sources, whilst enabling other benefits to be realised.

The approach will bring together all stakeholders to co-create a long-term, unified vision for future management recognising all of the ecosystem services the area provides and its important economic role in water provision, agriculture, tourism and timber production, and will establish an effective form of governance.

In AMP6, we developed our Brecon Beacons Mega Catchment strategy through an extensive range of stakeholder engagement events, and co-created a vision that recognises the shared value provided by the Brecon Beacons. Our strategy and aims are:

- Captures existing challenges to water quality in the Brecon Beacons;
- Identifies key land owners and stakeholders; and
- Includes a costed plan of work, including interventions such as land purchase, peatland restoration, tree planting, pollution control, and enhanced monitoring.

The approach will bring together all stakeholders and holistically manage the catchment for the wider benefit of the community it serves.

In AMP6 we have made good progress in making customers active participants in water management.

Our WaterSource programme saw 63 land managers and owners hire our weed wiper to manage rush infestations, our PestSmart programme has attracting £1 million of external funding and our tree planting trial in the Cantref catchment was initiated following recommendations of the stakeholder Steering Group which was set up by Welsh Water in order to ensure that future catchment management would be of benefit to multiple organisations. The strong relationships with stakeholders developed as part of these schemes has also resulted in early notification of pollution incidents that could have threatened our raw water quality. Benefits to the approach for our customers would be:

- Produce cleaner raw water;
- Prevent or delay future investment at our WTWs;
- Extend the life of our existing assets;
- Build resilience against future trends;
- Deliver multiple environmental, social, cultural and economic benefits for the people of Wales;
- Attract funding from stakeholders and government to support the delivery of wider multiple benefits;
- Improve engagement with our customers and their understanding of the role of catchment management for water supply; and
- Inform future work in our other catchments and share best practice.

2.6 AMP7 plan

Table 4: SR1 PR19 Measures of success

	Measures of success	Narrative	2017/18 Outturn	2019/20 Target (AMP6)	2024/25 Target (AMP7)
	Wt7 Water catchments improved	The number of our WTWs with catchments designated as requiring Safeguard Zones under the WFD	1	23	18

Table 4 presents the PR19 measure of success relevant to this Strategic Response and provides the outturn 2017/18 position, the 2019/2020 target at the end of AMP6 and the 2024/2025 target at the end of AMP7.

During AMP7, we will focus on taking a more proactive approach to catchment management over five activity areas – taking the position that prevention is better than cure.

- We will implement enhanced monitoring in all our catchments to provide greater visibility of raw water quality and evaluate the effectiveness of catchment management solutions. We will also continue to develop our modelling capabilities, and develop live Catchment Management Plans for all current WTW's which will include action plans for all 23 proposed Safeguard Zone catchments.
- We will address the root cause of issues associated with the acceptability of water through reservoir and land management.

- We will continue to work with partnership groups in order to achieve a number of our objectives. Campaigns will include PestSmart, NutriSmart and others initiatives that allow us to influence land management practices.
- We will implement pollution mitigation measures, including the restoration of peatland and management of bulk storage of slurry and oil.
- We will undertake collaborative research with leading academics and research establishments to further improve the understanding of catchment management and implementation of mitigation measures while working within the communities of Wales.

Within the Brecon Beacons Mega Catchment, from which we abstract almost half our water every day, we will take a more proactive approach. As part of this, we will strengthen stakeholder relationships and support the steering group. We will implement reactive protection measures where catchments are at risk of non-compliance with Water Framework Directive parameters, and proactive measures to prevent future raw water challenges arising. Specific activities will include peatland restoration, woodland restoration, land purchase and proactive awareness campaigns with stakeholders[11].

We will deliver a programme of work to support the National Environment Programme (See Chapter 6) which has identified 23 proposed safeguard zones within Wales that will be designated during AMP6. By the end of the AMP7 period, through proactive management, 5 (of the 23) Water Treatment Works will no longer have Safeguard Zone catchments. Eighteen Safeguard Zones will remain.

Within our Teifi Catchment which supplies water to Mid and South Ceredigion via 2 WTWs, we have identified an opportunity to trial a Sustainable Management of Natural Resources (SMNR) approach. Within this river system it has been noted that our Waste Water business also has drivers to manage the area to comply with tighter consents that will be applied in the future. This approach could provide dual benefits for the Water and Waste water business and provide a more catchment-wide approach to water management.

The Drinking Water Inspectorate has offered its support for our WaterSource approach to catchment management[12].

In AMP7, we will build on successful catchment management measures that we have trialled in AMP6 to protect water quality for our customers and ensure long-term affordability. We have identified candidate Safeguard Zones that are ‘at risk’ of deterioration in AMP6. Our MoS

(R13) will measure the success of our catchment management schemes in improving raw water quality and reducing Safeguard Zone designations over AMP7.

Catchment Management: Overview

We will start to install a network of sensors and associated communication systems within our high-risk catchments to provide greater visibility of raw water quality performance, and to support spatial risk mapping and modelling. The data will also be used to evaluate the effectiveness of catchment management solutions and inform future rewards that might be paid to land managers to incentivise land management practices and behaviours.

Building on our learning from Catskills catchment in New York, we will also develop an operational support tool that will utilise predictive and automated technologies to allow us to make the best decisions for our catchments. Using this tool, we will build catchment management plans for all our catchments and introduce modelling for our key catchment, and build enhanced monitoring into 30 catchments. We will adapt our approach as new data sources and technology become available.

We will also implement reactive protection measures where catchments are at risk of non-compliance with Water Framework Directive (WFD) parameters, and proactive measures to prevent future raw water challenges arising. Through our catchment interventions, by the end of the AMP7, 5 (of the expected 23) WTWs will no longer be considered as candidate Safeguard Zone catchments.

Water Source - PestSmart, NutriSmart and Animal Health Campaign and other activities

We will develop WaterSource further by delivering the PestSmart programme to all catchments prone to pesticide issues. The capital cost of installing GAC treatment at all our water treatment works is estimated to be around £210 million at today's prices, and continued catchment working will help us to partially avoid or delay such investments and keep our customer bills low. The PestSmart programme now includes the deployment of our Weed Wiper partnership, the introduction of new campaigns to promote good nutrient management (NutriSmart), and work to manage the bacteriological and cryptosporidium risks associated with managed livestock (Animal Health Campaign). We will work with landowners to create livestock buffer zones where these will help to protect raw water quality from pollution. We will also implement bulk storage of slurry and oil in partnership with landowners. And we will address the root cause of issues associated with the acceptability of water through a combination of appropriate catchment management solutions as well as reservoir interventions. We continue to trial reservoir mixing technology and the use of ultrasound units to control algae growth, building on our trials in AMP6.

Collaboration and research

We will continue to build on our research activities in AMP6, in recognition of the crucial role they play in defining our approach to catchment management. We will continue to build on our relationship with NERC, universities and funded PhD research programmes and other research agencies. Some of the areas being considered are:-

- Taste and Odour MIB and Geosmin and Algae;
- Environmental understanding of Crypto;
- septic Tank risk assessment investigation; and
- Land slip prevention (red events) early warning system.

Brecon Beacons Mega Catchment (BBMC) strategy

We will implement our Brecon Beacons Mega Catchment strategy,which was developed in AMP6. It has won the support of the DWI, NRW and the Welsh Government. In its letter of 28 August 2018, NRW said:

> *"We welcome the approach which seeks to take preventative, precautionary and collaborative action to manage catchment to protect raw water quality to ensure that deterioration does not occur and that the risk from catchments to drinking water remains low.*
>
> *We consider that the proposals for Brecon Beacons and other drinking water catchments are in line with Wales' legislative framework and have the potential to deliver cost-effective outcomes and multiple benefits at scale, as well as exploring new ways of working to inform future delivery and in so doing provide its customers with long term sustainable solutions which deliver wider benefits."*

As part of our approach we will continue to strengthen stakeholder relationships, and create and manage a sustainable steering group to oversee the implementation of activities.

Specific activities could include:

- The creation of buffer zones to limit livestock access to rivers;
- Tree planting to reduce landslips and provide water attenuation;
- Peatland restoration, to manage the loss of organic carbon and retain water within our upper catchments;
- Working with farmers to improve bulk storage of slurry and oil;
- Working with communities to help manage the impact of private wastewater treatment works (WWTWs);
- Explore developing a Farming for Water approach, which would consider appropriate rewards to drive good land management practice above regulation;
- Land purchase where necessary; and
- Proactive awareness campaigns with stakeholders[13].

2.7 Long-term planning: AMP8 and beyond

Table 5 SR1 Long-term measure of success

	Measures of Success	Narrative	2024/25 Target (AMP7)	2029/30 Target (AMP8)	2050 Target (AMP12)
	Wt7 Water catchments improved	The number of our WTWs with catchments designated as requiring Safeguard Zones under the WFD	18	13	5

Table 5 presents the PR19 measure of success along with the targets for 2024/25 end of AMP7, 2029/30 end of AMP8 and 2050 target at AMP12.

Beyond AMP7, we will build on our Mega Catchment approach in the Brecon Beacons, and extend this to all our at-risk catchments. By taking a proactive approach through our WaterSource approach, we plan to avoid needing to implement additional Safeguard Zones. We will continue our PestSmart programme (including Weedwipers), and examine the role of 'payment for ecosystems services' and General Binding Rule's standards for septic tanks and small private sewage treatment plants to influence land management practices.

We will pursue an approach that recognises the opportunities in our catchments, including investing in our catchments to realise cost savings at our WTWs, and generating valuable wider benefits for local communities and the environment. This will require continued active collaboration with a diverse range of partners. We will also be proactive in our control of land management through targeted land purchase of priority or high-risk land.

Innovation and efficiency

In AMP7, the delivery of our Brecon Beacons Mega Catchment strategy is our largest innovation investment. To support this investment, we will continue to invest in research such as:

- Identify areas where there will be emerging pesticide use or land use changes;
- Understand how Natural Organic Matter changes through the catchment and reservoir;
- Incorporate Earth Observation into dynamic risk maps of our catchments;
- Research the source, prevalence and consequences of Perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) in our catchments;
- Horizon scanning for new emerging pollutants.
- Endocrine disruptors
- Pestsmart/Nutrismart and Animal Health and how to affect a positive behavioural change.

The innovative approach will take the company from a catchment centred approach to a landscape approach to deliver multi-benefits that will also provide a beautiful landscape for the populations living and visiting the area and an environment that can support the farming community, while still providing the people of Wales with a clean and wholesome source of drinking water.

3 Strategic Response 2 - Enough water for all

Figure 3 The resource within a reservoir

3.1 Introduction

The Strategic Response 'Enough Water for All' is underpinned by the company's WRMP and Drought Plan. These plans state the company's strategies and builds schemes from that position.

The WRMP ensures that there is enough resource available with given constrains on treatment and distribution assets to supply the demand made by our customers including large industry, commercial businesses and the general public given a level of service that customers have decided as part of WRMP and Business plan consultations. Historically the drought plan has been developed to meet worst case historical events such as a 1976 type event. The company has examined its resilience against introducing extreme supply side measures in a 1 in 200 year event and our initial analysis indicates that we will meet this standard in all but our Vowchurch zone. For Vowchurch, we have made allowance within the business plan to link our Herefordshire and Vowchurch WRZs and to invest in drought resilience and ensure that all zones meet a minimum resilience standard of a 1 in 200 year drought. This type of event has not been seen within our historical record and changes the company's resilience to greater than our previously experienced worst case drought from 1976.

Each of these plans undertake their own consultation process with stakeholders and customers and these documents present the initial draft strategies for the company prior to conclusion within the business plan process.

As both plans are strategically linked the data needed to create a plan is the same and includes a number of factors. These include:

- The level of service customers are willing to pay for;

- The Hydrology of the catchment the supply of water is obtained from;
- Climate change – which will affect water resource availability and patterns of demand.
- Population growth – and specifically where spatially this is located especially in South Wales;
- Changes in customer behaviour – including when and how they use water
- Changes to the structure of the economy – including industrial decline, and a transition towards a more service-orientated economy;
- Growth in tourism and changes specifically from the demand;
- Tightening environmental regulations - which can restrict our ability to abstract;
- Land use change - which can affect the quality of the raw water we abstract;
- The strategies customers prefer relating to how we manage our assets such as the level of leakage and water efficiency initiatives on the demand side and obtaining new resources in the future on the supply side:

3.2 Water Resources Management Plan and Drought Plan

Key content for this section discusses:

- The WRMP - How the WRMP provides a framework for our long-term planning for water resources in terms of demand and supply;
- Drought Plan - How we manage short term impacts from dry weather;
- Links to Welsh Water 2050 - How we have moved beyond this to look for the long-term trends affecting water resources in the Welsh Water 2050 exercise.
- Level of Service- Customers views on emergency measures and level of service in terms of drought in relation to WRM Planning.

Water Resources Management Plan

The WRMP 2019 looks at the period from 2020 to 2050 in line with our "Welsh Water 2050" strategy, across our 24 WRZs. The key approaches are:

- To ensure that the views of customers are properly taken into account, particularly on service levels and cost;
- To consider all available options to balance supply with demand when water supply deficits are forecast to exist over the planning period;
- To provide the reasoning on why options are selected and why they are best value for customers and the environment;
- To take account of Welsh Government policy in the Environment (Wales) Act 2016 and The Well-being of Future Generations (Wales) Act 2015 and align with its "Water Strategy for Wales 2015". Using the ecosystem services approach, we will work towards more integrated management of our water resources;

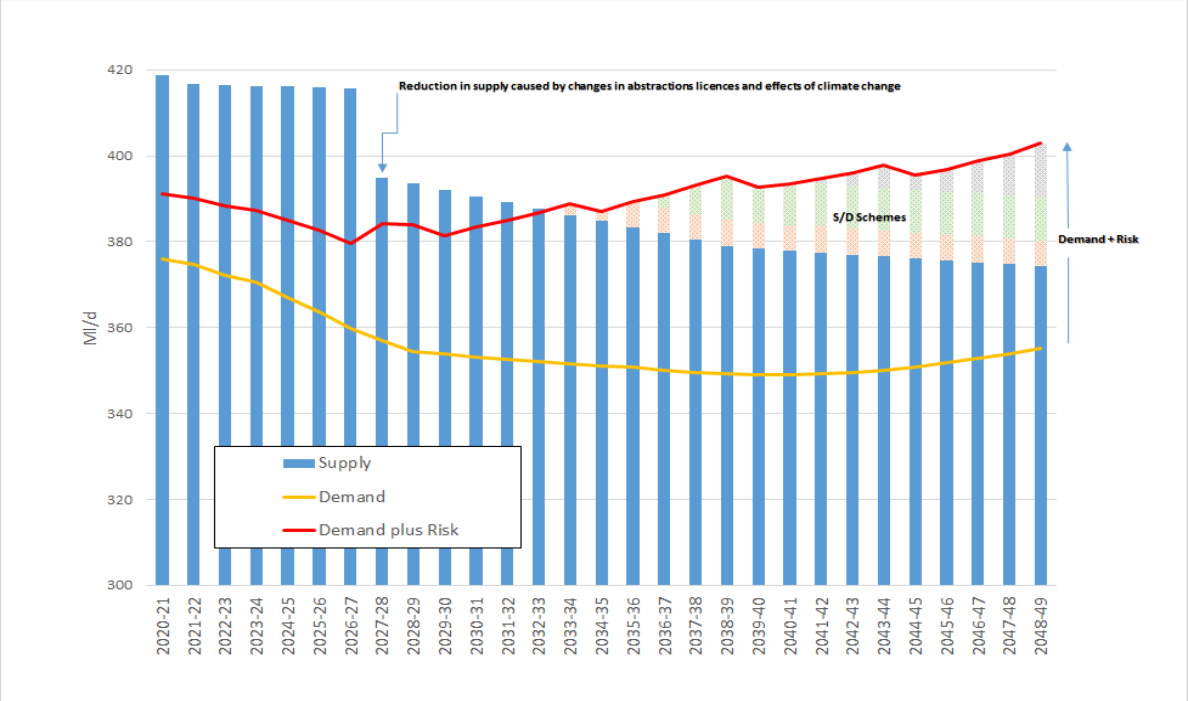
The WRMP is regulated to ensure good governance and a transparent process. Legislation sets out the requirement for water companies to maintain plans (Water Industry Act 1991 as amended by the Water Act 2003). Welsh Government both directs[14] the timescale for the development of the plan and provides 'Guiding Principles' for developing WRMPs[15].

Water resources planning is about trying to ensure there is enough water supplied to homes and businesses while protecting the natural environment. At the heart of this is our understanding of how much water is available from rivers, reservoirs and boreholes and supply to customers, not only

in ‘normal years’ when we expect good supplies of rainfall across our supply area but also in periods of drought. Our forecast of water resource availability takes account of environmental factors and climate change that reduce the amount of water that can be sustainably taken from our water sources. We have divided our supply area into 24 Water Resources zones (WRZ) to enable estimates of future supply and demand to be calculated at a meaningful level.

Long-term water resource planning is a complex process involving the analysis of large amounts of data, with varying degrees of certainty applicable to each data source. Within each of our zonal supply demand balances we therefore need an allowance for risk to account for the inherent uncertainties. For example, water resource uncertainty includes the inaccuracy of hydrological data. Demand forecast uncertainties arise in population and water usage estimates. Figure 4 is an example supply demand balance plot which shows the demand for water as a yellow line against supply capability (blue bars). A second red line indicates the demand plus the level of uncertainty (target headroom) for the zone.

Figure 4 Graphical representation of a zonal supply demand balance



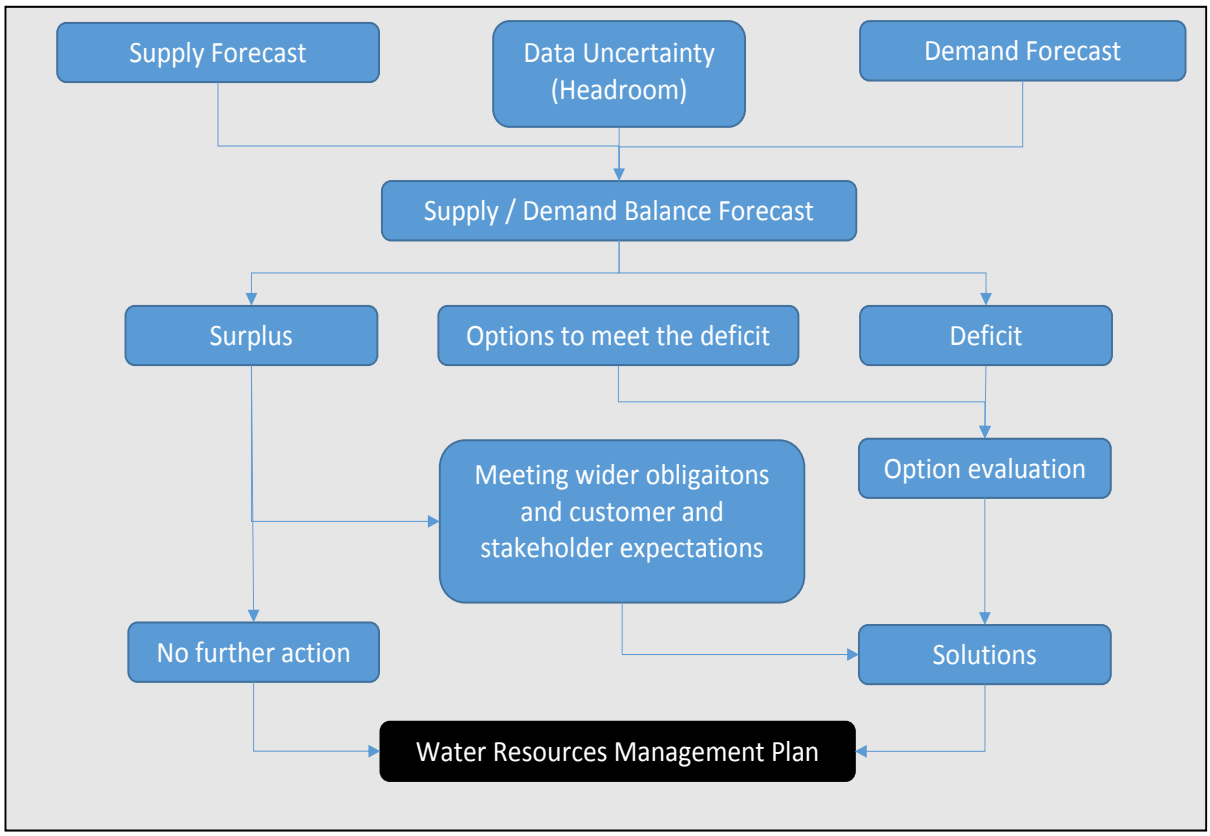
Where the supply demand balance for a given zone is positive we term the zone in ‘surplus’ and where it is negative we term the zone in ‘deficit’. For zones where we have a deficit then there is a lower LoS than our policy position. Where a zone is in surplus then we would not need to impose demand restrictions as often.

When our supply demand balance is in deficit, this does not necessarily mean that we would be unable to supply water to our customers. It does however mean that we would need to use demand restrictions not only during our worst droughts but during less severe droughts as well, or in other words have restrictions more often, hence we would provide a poorer level of service.

Our supply and demand forecasts are not static but will change into the future due to factors such as climate change, environmental legislation and changing population demographics Figure 5 shows the basic supply demand planning process used in developing the WRMP.

The WRMP shows where we believe we have sufficient water to meet demand in the future and, where we do not, explains what we will do to resolve any imbalances with justification for our choice of schemes.

Figure 5 - Basic WRMP process



The WRMP takes account of the wider water business assets base as this can constrain our ability to utilise available water resources to meet customer demand. We therefore need to understand the future capability of our water assets. The company's baseline maintenance program and strategic enhancements make a marked impact on the outcome of the supply demand balance and decisions on maintenance are an important element of the plan.

Drought plan

The Drought Plan is directly linked to our WRMP19 and sets out the practical steps that Welsh Water will take in each of its 24 WRZ through the stages of 'Developing Drought', 'Drought', 'Severe Drought' and 'Post Drought Recovery'.

The plan meets the requirements of the Water Act 2003 and Flood & Water Management Act 2010 and has been developed in accordance with the 'Water Company Drought Plan Guideline 2011' published by the Environment Agency in June 2011.

The Drought Plan describes

- When to communicate with customers when supplies are below expected levels for the time of year, encouraging them to work with us to use water wisely and to protect the natural environment.
- The operational and regulatory actions to be taken to preserve supplies of drinking water.

- Actions to constrain demand through the use of Non-essential use bans and Temporary restrictions.
- How we will monitor the effects of the drought and the measures we take.

The drought plan brings together actions that the company will undertake and states the impacts that could be experienced by customers and the environment. The drought plan also describes the steps that will be taken if harm is experienced by the environment. This process is managed through Pre, during and Post environmental assessments. Continued monitoring is required to understand the changes to the environment to ensure that mitigation after an event is the correct solution for the species affected.

Links to Welsh Water 2050

Welsh Water 2050 provides a springboard to take the company beyond the prescriptive water resource management planning process and move to a holistic source to tap approach to resilience and asset management.

There is now a greater emphasis with both the WRMP and price review process to examine resilience. In terms of water resources planning this includes our approach not only to climate change but also to our level of redundancy of assets. The WRMP has an element of climate change uncertainty contained within it. Greater resilience to climate change and other outages can be achieved through linking treatment works to more than one source within an area or across WRZs. We have a long-term aim to reduce the number of WRZs from 24 down to 11.

The WRMP process however mainly focuses on the resource given assumptions relating to key strategic assets. Welsh Water 2050 however considers where the company would like to be at a point in time i.e. 2050 and develops options for all areas of the business with incremental steps to achieve the desired outcome by 2050. This approach considers the constraints of deteriorating raw water quality, volume of resource, climate change on resource, maximum and minimum treatment works capabilities, network connectivity, the sizes of network storage and new developments, and the likelihood of demographic change.

Level of service appertaining to WRMP and DP.

The long-term supply demand balance is intrinsically linked to the level of service (LoS) supplied to our customers. If we anticipate that we might be unable to meet the demand for water during a severe drought we will put measures in place to limit demand. We have used measures such as hosepipe bans and non-essential use bans during the droughts of 1976, 1984 and 1989-90. How often we would put these in place is a measure of our water resource LoS.

Our customers accept that it is expected that there will be times when sanctions are imposed but do not support changing this LoS in the near future, and short term non-essential water usage bans are acceptable[16]. Our current LoS is:

- Not to have a hosepipe ban (now called temporary water use ban) more than once in every 20 years (1-in-20), on average;
- Not to restrict water for commercial purposes such as car washers, building cleaning, dust suppression (called as non-essential use ban) more than once in every 40 years (1-in-40) on average.

3.3 Water resources trading

Trading of a company's water resources is not new. Welsh Water along with many other companies have been providing strategic supplies of raw and potable water for many years. These supplies have mainly been provided when the nearest resource has been located within another company's boundary of supply which was developed prior to privatisation in 1989.

Our operating area shares a land boundary with Severn Trent Water and Dee Valley Water and a water boundary with Bristol Water and United Utilities. There are also two other companies who operate as 'inset' appointees within our area, located in Deeside North Wales and in Llanilid in South Wales.

We are the largest 'trading' company in the industry with more than 20 bulk water trades already in place plus the largest bulk supply in the UK between our Elan Valley reservoir system and Severn Trent Water for drinking water supplies to Birmingham.

This section sets out the company's view on trading and discusses our current bulk supply situations.

Bulk supplies – current position

In our Water Trading Prospectus we make it clear that we are willing to trade with other water companies and with third parties.

We believe water trading can play a part in supporting the economy, as long as it is done in a sustainable way. We support the position set out by the Welsh Government that water trading must benefit Wales and the people of Wales, and not jeopardise the environment, our own business and the customers we serve.

Our Trading and Procurement Code was approved by Ofwat in February 2016 – the first in the industry. The code is intended to provide reassurance that any trades we conduct will be in accordance with the code and that in contracting for the provision of water resources we will purchase from the most economical sources available, having regard to the quality, quantity and other relevant factors.

Our WRMP shows that we are open and transparent when considering supplies of water to us from third parties and support the use of competitive processes. As part of the WRMP pre-consultation process, we published our view of the need and availability of water resources across our supply area on our website and a Prior Information Notice in the Official Journal of the European Union (OJEU) seeking either bulk raw or treated water supplies in our suspected deficit zones. To date there have been no substantive responses to our publication on the website or the OJEU.

Whilst seeking economically efficient imports of water to deficit zones, the vast majority of our supply region has water surpluses making water exports more likely. Any potential export would need to comply with the following conditions:

- No water resource zones placed into deficit as a result of the export;
- No impact on our ability to supply water during periods of drought;
- No impact on our company's level of service;
- The environmental sustainability of supply (no deterioration of raw water source).

With the potential to benefit customers and the wider Welsh economy we have scrutinised the plans of neighbouring water companies and the potential for water imports and exports. Discussions have taken place with United Utilities, Bristol Water, Severn Trent Water and Thames Water as well as the

Canal and Rivers Trust. However, at present there are no suitable opportunities to import water to supply our deficit WRZ due to their location in West Wales. We have discussed potential options for export to Severn Trent Water and Thames Water and the most favourable possibilities remain under active review. However, we have not reached the stage of agreeing specific terms as this will need further detailed work. Once this work is complete we will discuss these options with Welsh Government and present them as part of our approach to our WRMP.

We are also working with the Canal and Rivers Trust on a raw water export solution to support the Brecon and Monmouthshire canal during periods when their abstraction from the River Usk is restricted.

The company provides over 300 MLD of raw, partially treated and treated water for both the commercial and the domestic customer markets and receives just under 20 MLD of potable drinking water.

As required for draft WRMP19 submission, we published a full set of Market Information Tables for each of our 24 WRZs.

Figure 6 shows where our current imports, exports and transfers of water within the company exist.

Figure 6 the map of our exports and imports of water, and areas where water is transferred between WRZs

Trading in our Water Resources Management Plan

The WRMP guidelines describe how companies in England and Wales are to engage with other companies as part of the initial consultation on the draft WRMP prior to the process beginning. This allows companies with surpluses to consider trades in the early stages of their solution planning.

A further opportunity to discuss trading happens during the WRMP consultation period this sets out areas where the company would like to hear from 3rd parties. This is carried out by publishing OFWAT Market tables for each WRZ. These tables set out the latest position of supply surplus and resource deficit within the companies operating area. During the draft consultation period the company provides the current position on deficits and implications for water trading.

As part of the further development of Welsh Water 2050 and its links to the Water Resources Management Plan the company will first work to utilise surpluses within the company to supply WRZ where deficits or shortfalls could be foreseen in the future.

Abstraction reform could change this situation as NRW will review abstraction licences and where there are unused licenced volumes at transition to the new system NRW will be remove the unused abstraction volume from these licences. In addition some retained abstraction volumes may be considered to impact “no deterioration” under the Water Framework Directive and this may increase our need to import water from other companies.

New ‘bilateral’ trading framework

The Water Act 2014 made provision for new ‘bilateral’ water trading markets that allow water retailers to procure water resources from third parties directly. The Welsh Government has not brought into force the relevant areas of the Water Act 2014 that relate to ‘bilateral’ markets.

This means that we will continue to operate under the existing framework, whereby we publish annually a Network Access Code, network access pricing, and indicative Wholesale Tariffs. These access prices comply with licence condition S and Section 66A-66E of the Water industry Act 1991.

Trading as a ‘supplier’

In accordance with Welsh Government guidance and our own Water Trading and Procurement Code, we would not consider trading water resources with other companies or third parties unless we can demonstrate there would be no impact on customers and the environment, and that our customers would benefit. To enable the company to act as a supplier, therefore, the company would have to carry a water resources surplus within a given WRZ. Our current situation does not show any sustainable surpluses which we could use for water trading in this way. However, with investment we could potentially create surpluses that, subject to the relevant approvals and conditions, could be made available to neighbouring companies or organisations.

We are currently working with the Canals and Rivers Trust to identify opportunities were we can act as the supplier, and we will continue to work with organisations in similar positions to aid the most efficient and sustainable water environment.

Customer views on water trading

The WRMP research asked questions on water sharing and water trading. Customers thought that “sharing within Wales was already happening” and others commented that we were “all part of the same country”. The conclusion to this research on selling water to stretched areas of England was in support of trading for income “On Balance, revenue generation potential and associated positive impact on WW bills or projects outweighs environmental concerns for most but not all”.

To summarise this qualitative research trading has a high appeal but can be considered negative for the environment but perceived as a cash generator (WRMP qualitative findings[17] and WRMP Final WTP report[18]).

Trading opportunities and development

During our Welsh Water 2050 development we will develop opportunities to improve resilience by looking to increase links to second sources where a treatment works currently only has a single source of supply. During the relevant assessments opportunities may arise to develop sources for the benefit of our customers and that of other water companies. These opportunities will be considered alongside other options within our WRMP planning process to ensure a robust cost benefit analysis is undertaken and consideration for these options are considered equally.

3.4 Drivers

Water Resources planning assumes that our baseline assumptions and our regulatory and statutory obligations are met. These assumption ensures that the WRMP are entwined into all areas of business from the source all the way to the tap.

These underlying strategies and assumptions form part of the Water network plus business plan (2.2) and are not included here.

Our efforts related to Welsh Water 2050 and to deliver our water resources obligations under the WRMP are documented in our Draft Water resources Management Plan 2018. A summary of the investment is included here.

We will use our Water Resource Management Plan (WRMP) to ensure the water supply demand balance to 2050 always showing a slight surplus. Our proposals include the implementation of water transfers, trading and demand management measures.

3.5 Customer and stakeholder priorities

Customers have made clear that a reliable source of water is of great importance to them, and that we should be able to sustain water supply to customers in all but the most extreme of droughts. They view old pipes, a growing population and drought among their top threats to water supply[19]. Our customers often give us an emotional response when we talk about leaks – they feel it is inherently wasteful.[20,]

The majority of our customers want to introduce initiatives to avoid waste and reduce leakage, including meter telemetry and water efficiency products[21]. They support incentives for rain water harvesting and are keen for us to educate and provide advice on services to save water[20].

An intrinsic element of WRMP and Drought Planning is to set the level of service that customers want in relation to extreme weather and drought. The plans need this information prior to making any conclusion relating to a baseline position. Welsh Water has asked its customers whether it would consider changes to our approach and customers have chosen to support our proposal to the level of service which will remain the same.

The WRMP process contains a customer consultation element in its own right. WRMP process means that the whole document is published as a consultation draft followed by a statement of response and then updated to a final document with consideration from those responses.

The results from the consultation will be published on our website in due course as a revised draft WRMP and statement of response. The business plan dated September 2018 reflects schemes that relate to the draft WRMP.

3.6 Our approach

We are actively engaged in demand-side and supply-side measures to ensure there will be enough water for all in the long-term.

Where we predict a long-term supply-demand deficit, we are increasing our raw water abstraction volumes or implementing water transfer schemes between our water resource zones. Where severe weather, such as droughts, will affect our ability to provide a continuous supply for our customers, we are building strategic storage at our water treatment works or in our distribution network.

We are also working with our customers to meet our ambitious long-term demand reduction targets. We are proactively identifying domestic-level leakage and are offering free repairs and water efficiency audits to help our customers reduce the amount of water they use. Moreover, our Smart Meter trials and provision of free water efficiency devices are contributing towards our understanding of how behavioural change will contribute to reduced demand.

As covered under the water resources price control, we have developed our Water Resource Management Plan (WRMP) to ensure water supply demand balance to 2050.

Enough water for all has been developed using the overall WRMP and DP guideline. This includes consideration of all basic strategies the company is considering as part of the building blocks to providing enough supply of water to drink while supporting the environment plus providing enough water to meet the demands of customers, stakeholders and third parties.

The approach undertaken while developing Welsh Water 2050 took the WRMP and DP and our appetite for water trading a stage further; and considered not just a status quo of supply and demand but took steps to address resilience at single source water resources zones, resilience at our treatment works, resilience through our network structure, capability of our sources during wet, normal and dry periods, how our treatment works reacts to quantity of supplies during wet normal and dry periods and how our network can supply these varying volumes of water while still providing consistent wholesome safe drinking water.

Further developing this approach for the future will require research investigations into customer behaviours, social activities, the needs of our changing farming and manufacturing industry in a changing technological society and demands from changes to our leisure industry driven by more leisure time and differing working time patterns.

3.7 AMP6 performance

	B1 Abstraction of water use	% compliance with our abstraction licences, as regulated by Natural Resources Wales	100%	100%	100%

Table 6 SR2 PR14 measure of success

Table 6 shows the PR14 measures of success relating to this strategic response and provides the starting position during 2015/16 our current position as reported during 2017/2018, and the latest forecast of where we predict we will be at the end of AMP6.

Resource management

The management of the resource is a continuous process for the company and includes management of the water within our reservoirs, rivers and groundwater's plus the physical assets themselves. Critical Assets such as the dam structure are considered separately in Section 4.

We have improved efficiency at three of our south east Wales abstraction sites which are located in the Rhondda and Cynon valley's to maximise the water available and ensuring even though our licence does not always require it water can be prioritised for the environment.

We have continued to improve our reservoir refill scheme to reintroduce a previously drawn down reservoir in the centre of Cardiff as part of an alternative resources to supply industrial customers.

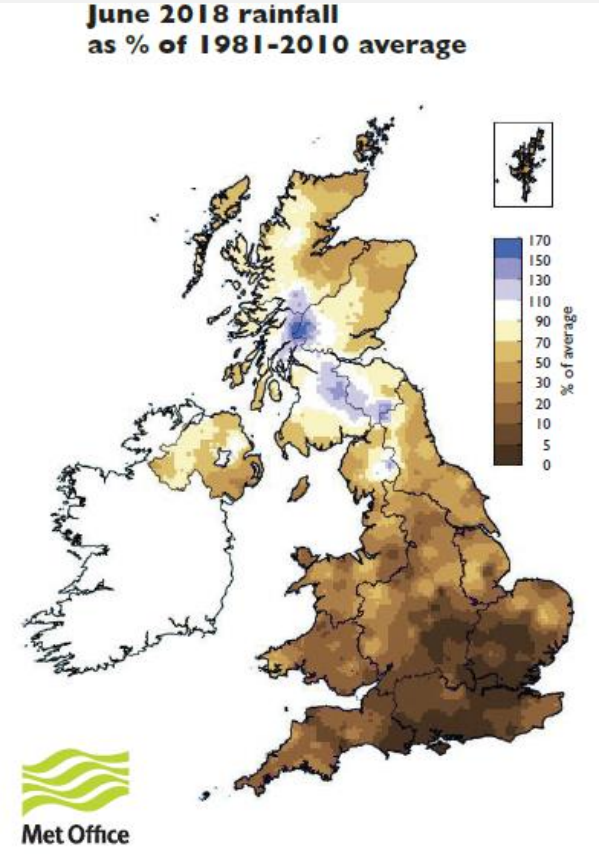
We have delivered an updated drought plan and continued updating our environmental investigations with further environmental investigations during the dry weather of 2018.

We have continued to measure, improve and enhance our hydrometric capability by reviewing the efficiency of our current process and equipment and beginning a rationalisation programme and taking advantage of technological advances.

Raw and Intake Water Assets

We have monitored and maintained our raw water mains to ensure continued supply to our WTWs and carried out repairs on two of our raw water mains. We have also carried out work at three of our raw water pumping stations.

Raw distribution assets, leakage and water efficiency activities are discussed as part of the support document 2.2 (Water network plus business plan).



© NERC – Hydrological Summary for the UK – June 2018[1]

Drought during May - July of 2018

- The period between early-May and mid-July 2018 was notably hot and dry in Wales very little effective rainfall for 10 weeks.
- In Wales the mean temperature for June was provisionally 2.2°C above the long-term average, making it the hottest June since records began in 1910.
- The June and July combined rainfall was 48% of the long term average and from May to July 57% (drier than 1976).
- Linked to the temperature, demand for water was 200Ml/d above the average we normally put into supply, mirroring the demand during Storm Emma but rather than a few days this was for a prolonged period of around 2 weeks.

Learning from developing drought of 2018

The development of our plans for resilience as part of WRMP19 and Welsh Water 2050 improved our understanding of water supply system constraints and, more importantly, the potential for enhancing resilience through better connectivity between water resource zones. We identified preferred schemes for development and implementation between 2020 to 2050, to reduce the number of separate water resource zones from 24 to 11. During the drought of 2018 we had to accelerate some of these connectivity schemes to address the fact that some zones were moving into 'drought' status. The works undertaken temporarily connected six of our water resource zones, four in North Wales and two in South Wales, and we added connectivity in three other zones to move water around the network. Funding to make the above schemes permanent will be allocated from within the AMP7 plan through prioritising against other maintenance schemes. We provide below a summary description of what took place in some of the key affected zones.

South East Wales Conjunctive Use System (SEWCUS)

The majority of the WRMP14 schemes to improve the connectivity and water resource resilience within the area were delivered during AMP6, including dry weather pipelines to protect the Heads of the Valleys areas. These include the reinstatement of the Manorafon

[1] NERC Open Access Research Archive (NORA) Available: http://nora.nerc.ac.uk/

WPS on the Tywi River, and the Memorial and Llantrisant pumping stations. All these schemes were used during the drought of 2018 to facilitate bulk transfer of water across the zone.

Although Manorafon is within our Tywi conjunctive use system (CUS) this alternative supply of water was used this year to preserve storage in the Usk reservoir, one of our big five SEWCUS reservoirs. We also reinstated our Llantrisant WPS to support our lowland WTWs at Court Farm and Sluvad which during dry weather are utilised to preserve stocks in our upland reservoirs at Taf Fawr and Taff Fechan. The conjunctive possibilities between the two WRZ of SEWCU and Tywi CUS can be further enhanced by the PR19 scheme West-East-West transfer of potable water. Currently this trunk main has a limited capacity and is not capable of supplying water bi-directionally. The need for a higher capacity trunk main has been proven during the drought of 2018.

North Eryri, Ynys Mon – Installed bi-directional connectivity and connection to Llyn Harlech and Barmouth.

Historically the interconnectivity between these areas has facilitated the supply of water from the North Eryri (Snowdonia) area onto Ynys Mon (Anglesey) to supplement the resource at Cefni reservoir. We have also connected the two Ynys Mon reservoirs, Alaw and Cefni to further support Llyn Cefni from the larger Llyn Alaw during very dry years. During the 2018 drought the North Eryri sources (Llyn Cwellyn and Ffynnon Llugwy) depleted more quickly due to the combination of increased demand and little rainfall but through a temporary pumping arrangement we were able to reverse the flow across the Menai Straits to move water from Llyn Alaw across the island to Cefni then and onto the mainland to support Llyn Cwellyn. This bi-directional capability will be made permanent in AMP7.

Barmouth – Connected Barmouth to Lleyn Harlech zone.

In order to support the Barmouth area, (Llyn Bodlyn reservoir and Eithinfynydd WTW), water was transferred from the Lleyn Harlech zone via the treatment works at Cilfor and Rhiwgoch. This involved the addition of a temporary contact tank and final water sampling point at Cilfor WTW, again this will be made permanent during AMP7 providing future resilience to the Barmouth zone.

North Ceredigion – Demonstrated increased connectivity within the water resource Zone.

Llyn Llygad Rheidol and Craig y Pistyll reservoir levels dropped in June so we implemented a scheme to support more of the Bontgoch WTW supply area from our Cefnllan and Lovesgrove boreholes than had been previously been achieved in practice. This significantly improved the resource forecast for the area.

Tywyn Aberdyfi – New abstraction needed

Water quality and reliable flows from the two spring sources that feed Penybont WTW continue to provide constraints during summer periods. We have included a PR19 scheme on the Afon Dysynni to provide an alternative source of supply to Penybont. The need for its implementation has been demonstrated during this event which allow not leading to restrictions resulted in some tankering to maintain supplies.

Vowchurch – Drought resilience

The Vowchurch zone is solely supplied from a single groundwater source with environmental driven licence conditions restricting abstraction to 3Ml/d during low flow periods. During the drought of 2018 demands in our Vowchurch area peaked close to our licence limit of 3Mld

during this year. The resilience scheme put forward within the WRMP19 to connect the Hereford WRZ to the SRV within Vowchurch would provide greater resilience for drought and also for other purposes such as risks from pollution event and poor water quality.

We will take learning from the recent event of 2018. Which has provided early indication for further scope that will be reflected in the WRMP review 2018.

AMP7 improvements

In summary the drought of 2018 has reinforced our understanding of the peaking in demand by over 150Ml/d above normal levels during hot dry years. The recent dry weather also provided additional data regarding reservoir inflows and work needs to be concluded to understand the context of the drought against other historical events. What can be concluded to date is that, in line with our Welsh Water 2050 plans, the additional connectivity temporarily employed during this summer has provided significant resilience benefits.

There is a strong case to make these schemes permanent by inclusion within the supporting document 2.2 (Water network plus business plan). These may also impact upon zonal deployable outputs and we will include these within our updated system modelling and include results within our WRMP annual review. Schemes will include:

- Connect permanently, for use bi-directionally, Anglesey with mainland North Eryri;
- Integrate Lleyn Harlech WRZ to Barmouth WRZ to enable the two zones to be considered as one conjunctive use zone;
- Increase the capacity and create a bi-directional connection between SEWCUS and Tywi CUS which provides an additional step to merging these WRZ as part of our aim under Welsh Water 2050.

3.8 AMP7 plan

Table 7 SR2 PR19 measures of success

	Ft1 Risk of severe restrictions in a drought	Percentage of the population the company serves, that would experience severe restrictions in a 1-in-200 year drought.	4%	4%	0%

Table 7 presents the PR19 measure of success relevant to this Strategic Response and provides the outturn 2017/18 position, the 2019/2020 target at the end of AMP6 and the 2024/2025 target at the end of AMP7 target.

Resource Management

During AMP7 the WRMP has forecast a deficit within 2 of the 24 WRZ's. These zones now require a solution which has been designed to meet the size of the deficit and by the most cost beneficial scheme for the WRZ. The investment programme for AMP7 will build on the work already untaken.

We have developed 3 schemes to reduce the risk of severe restrictions in a drought in the 3 affected water resource zones (Tywyn Aberdyfi, Pembrokeshire and Vowchurch). In Tywyn Aberdyfi, as the flow from the two streams that are the current source will not be able to meet demand in the future, we will construct a new abstraction point on the Afon Dysynni. This will meet future needs with the least environmental impact and also be more resilient to drought, as the Afon Dysynni is a much larger source. We also propose to install a raw water bankside storage reservoir, allowing temporary closing of the two original sources if necessary.

In Pembrokeshire, we will install variable speed pumps at the Cannaston pumping station, allowing us to more efficiently regulate the Eastern Cleddau River and reduce the amount of water we release from the Llysyfran reservoir. This will enable us to retain reservoir storage during critical dry years.

In Vowchurch, as there are limited options of increasing abstraction and after extensive customer consultation, we will increase resilience to drought to a level of 1-in-200 years. In addition to increased demand management efforts, this will be done by laying a main between our Hereford and Vowchurch zones to improve the situation.

We will further assess our intake and source assets to ensure they are still fit for purpose today and for the future taking into account climate change.

The Water Resource capability will be checked again in readiness for the next WRMP and DP to be produced. Checking that the assumptions are still valid and the schemes have delivered as expected and the deficit removed. The 5 yearly reassessment is a statutory requirement and will deliver the outputs ready for investment in AMP8.

In the last year our Water resources team have undertaken initial risk identification to check if our assets are fit for our changing climate. During AMP7 a number of assessments will take place on our intake and source assets. The outputs of these assessments will form the next priorities for delivery during AMP8.

The drought of 2018 has already shown that demand has been exceptional at 150 Mld at its peak. The Welsh Water 2050 plans to connect WRZ together. This will drive further schemes for resilience,

even though some of these schemes are related to Network Plus areas of the business the WRMP process will be used to provide the need for each scheme. Schemes such as:-

- Connect permanently for use bi-directionally, Anglesey with mainland North Eryri;
- Integrate Lleyn Harlech WRZ to Barmouth WRZ to enable the two zones to be considered as one conjunctive use zone;
- Increase the capacity and create a bi-directional connection between SEWCUS and Tywi CUS which provides an additional step to merging these WRZ as part of our aim under Welsh Water 2050.

3.9 Long-term planning: AMP8 and beyond

Table 8 SR2 Long-term measure of Success

	Ft1 Risk of severe restrictions in a drought	Percentage of the population the company serves, that would experience severe restrictions in a 1-in-200 year drought.	0%	0%	0%

Table 8 presents the PR19 measure of success along with the targets for 2024/25 end of AMP7, 2029/30 end of AMP8 and 2050 target at AMP12.

Water resources management

During AMP8 and beyond we will further develop our understanding of our condition and remaining lifespan of our assets. The replacement programme developed for AMP7 will be continued during AMP8 and beyond but at a higher rate than currently planned. This maintenance activity which has been limited in previous AMPs will gain pace over time to ensure the asset renewal programme maintains progress and does not reduce the capability of the company to supply water to our water treatment works. The WRMP is a plan that spans a minimum of 25 years and includes schemes that are required to be delivered over the life of the plan. We will continue to update our WRMP and DP in AMP8 as new evidence becomes available.

The Strategic Area Investment Plan which underpins our Welsh Water 2050 will also continue to develop options to increase resilience and reduce risks from short and long-term pollution at our sources and develop new approaches to resource management to improve efficiency and reduce costs. These plans bring together the mission ‘To become a truly world class, resilient and sustainable water service for the benefit of future generations’ and provide holistic asset planning that includes all water assets from source catchment to tap.

Innovation and efficiency

We will continue to innovate to ensure that we provide cost-effective solutions for our customers. During AMP6, we have adopted innovative approaches to provide more cost-effective, evidence based, and safer solutions to enable supplies to our customers to be maintained.

We will adopt some of the innovations we have developed in AMP5 and 6 to deliver our projects in AMP7, 8 and beyond. In addition, we will continue to innovate. These innovations will include:

- Advanced smart monitoring of our reservoirs to ensure accurate and timely estimates of stock;
- Exploration of remote monitoring and sensing technologies;
- Further development of better hydrological models and wider use of stochastically generated inflows to better test our systems against; and
- Review the impact from solar panels on the surface of the water to retain resources and supply energy for our additional monitoring units and telemetry at these remote sites.

4 Strategic Response 4 – Protecting our critical water supply assets

Figure 7 Pontsticill reservoir

4.1 Drivers

We have identified our most critical assets, these range from assets that would lead to a significant service impact and assets that could cause a catastrophic impact such as flooding to property or loss of water supply. In these cases risks cannot be mitigated by operational activities alone. Part of this assessment included the designation as critical national infrastructure (CNI) under the Security and Emergency Measures (Water and sewerage Undertakers) Direction 1998 (SEMD). All of our assets that distribute treat or store water for more than 350,000 customers are treated as Critical National infrastructure. For non-designated sites we will mitigate risks based on the Water UK security standards.

We need to significantly increase in the level of investment in our reservoirs over the next three AMPs, spanning a horizon of 15 years. We have already made a strong start. By the close of AMP6 we will have delivered our most extensive reservoir investment programme ever (totalling £80 million) and are committed to building on this progress in AMP7. Further information relating to our Investment programme for Dam safety can be found in our Cost adjustment claim for Impounding Reservoirs (Supporting Document 5.8B).

4.2 Customer and stakeholder priorities

Protecting our critical supply assets is consistently ranked as being of high importance by our customers as problems would have a major impact upon customers. Terrorism is one of the “top of mind” threats to water supply.

4.3 Our approach

We are facing increased environmental and human risks to our assets, including emerging threats from terrorism and cybercrime. To mitigate these we are using our resilience scorecards to prioritise our investments for improving the resilience of our critical water treatment and supply assets, and measure the progress of these activities.

In addition, we manage our Critical National Infrastructure (CNI) under the Security and Emergency Measures Direction (SEMD), and non-designated assets using Water UK Security Standards.

Managing the safety of our reservoirs is one of the most critical roles we undertake as a water company. These assets are an essential component of the water resource system in most of our zones. A failure of one of these assets has the potential to lead to loss of life, and the disruption of water supplies to tens of thousands of people. Over the past five years, regulation and good practice guidance relating to reservoir safety have seen significant updates. New regulations were introduced in 2016 driven by the Floods and Water Management Act 2010, reducing the capacity of reservoirs that are covered under the Reservoirs Act 1975 from 25Ml to 10Ml. This regulation has only been introduced in Wales and has increased the number of our reservoirs from 86 to 131; which will require statutory inspections and related maintenance.

In addition, good practice guidance relating to the management of flood risk at reservoirs (Floods and Reservoirs 4th Edition, 2015) and relating to drawdown in an emergency (Guide to drawdown capacity for reservoir safety and emergency planning, 2017) have been introduced. These guidance documents will lead to the Reservoirs Act Section10 driven need to upsize spillways, raise dam crests and upgrade pipes and valves at our reservoir sites.

To address these changes in legislation and guidance and the challenges of this ageing asset base in a risk-based and proactive manner, we have adopted the industry-leading Risk Assessment for Reservoir Safety (RARS) methodology, introduced by Defra in 2013. This is a proactive, quantitative portfolio risk assessment to build a detailed and quantitative understanding of the risks across all of our reservoirs, and prioritise which reservoirs require investment to ensure they achieve an acceptable level of risk for our customers.

The results of the RARS methodology are also included in our resilience scorecard alongside Security and Emergency Measures Directive (SEMD) and access.

Innovation: RARS methodology

The Risk Assessment for Reservoir Safety (RARS) methodology, introduced by DEFRA in 2013, is the industry-leading approach to reservoir risk management. It is a proactive methodology for prioritising investment and intervention, based on a quantitative assessment of risk and failure. This is carried out by examining internal and external threats to reservoir safety, the response of the reservoir or dam system to these threats and different resultant failure modes. These failure modes are then quantified based on the loss of life associated with each, and the probability of each event based on the age, design and construction of the dam. The process then offers guidance to support reservoir undertakers in using the outcomes to manage operational and management risks efficiently and effectively. Such management activities could include a programme of works or a schedule of inspections by a supervising engineer.

4.4 AMP6 performance

Table 9 SR4 PR14 measure of success

	F3 Asset Resilience - Water	% of critical assets that are resilient against a set of criteria.	90.4%	91%

Table 9 shows the PR14 measures of success relating to this Strategic Response and provides the starting position during 2015/16 our current position as reported during 2017/2018, and the latest forecast of where we predict we will be at the end of AMP6.

In AMP6, we have used the industry-leading Risk Assessment for Reservoir Safety (RARS) methodology to build a detailed and quantitative understanding of the risks across all of our reservoirs, and prioritise which reservoirs require investment to ensure they achieve an acceptable level of risk for our customers. We have also adopted a proactive risk management approach to our pipes and valves in dams. We have completed a national condition assessment of the pipes and valve in all our reservoirs. We have produced a multi-AMP delivery plan requiring a significant increase in investment to enable us to meet our legal obligations and bring the level of risk associated with our reservoirs to an acceptable level.

We have also implemented our 'pipes in dams' project at Caban Coch reservoir to replace scour pipe valves and sections of pipework. To avoid interruptions to supply associated with reservoir draw-down, we developed an inflatable plug and plate which could be installed by divers. This has generated interest in the wider water industry in England and Wales.

At PR14 a joint MoS was defined that included impounding reservoirs as wells as WTW, WPS etc. within its calculation. The MoS at the start of AMP6 2015/16 was predicted to be 80% rising to 87% by 2019/20. We are currently reporting a score of 90.4% against this measure. Our end of AMP6 resilience score based on the PR14 resilience scorecard for Water Assets together is expected to be 91%.

We will need to significantly increase in the level of investment in our reservoirs over the next three AMPs, spanning a horizon of 15 years. We have already made a strong start; by the close of AMP6 we will have delivered our most extensive reservoir investment programme ever (totalling £80 million). Through our interventions, we have reduced our highest risk assets from 14 to 8 and our high risk assets from 30 to 23.

Through our portfolio risks assessment, we planned our works across three AMPs to target work at our high-risk assets.

In April 2016, the Welsh Government introduced amendments to the Reservoirs Act that places additional obligations on us as reservoir managers. In addition, we have adopted the industry-leading Risk Assessment for Reservoir Safety (RARs) methodology, introduced by Defra in 2013, to develop a detailed understanding of the safety of our portfolio of reservoirs and which reservoirs require priority investment to ensure they achieve and maintain an acceptable level of risk for our customers.

This methodology represents a change from a reactive approach to one that is proactive and based on a quantitative assessment of risk and the consequence of failure. The implication for us is significant additional investment expenditure to bring all of our reservoirs in line with the new obligations. We have produced a multi-AMP delivery plan that sets out a significant increase in investment to bring the level of risk associated with our reservoirs to an acceptable level in order comply with these new legal obligations.

Activities we have undertaken are:

- We have refurbished or replaced overflow spillways – see below.
- We have refurbished and replaced pipes and valves.
- We have carried our investigations into dam leakage
- We have refurbished towers
- We have completed the S10 measures in the interests of safety required of us with no need for intervention by the enforcement authorities
- We have completed routine and regular maintenance

We have worked hard in AMP6 to understand the level of risks posed by our reservoir assets, and to develop an investment plan that reflects the need to proactively manage these risks whilst balancing cost and deliverability. This has allowed us to prioritise upgrades to our reservoirs and to ensure that we do not have to interrupt customer supplies due to emergency drawdowns or for maintenance works. We will meet new legislative requirements for spillway and drawdown capacities as part of 10 year inspection cycles. The investigations that are currently being undertaken will then lead to design and delivery of new spillway and drawdown facilities that will not be completed until the end of AMP8.

Resilience scorecard

Our PR14 business plan committed to improve our understanding of the resilience of our most critical water treatment and supply assets. Resilience was introduced as a new driver in AMP6, and over the course of the AMP we have risen to the challenge and developed a bespoke resilience scorecard process for our critical assets. These scorecards rate resilience in terms of how well protected they are against extreme weather events, power failures, control failures and other stresses such as coastal erosion.

The scorecards also consider the ability of assets to recover from service failures arising from such events, and hence the overall risk to asset operations. Our scorecard resilience scores are reported to Ofwat annually, to demonstrate progress made in protecting our assets.

For PR19 the asset resilience score card has evolved and the water resources scorecard now focuses on our critical dam structures. Our resilience scores for AMP7 are therefore not comparable to AMP6 scores and thus only AMP7 scores are quoted as part of our measure of success in Table 11.

Physical and technological measures

We have identified a number of issues with our dam assets during AMP6 and developed our portfolio risk assessment approach which has led to increased mitigation measures being actioned. This has included repairs at Caban Coch (one of the Elan Valley Dams), Talybont, Brenig and Wentwood reservoirs. The work carried out has resulted in innovative approaches to repairs for pipes through dams and dam valves. We have carried repairs and rebuilt spillways to a number of dams such as Ystradfellte, Rhymney Bridge Number 2, Shon Sheffrey, Usk reservoir and Llyn Teifi reservoirs. The examples in Table 11 show innovative approaches that were developed as bespoke solutions to resolve risks.

'Bus shelter', Rhymney Bridge Number 2, South Wales

When designing the new spillway we undertook detailed physical and computational fluid dynamics (CFD) modelling to identify the location which was at risk of water leaving the structure at change of direction. Rather than increase the height of the walls along the entire length of the structure, rthe design included a localised 'bus shelter' arrangement to ensure that any water is returned safely into the new structure. This detailed analysis enabled this localised approach which was less expensive than the alternative of a greater length of higher concrete walls.

Vulcan, Remote operated vehicle (ROV)

Labyrinth weir, Shon Sheffrey reservoir, South Wales

In 2014/15 (AMP6) the spillway was upgraded with a new labyrinth weir and tailbay. The design was informed by a 1:20 scale physical model. The use of a labyrinth type spillway resulted in a more economic solution as the alternative would have involved raising the height of the wave wall along the entire crest of the dam. This saved around £2million CAPEX.

Caban Coch dam, Elan Valley, Mid Wales

When replacing or enhancing our reservoir pipes we need to isolate these pipes which will often involve the use of divers. This is a high-risk task. Therefore, to improve safety of this process an innovative alternative method has been started to reduce the Health and Safety risk to our staff and sub-contract partners.

We have been working with our contract partners to design, manufacture and commission a prototype remote operated vehicle (ROV), called Vulcan. It can be operated from the surface via hydraulic control and can carry out these isolations instead of divers. This is the first of its type and was manufactured by a local Company in Cowbridge.

Following a leak on a scour pipe at another of our Dam's we started our innovative 'Pipes In Dams' project, with the Dam at Caban Coch being one of the first surveyed. We were concerned about the condition and rate of deterioration of some sections of pipe inside the Dam. We identified work to replace the scour pipe valves and sections of pipework. We were initially unable to provide any means of isolation upstream to enable safe working and drawing down the reservoir was not an option as we need to maintain supply to 1.5 million people across Birmingham, Mid Wales and Herefordshire. We developed a solution to provide upstream isolation by divers using a proprietary inflatable plug and plate technique.

We were challenged by the altitude and the depth of the diving operation due to the restriction it placed on the time the divers could spend working underwater. Considerable planning was required to ensure the works could be completed safely and in 2017 we managed to replace all valves inside the Dam without the need to interrupt customer supplies.

Table 10: Innovative techniques used by Welsh Water

4.5 AMP7 plan

Table 11: SR4 PR19 measures of success

	Ft5: Asset Resilience (Impounding Reservoirs)	Percentage of critical assets that are resilient against a set of criteria	-	92.2	95.5

Table 11 presents the PR19 measure of success relevant to this strategic response and provides the outturn 2017/18 position, the 2019/2020 target at the end of AMP6 and the 2024/2025 target at the end of AMP7 target.

We will be continuing our investment during AMP7 to ensure that the resilience aspect of water resources improves. The investment in our dams will reduce the overall risk assessment score and will increase our resilience. The Impounding Reservoir investment case explains in more detail the

significant additional investment required as a result of new obligations and bringing all our reservoirs in line.

The programme of work will cover many activities such as spillway improvements, greater control on valves to include compensation, regulation and draw down releases and repairs to towers and pipework contained within the dam itself.

We will carry out our required Section 12 and Section 10 inspections under the Reservoirs Act 1975 and react as directed by the specialist engineers to problems found from these inspections. Inspections can often lead to:-

- Investigations and studies;
- Patching repairs to concrete and masonry spillways;
- Re-pointing of masonry spillways and walls to reduce the chance of stones coming loose;
- In-situ repairs to leaking valves;
- Capital maintenance works at our Service Reservoir (SRV) sites to address issues where a Section 10 inspection is planned.

In addition when these interventions are carried out additional maintenance will be considered such as:-

- CCTV inspections of existing drainage pipework;
- Improved access to sites with localised works;
- Provision or replacement of access steps and hand railing to reservoirs to avoid the need to walk up and down a grassed slope;
- Minor health and safety works, such as improved signage; and

To address regulatory change and changes to good practice guidance and the accelerated investment required to proactively manage our reservoir safety due to managing the risk highlighted by the introduction of the Portfolio Risk Assessment approach we will address the following risks included in the list below:

- Seven spillway replacements and Seven spillway refurbishments;
- Pipework replacements at thirteen reservoirs;
- Valve replacements at twelve reservoirs;
- Capital maintenance at our SRV sites, which are between 10-25Ml of capacity and have recently been brought under the Reservoirs Act 1975. (In developing this investment case we have ensured that there is no overlap with the delivery of the Service Reservoirs maintenance investment case. Operational maintenance of the SRVs are accounted for separate from this investment case.)
- Tower access improvements at eight reservoirs;
- Tunnel refurbishments at two reservoirs;
- Discontinuance of one reservoir;
- Grouting at 10 reservoirs;
- Ground anchoring at two reservoirs;
- Stabilising works at one reservoir.

This work is the beginning of the investment required to mitigate the risks highlighted and will continue into the future.

Our approach, shaped by emerging best practice and necessitated by changing legislation, will require a £116.5 million investment in AMP7, which will include:

- Repairing or improvement of reservoir spillways;
- Refurbishment or improvement of pipework and valves in reservoirs; and
- Increasing the size of pipework and valves for improved drawdown capacity.

The investments will help to meet new legislative requirements, ensure that our reservoirs remain safe in light of an expected increase in extreme rainfall events, and support operational flexibility to respond to more frequent drought periods.

In AMP7, we will reduce our risk position as measured by the portfolio risk assessment for our highest risk assets from 8 to 0 and our high risk assets from 23 to 12.

Our end of AMP7 resilience score for these assets is expected to be 95.5%.

We have made significant progress in the current AMP to better understand the level of risks posed by our reservoir assets, and to develop an investment plan that reflects the need to proactively manage these risks whilst balancing cost and deliverability. This has allowed us to better prioritise the work required to our reservoirs and to ensure that we do not have to interrupt customer supplies due to emergency drawdowns or for maintenance works.

4.6 Long-term planning: AMP8 and beyond

Table 12: SR4 Long-term measures of success

	Ft5: Asset Resilience (Impounding Reservoirs)	Percentage of critical assets that are resilient against a set of criteria	95.5%	97%	100%

Table 12 presents the PR19 measure of success along with the targets for 2024/25 end of AMP7, 2029/30 end of AMP8 and 2050 target at AMP12.

We will continue to work towards a score of 100% on the resilience scorecard and reduce the level of risk across our portfolio of dams. The programme of work will continue the programmes from AMP7 such as improvements to spillways, greater control on valves to include compensation, regulation and draw down releases, automation of these valves as part of the smart approach where appropriate, repairs to towers and pipework contained within the dam itself and the towers that are separate from the dam structure where appropriate. We will increase dam stability and reduce leakage lost through the dam structure. The programme of work will build on the investment delivered during AMP7 and conclude once each dam has been reviewed and actioned to reduce the risk.

We will continue to improve dam maintenance and safety, embracing new legislation as it develops. Our new proactive approach to managing our reservoirs will be continued in AMP8 and AMP9. We anticipate that it will be possible to reduce investment to historical levels from AMP10 onwards.

Innovation and efficiency

During the design and construction of our reservoir upgrades, we will continue to innovate to ensure that we provide cost-effective solutions for our customers. During AMP6, we have adopted the

innovative approaches to provide more cost-effective and safer solutions whilst maintaining supply to our customers.

We will adopt some of the innovations we have developed in AMP5 and 6 to deliver our projects in AMP7, 8 and 9. In addition, we will continue to innovate. These innovations will include:

- Advanced smart monitoring of our reservoirs to reduce the need for reactive maintenance by providing timely information to operators;
- Explore opportunities to use procurement routes to drive innovation and deliver efficiencies as we move through this significant interment programme;
- Exploration of remote monitoring and sensing technologies;
- Where feasible and practicable standardise the specification of products across our reservoir asset base to increase efficiency;
- Where feasible and practicable explore opportunities for off-site fabrication and construction techniques, minimising the down-time of our reservoirs;
- Continue to research, evaluate and implement the most appropriate methods for the individual dam characteristics taking into account the remote nature of the asset, the amount of water that can allowed to be drawn down from the reservoir while continuing to supply its operational area;
- Continue to use remotely operated vehicles (ROVs) to undertake surveys under water, and support advancement in this area of technology; and
- The additional use of hydropower schemes as a method to extend the life of assets within the dam structure while ensuring no impact from such an installation to the safety of the dam.

5 Strategic Response 13 – Smart water system management

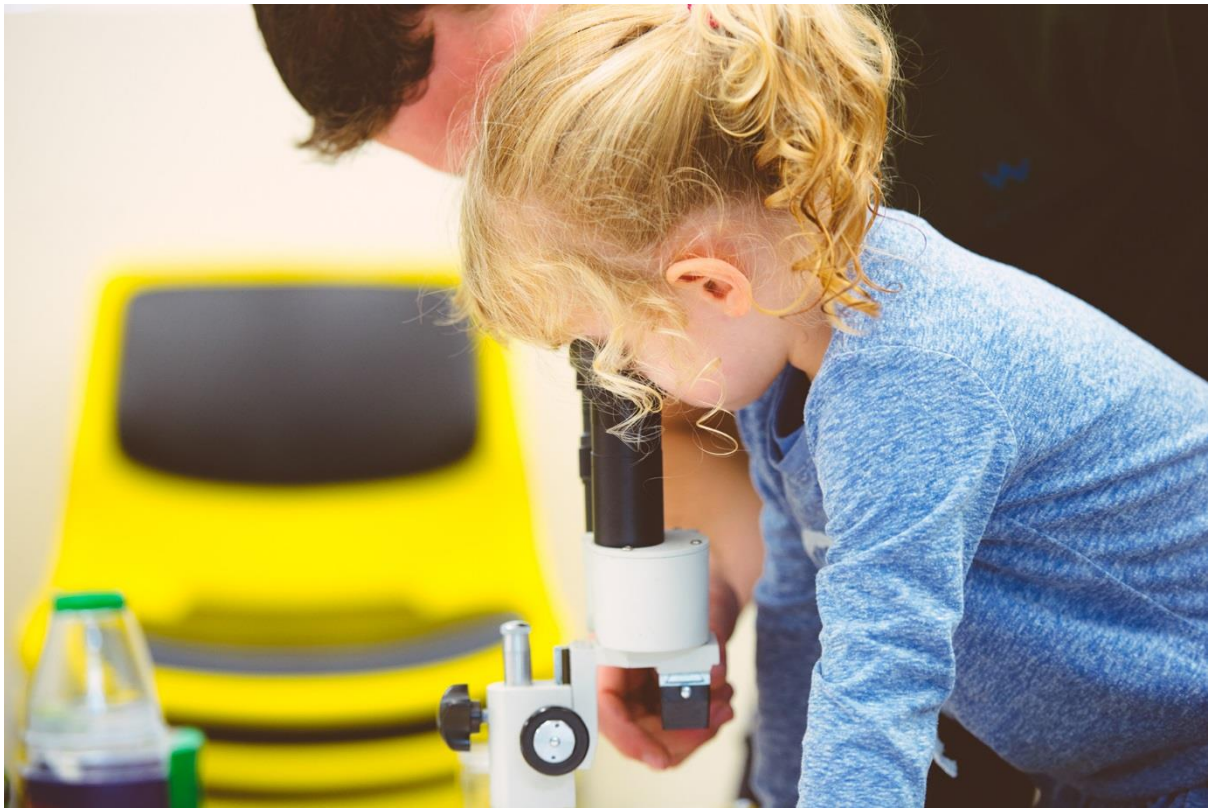


Figure 8 Educating innovation

5.1 Drivers

In our long-term strategy, Welsh Water 2050, we highlighted many of the critical challenges we face, including population growth, deteriorating raw water quality and ageing infrastructure. These complex and multi-dimensional challenges have been the drivers behind our focus on adopting smart technologies and changing how we use data. To meet these new challenges and take full advantage of the emerging possibilities that the development of smart technologies and data bring, we have developed our Smart Strategy.

Digital technologies will change what our customers expect of us. Emerging digital technologies will also change the way that networks are managed, with new opportunities for remote asset control and integration of networks. At the same time, digital initiatives will increase our vulnerability to cyber threats and drive a need for resilience against cyber-attacks.

New technologies will provide business efficiencies for the way we operate on a day to day basis.

In the water resources area of the business information technology will enable greater amounts of data to be gathered to improve how we manage, analyse and model our supply process streams.

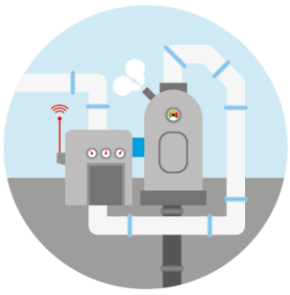
5.2 Customer and stakeholder priorities

Our customers expect that future technology, such as analytical tools and enhanced monitoring, will help to eradicate supply interruptions. They also believe we will need increased resilience against cyber-attacks. Several of our stakeholders, including Waterwise, have told us that smart water system management should be a priority for us in the next five to 10 years.

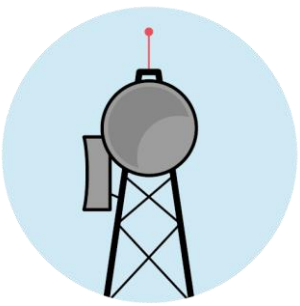
Our customers expect that future technology such as analytical tools and enhanced monitoring will support the business to ensure an efficiency and cost beneficial service.

Figure 9 Smart areas of work

New ways to collect data



New ways to control equipment



New bidirectional ways to communicate faster

5.3 Our approach

Technology and better use of data are vital components of our overall approach to mitigating the diverse range of challenges we will face going forward. They will also allow us to operate more efficiently and provide long-term value for our customers. Specific elements include:

- Smart Technology considerations for catchment monitoring and modelling, Resource Management and Dam Safety.

We are considering ways in which the business can use our resources in a more efficient manner. The approach we have considered introduces the principle of the “mothership”. This approach relies on our ability to communicate with our assets to remove delays that are inherent with sending a person to site. The Water Resource area of the business includes assets that are remote and can sometimes be cut off during adverse weather. Improving our remote communication and automating our assets will reduce the need to travel to site other than for routine maintenance activities. With increased communication comes increased volumes of data. The consequence of this additional information provides an opportunity to automate some reporting activities increase the frequency of compliance reports.

5.4 AMP6 performance

	PR14 Measures of Success	Narrative	2014/15 performance	2017/18 performance	2019/20 target (latest forecast)
	A3: Reliability of supply - minutes lost per property per year	Supply interruptions greater than three hours (expressed in minutes per property).	23	43	12.0

Table 13 SR13 PR14 measure of success

Table 13 shows the PR14 measure of success relating to this strategic response and provides the starting position during 2015/16 our current position as reported during 2017/2018, and the latest forecast of where we predict we will be at the end of AMP6.

Our PR14 business plan acknowledged the potential that advances in technology could have on the quality and affordability of the service we are able to offer to our customers. In AMP6 we have trialled new technology such as the use of drones to monitor our dams in isolated locations, new monitoring equipment at our reservoir sources to establish routes of pollution and poor raw water quality and improving the modelling capability to deliver WRMP and DP. Trials relating to Systems and Management Reporting have been undertaken in AMP6 to ensure a 'one business' view of the data and to provide consistent information to users. For example research is being undertaken jointly with Cardiff University to look at algae and DNA markers to create an early warning system for geosmin and MIB and is likely to conclude early in AMP7.

5.5 AMP7 plan

	Wt5 Water process unplanned outages	Total unplanned outage as a proportion of the company's total production capacity (%)	1.57%	-	0%

Table 14: SR13 PR19 measure of success

Error! Reference source not found. presents the PR19 measure of success relevant to this strategic response and provides the outturn 2017/18 position, the 2019/2020 target at the end of AMP6 and the 2024/2025 target at the end of AMP7 target.

An in-reservoir water quality monitoring trials undertaken at Cowlyd Reservoir during AMP6 has provided a system that could be installed at other similar sites to improve the knowledge and understanding of water transport and quality parameters through the catchment at a local scale, the volume of water entering the reservoir through tributaries and how sediment settles within the reservoir thus reducing the capacity of storage.

- We plan to trial options to manage rivers and groundwater for pollution and poor raw water quality changes.
- We plan to extend trials to analyse the benefits from improved raw water quality at our treatment works as a consequence of catchment management schemes and effort.

To effectively manage the operation of our water resources we monitor and collect hydrometric data from our raw water assets. This data underpins both the day to day running of our water supply systems as well as informing our longer term strategies. In AMP7 we are looking to further improve the way we monitor, collect and analyse this data and so a number of actions will be undertaken:

- Implement a new hydrometric database that allows us to store, analyse and report on the data we collect more effectively
- Increase the amount of hydrometric data we collect with a particular focus on better understanding the hydrology of our reservoir catchments
- Improve the measurement and operation at a number of our raw water abstraction sites

- Improve the operation of water supply systems through development of better rule curves utilising the Aquator software

Investment in alternative technologies to supplement dam safety activities will include consideration of new approaches to monitoring our assets such as using aerial or satellite imagery to verify dam movement over time using a remote sensing approach. We will also explore the benefits to the use of drones to carry out surveys that may improve the frequency of surveys and improve risk management.

- Use of ROV's and development of this technology area to gather and process and present better data from challenging environments.
- Consider alternative technology to supplement our visual inspections and explore methods to collect and store that information.

5.6 Long-term planning: AMP8 and beyond

Table 15 SR13 Long-term measure of success

	Measures of Success	Narrative	2024/25 Target (AMP7)	2029/30 Target (AMP8)	2050 Target (AMP12)
	Wt5 Water process unplanned outages	Total unplanned outage as a proportion of the company's total production capacity (%)	0%	0%	0%

Table 15 presents the PR19 measure of success along with the targets for 2024/25 end of AMP7, 2029/30 end of AMP8 and 2050 target at AMP12.

We plan to extend the Cowlyd reservoir approach to catchment management to include rivers and groundwater, the successful trials undertaken during AMP7 will be implemented to provide an early warning system to be managed as part of our mothership approach.

We plan to develop a data warehouse to hold our core data. This warehouse approach will ensure that data turns into information that is reliable and that a consistent message is provided to internal and external stakeholders. The incremental changes to our systems will ensure continued reliable service.

Innovation and efficiency

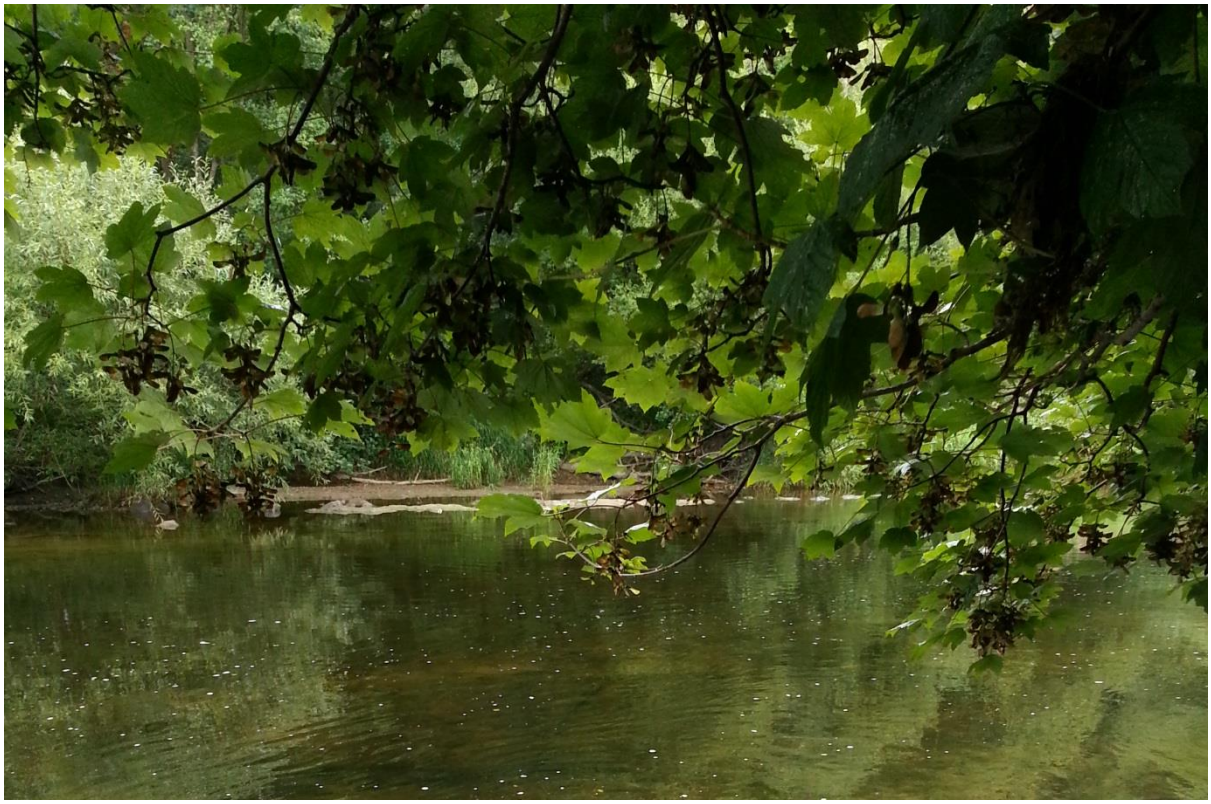
Some of our key research and innovation areas for AMP7 are:

- Sensing and control: improve raw water quality data and real time quality monitoring
- Control and monitoring: improve raw water quantity monitoring by improving flow and level measurement including the frequency of the data obtained and the availability of that data to the business.
- Data Management and management reporting: improve the capability and frequency of end to end whole process reporting in one place including data governance retention policies and analytical tools.
- Integrated data and management reporting: improve the understanding of how to implement and continually improve with the latest systems and IT language in a timely and efficient manner.

6 Strategic Response 14 – Promoting ecosystems and biodiversity

Water is fundamental to all life, as well as being essential to health and economic prosperity. Water is a renewable but finite resource and the links between our customers and environmental needs for water are recognised in the science, policy and regulation of water management.

Figure 10 Flowing Welsh river



6.1 Drivers

Welsh Water 2050 highlights changing demographics, land use changes, climate change and new sources of pollution all contribute to increasing pressure on the environment. Due to these and other factors, biodiversity and ecology face many threats in the future. Growing population can lead to habitat loss and fragmentation, while increasing the demand for abstraction leading to potential over-exploitation. Our mission “To become a truly world class, resilient and sustainable water service for the benefit of future generations” highlights the important we put on the environment. Our activities need to be carried out to support and enhance the environment as we need to take water from its natural location and treat it and take it to customers that may not be living and working in the same catchment. We cannot do this on our own we have to play our part along with our government, regulators, industry, environmental stakeholders and land users including customers and visitors.

In the longer-term, changing rainfall patterns and extreme temperature fluctuations can have a negative effect on biodiversity, through for example altering river flows, impacting migration of species like salmon, reducing the protection from pollution events and decreasing oxygen supplies to aquatic fauna.

We have a duty to enhance biodiversity and promote the resilience of ecosystems in the exercise of our operation. Enhancing biodiversity and ecosystem resilience can have many positive effects, not

just for the Welsh environment, but also for our communities. An environment that supports biodiversity is likely to be of high quality and unpolluted, which can encourage more public participation and engagement. A wider public engagement with nature can also increase public health and social well-being.

Our drinking water supplies are sourced mainly from surface waters – rivers and reservoirs – around Wales. These water bodies are generally of high quality which means they also support a healthy variety of flora and fauna. A significant proportion are designated under national and international law in recognition of their nature conservation importance. We work closely with our regulators, Natural Resources Wales and the Environment Agency, as they set the licences that allow us to abstract water from these water bodies.

Some of our licences allow us to take water from rivers and lakes that are Special Areas of Conservation, a designation made under the EU Habitats Directive. These Areas form part of a pan-European ecological network of "Natura 2000" sites to protect specific priority species and habitats. Under an exercise called the "Review of Consents", our regulators have previously reviewed our existing abstraction licences to make sure that our activities continue to have no significant adverse impact on the environment. For example, we have modified our abstractions on the Rivers Usk and Wye to ensure greater river flows during critical fish migration periods.

We also have a duty to have regard to River Basin Management Plans (RBMP) when carrying out our functions. The WRPG states that our Plan must support the achievement of Water Framework Directive (WFD) obligations and RBMP objectives and to ensure that our planned abstractions will:

- Prevent deterioration in water body status compared to the baseline status reported in the 2015 RBMP. If deterioration has occurred in the water body during the first RBMP cycle there may be a need to restore sustainable abstraction;
- Support the achievement of Protected Area objectives;
- Support the achievement of the environmental objectives in the 2015 Plans and where relevant; and
- Ensure a new activity or new physical modification does not prevent the future achievement of good status for a water body.

In meeting these obligations we are delivering against our strengthened biodiversity duty under Section 6(1) of the Environment (Wales) Act 2016.

6.2 Progress so far

Habitats Directive

The Habitats Directive was brought into UK law through regulations that

- provide for the designation of "European sites" (Natura 2000 sites);
- afford protection of "European protected species";
- provide for the adaptation of planning and other controls for the protection of such sites; and
- Impose a statutory requirement to deliver improvement schemes.

Under the Habitats Regulations, 'competent authorities' i.e. any Minister, government department, statutory authority, public body, or person holding public office, have a general duty, in the exercise of any of their functions, to have regard to the EU Habitats Directive. As the designated competent authority for Wales, Natural Resources Wales is required to ensure that its 'permissions', such as abstraction licences have no adverse effect on the 'integrity' of the Special Areas of Conservation

(SAC) and Special Protection Areas (SPA) that form part of the pan-European network of Natura 2000 sites.

As a competent authority ourselves, we must have regard to the requirements of the Habitats Directive so far as they may be affected by the exercise of our functions.

NRW and the EA undertook a detailed review of a number of our abstraction licences and concluded there were twenty-one sites where potential adverse effects upon the protected species could not be discounted. Working closely with both the EA and NRW we have agreed all the required amendments to our abstraction licences in order to ensure they are sustainable now, and into the future. All amendments to our abstraction licences have been built into our baseline deployable output calculations

Eel regulations

We have undertaken extensive studies during AMP6 to understand our obligations under the Eels Regulations. The output from this work is a programme of measures designed to reduce or eliminate the impact that our assets have on eel lifecycle. We are currently delivering these schemes which include intake screens and eel passes and alternative catchment measures where the hard engineering of schemes is not cost effective. Overall, this work does not impact upon our ability to abstract water or require the additional release of water from our reservoirs. There is, therefore, no impact from the regulations on the DO within any of our WRZs.

Water Framework Directive Heavily Modified Water Bodies

The European Water Framework Directive (WFD) came into force in December 2000 and became part of UK law in December 2003. Under the WFD, all inland water courses are divided into 'water bodies'. Some water bodies are designated as 'heavily modified'. A heavily modified water body (HMWB) is an existing body of water that has had its original character significantly changed to suit a specific purpose, such as water storage and flow regulation for water supply. Where a water body is classified as heavily modified, the UK should aim for that water body to reach Good Ecological Potential (GEP).

A number of water bodies have been designated as HWMB's due to the presence of our assets and their operation e.g. our impounding reservoirs that have dammed the river and disrupted the natural flow regime. For those sites identified as not being at GEP, NRW required us to investigate whether the main cause of this failure is the effects of our assets, and if so, what steps we should take to resolve this.

During the AMP6 we undertook the required investigations, working closely with NRW through a series of workshops, with the overall objective of appraising options that will achieve GEP for HMWBs where these are presently inadequate or do not exist. The investigations were undertaken in accordance with the UKWIR HMWB appraisal guidance. Following completion of the investigations, which included the assessment of 'disproportionate cost' when comparing potential improvements against the ecological benefit, a number of schemes are required for us to deliver in order for these water bodies to achieve GEP.

Water Framework Directive Article 7 'No deterioration'

After discussions with NRW and EA, we have confirmed that for AMP7 there are currently no abstraction sites identified that, either due to growth or other reasons for increased use will cause an impact upon the waterbody status. This is principally a function of the work completed to date

under the Habitats Directive and HMWB projects that have modified a number of our abstraction licences to ensure they are sustainable at their maximum volumes.

Abstraction reform

In its 'Water Strategy for Wales' (2015) the Welsh Government confirmed its commitment to reforming the system of abstraction licensing in Wales. The aim is to "Create a better, fairer and more modern approach that will ensure that we make the best possible use of our water resources whilst protecting the environment." (WG, 2015) [22]

The WRPG[23] (2017) states that for catchments managed by NRW, they will review all our abstraction licences at the point of transition and will make changes to licensed volumes where the unused amounts cannot be justified. The evidence NRW require us to provide is detailed in the following bullet points:

- Licensed volumes that are part of your deployable output (dry year annual average and/or critical period);
- licensed volumes that are used operationally (e.g. to reduce costs by using low cost groundwater or to retain year to year flexibility) providing records of this use;
- licensed volumes that are retained for emergency purposes e.g. in a drought;
- licensed volumes that are set out in your (or another water company's) feasible options list;
- Adequate infrastructure is in place or will be provided within the life time of the Plan; and
- Licensed volumes that are a direct abstraction from a reservoir.

Using the above criteria, we have an undertaken an initial risk assessment of all our abstraction licences to identify those unused licensed volumes that could potentially be removed without impact to our short term and long-term water resource capability. The outputs are summarised below. We need to confirm that these licences do not offer resilience under extreme droughts as part of our contingency plans. We will be undertaking this further review as we develop our Drought Plan in 2018.

Invasive Non Native Species (INNS)

By transferring water from one area to another for storage prior to treatment, we risk enabling the spread of invasive non-native species (INNS). INNS are defined as any non-native animals or plants that have the ability to spread outside their native range causing damage to the environment, the economy, our health or the way we live. INNS pose a number of risks to the UK Water Industry (UKWIR 2016)[24]. Recent legislative changes are likely to increase water companies' responsibilities for containing and managing INNS and force the implementation of wider biosecurity measures. Of particular importance are the EU Commission's Invasive Alien Species legislation (EU Invasive Alien Species Regulations (Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014) and The Infrastructure Act 2015 (February 2015). The EU Regulation became law in January 2015. It proposes interventions in the forms of: prevention; early warning and rapid response; and; management of the spread of INNS. It requires Member States to produce a list of INNS of concern, which is to be managed using risk assessments and scientific evidence.

6.3 Customer and stakeholder priorities

Our customers want us to have a strong environmental conscience and reduce the impact we have on the environment[25]. Our customers think that the countryside and rivers should be protected for wildlife as well as for health and tourism benefits[26].

Many of our stakeholders, such as NRW, Wildlife Trust Wales and RSPB Cymru, also support our focus on fulfilling our biodiversity duty. The Wildlife Trust Wales has highlighted that healthy ecosystems and the environment are fundamental to us and our customers, improving raw water quality, healthy rural and urban ecosystems and providing value for money services. Stakeholders, such as the Canals and Rivers Trust are also keen to work with us in partnership to improve ecosystems.

6.4 Our approach

We will deliver investigations, option appraisal and solutions as part of our commitment to the environment and via our obligation to comply with environmental regulations

- Consider the best option for the environment and that supports the needs of the company.

The water industry in England and Wales aims to provide water services in an equitable, sustainable and affordable way, based on regulatory control and environmental laws to ensure that ecosystem services are preserved while at the same time ensuring customer wellbeing and economic development.

The water resource planning process reflects this through a range of measures, including:

- The protection of environmental flows, via our environmental regulators' Catchment Abstraction Management Strategies process;
- The aim of achieving Good Ecological Status (or potential) as required by the European Water Framework Directive;
- The protection of habitats and species of international importance via the enactment of EU Habitats and Birds Directives;
- The need to identify the least cost, most sustainable solution for maintaining a balance between supply and demand, taking account of carbon costs of schemes, and wider environmental issues via SEA and HRA; and subsequently to identify the best value option and,
- The statutory duty placed upon water companies to promote water efficiency.

We recognise that many rivers in Wales and Herefordshire are not meeting the requirements of the Water Framework Directive (WFD), and we have been playing our part in trying to meet this challenge and we have been working across all our areas to improve the rivers we have an impact on. In AMP6 we implemented several successful projects and initiatives, including research and trial projects, investigations, education programmes, collaborations with stakeholders and third parties and funding schemes for independent organisations.

These policies, legislation, regulations and guidance already accommodate principles of the ecosystems approach, to a large degree. We always endeavour to optimise the operational efficiency of our water supply system whilst remaining within control rules, ensuring that we achieve the appropriate levels of service. This contributes to achieving ecosystem goals by reducing operational costs and carbon emissions.

We align this ecosystems approach with internal processes that review the quantity and quality of our raw water sources, to ensure that our customers' health is protected as best as possible. As part of this, we assess the source areas from which our water originates and try to address any potential management issues which could pose a risk to customers' health.

Our Catchment Team is charged with identifying and understanding potential threats to raw water sources from contaminants, for example from pollution events or ongoing land management practices. If we identify any potential risks, we investigate the causes, and aim to address the situation through our work with land owners and third parties.

We are addressing our biodiversity duty across all the work that we undertake across all our services.

Biodiversity plan

We published our biodiversity plan in July 2017 and it sets out our commitments to maintain and enhance biodiversity to 2019. This plan is a legal requirement for us under the Environment (Wales) Act 2016 and we are the first public body in Wales to publish a biodiversity plan. Our plan includes a commitment to report periodically to our customers on the progress that we have made against the suite of targets set out in the plan.

In order to fulfil our biodiversity aims, we are undertaking a range of actions in our biodiversity programme, working with staff, stakeholders and customers to improve the environment for all.

Collaboration with partners and stakeholders

Our WaterSource approach to create collaborative catchment management reduces pollution entering the environment (as detailed in chapter 2).

We will continue to fund projects which focus on eradicating weeds by promoting biodiversity through the invasive non-native species (INNS) funding scheme, which has so far funded the Dee INNS and 'Giving up weeds' projects.

We are also supporting community and volunteer groups, by making funding available to projects which focus on combatting the spread of invasive species.

Encouraging colleagues and suppliers

We aim to ensure that our colleagues understand the importance of biodiversity and how to manage the threats to it. To achieve this, we will continue to educate and engage our people and ensure that staff can recognise invasive species and know how to manage them, by supplying them with training courses and the non-native species identification booklet.

6.5 AMP6 performance

	Measures of Success	Narrative	2015/16 Performance	2017/18 Performance	AMP6 end forecast
	B1: Abstraction for water for use	Percentage compliance with our abstraction licences, as regulated by NRW.	100%	100%	100%

Table 16 SR14 PR14 measure of success

Error! Reference source not found. shows the PR14 measures of success relating to this strategic response and provides the starting position during 2015/16 our current position as reported during 2017/2018, and the latest forecast of where we predict we will be at the end of AMP6.

We have, and will continue to, fully comply with our abstraction licenses as set by NRW and the EA.

In AMP6 we implemented several successful projects and initiatives, including research and trial projects, investigations, education programmes, collaborations with stakeholders and third parties and funding schemes for independent organisations. Some of our most successful initiatives were:

- We successfully continued our WeedWiper programme which led to the development of our PestSmart programme which was launched in November 2016 at the Royal Welsh Winter Fair. Both programmes focus on a catchment wide approach to biodiversity protection measurements. WeedWiper was started in 2015 and works with farmers and land managers to promote better advice on dealing with the eradication of weeds and improving land conditions to address the underlying causes of infestations. PestSmart is supported by the Welsh Government and works across the whole pesticide supply chain to encourage all users to consider 'smarter' ways of weed, pest and disease control that don't impact on people, water and wildlife.
- To promote biodiversity among our colleagues, we have produced a booklet on 'invasive non-native species identification' to help our colleagues identify and report them. We have also created an in-house e-learning course on biodiversity.
- Within the INNS (invasive non-native species) funding scheme we have funded the Dee INNS and 'Giving up weeds' projects, which focus on eradicating weeds on a catchment wide scale and promoting good practice biosecurity.
- We have supported various projects under the WFD funding scheme
- We have established / worked in various partnerships to promote biodiversity and sustainable land use

6.6 AMP7 plan

	Wt7: Water catchments Improved	The number of our WTWs with catchments designated as requiring Safeguard Zones	1	23	18
	En6 km river improved	The length (in km) of river improved as a result of Welsh Water action (cumulative within an AMP)	36	562	418

Table 17: SR14 PR19 measures of success

Error! Reference source not found. presents the PR19 measure of success relevant to this strategic response and provides the outturn 2017/18 position, the 2019/2020 target at the end of AMP6 and the 2024/2025 target at the end of AMP7 target.

Collaboration with partners and stakeholders

We have jointly agreed a programme of work with NRW and the Environment Agency for AMP7 in order to meet our environmental obligations under the National Environment Programme (WINEP in England and NEP in Wales). Our programmes of work will include:

- **Heavily modified water bodies** – we will undertake investigations into the viability of sediment management at Talybont reservoir, Castell Nos reservoir, Pontsticill reservoir and Llwynon reservoir.
- **Ground water investigation** - an investigation of the impact of our ground water abstraction on flows in the River Teme
- **Barriers to fish** – we will investigate AMP5 and AMP6 schemes to ensure they are still fit for purpose, identify further sites that could be a barrier to fish migration during AMP8, and carry out mitigation works at 28 sites.
- **Abstraction reform** – we will investigate which of our sites will require investment in order to meet the requirements of DEFRA / Welsh Government driven abstraction reform.
- **Invasive non-native species** (INNS) – we have identified 18 sites where investigation is required in AMP7 to confirm if there is a risk of INNS translocation due to the transfer of raw water from one source of supply to another.

In AMP7 we will further continue to enhance biodiversity and enhance the resilience of ecosystems, through several research projects, customer education, improved catchment management, reducing pollution and collaboration with third parties. Some of our key project will be:

- We will continue our education programmes
- We will raise awareness of our biodiversity duties to contractors and encourage them to play their part
- We will make funds available to support community and volunteer groups, who have projects to curb growth and spread of INNS to enhance our approach to INNS.

- We will work in partnership with several stakeholders, e.g. Natural Resources Wales, Environmental Agency & Welsh Government

The investment contributes to achieving good ecological status along the stretch of the river. Each water body length will be improved due to the work, for example when a barrier is removed which is within a river bed, the water body upstream can then see a change to its ecology such as showing a presence of fish that were not able to traverse the barrier previously; this improves the status of that water body.

6.7 Long-term planning: AMP8 and beyond

Table 18 SR14 Long-term measure of success

	Wt7: Water catchments Improved	The number of our WTWs with catchments designated as requiring Safeguard Zones	18	13	5
	En6 km river improved	The length (in km) of river improved as a result of Welsh Water action (cumulative within an AMP)	418	148	N/A

Table 18 presents the PR19 measure of success along with the targets for 2024/25 end of AMP7, 2029/30 end of AMP8 and 2050 target at AMP12.

By working collaboratively with our regulators we can prepare for the future by understanding our impact on the environment so that the most sustainable and cost effective solutions can be delivered. SMNR is being considered and trialled during AMP7 and if found to be a solution that provides added benefits then this type of approach will be considered for further development in the future.

Innovation and efficiency

Innovation in this area is difficult to predict. The approaches currently being considered are themselves innovative. Further developments relating to our environmental community will be considered as they emerge.

SMNR – Our approach to the Teifi system in West Wales developed and applied across the company.

7 Summary

Our Water Resource Business Plan demonstrates how we will continue to meet our customer promises in the face of a diverse range of future challenges to our business. We have built this plan based on our range of recent customer engagement activities, and in alignment with our long-term Welsh Water 2050 Strategy. We have recognised that we will need to innovate and collaborate, whilst partnering with a wide range of stakeholders to achieve our shared objectives. This is especially important in areas where we have limited or no control, such as land use in our catchments. Table 19 shows our AMP7 activities in relation to our Strategic Responses.

Table 19 shows our AMP7 activities in relation to our Strategic Responses

Strategic Response	Activities in AMP7
1. Safeguarding clean drinking water	Developing and expanding our WaterSource approach to catchment management Implementing our Brecon Beacons Mega Catchment Strategy Deliver Catchment Management Plans Expanding our PestSmart programme (including Weedwipers) Deliver PestSmart, NutriSmart and animal Health Campaigns; Mitigating Metaldehyde and reduce disinfection by-products at our treatment works Managing manganese in our reservoirs Develop Within Catchment monitoring; Continue developing new research areas affecting
2. Enough water for all	Deliver our Water Resource Management Plan and a Drought Plan. Deliver schemes to remove deficits within Pembrokeshire and Tywyn Aberdyfi Deliver a scheme to ensure resilience for a 1 in 200 drought at Vowchurch. Assess the capability of Intake and Source Assets. Further Develop opportunities to create conjunctive use zones and improve resilience Assess the impact on treatment processes and the ability to abstraction from dead storage in our Impounding reservoirs

4. Protecting our critical water supply assets		Meet new legislative requirements for reservoir spillway and pipes and valves and reduce our risk profile for our reservoirs as measured by the Portfolio Risk Assessment. Reduce our risk position of our assets as measured by our Resilience Scorecards. Perform condition assessments on critical sections of trunk main where they are the single source of supply and cross trunk roads, motorways, railways or are in tunnels. Mitigate risks in a prioritised manner through duplicating pipelines, proactively replacing or improving temporary works conditions. Survey our tunnels containing water mains and plan future investment Perform CNI Reviews and Audits and SEMD and Security upgrades at strategic sites including intrusion detection and attendance management.
13. Smart water business		We plan to trial options to manage rivers and groundwater for pollution and poor raw water quality changes. We plan to extend trials to analyse the benefits from improved raw water quality at our treatment works as a consequence of catchment management schemes and effort. Implement a new hydrometric database that allows us to store, analyse and report on the data we collect more effectively Increase the amount of hydrometric data we collect with a particular focus on better understanding the hydrology of our reservoir catchments Improve the measurement and operation at a number of our raw water abstraction sites Improve the operation of water supply systems through development of better rule curves utilising the Aquator software Use of ROVs and development of this technology area to gather and process and present better data from challenging environments. Consider alternative technology to supplement our visual inspections and explore methods to collect and store that information. Continue to expand our Mothership programme, moving towards the monitoring and control of all our assets. Continue to replace our legacy SCADA, telemetry and control equipment. Implement new data visualisation tools.

14. Supporting ecosystems and biodiversity		Protecting the environment through our WaterSource approach and our Brecon Beacons Mega Catchment Strategy. Build a new visitor centre in Cardiff. Continue to develop our education programmes. Implement outputs required as part of the National Environment Programme, including removing barriers to fish migration. Provide support for volunteer and community groups that contribute towards eliminating invasive species. Provide support for volunteer and community groups that contribute towards eliminating invasive species. Improve the management of flow and sediment transport through our reservoirs causing Heavily modified water bodies Deliver improvements for Eel regulations at Whitbourne To investigate our impact on sites of SSSI from our Leintwardine abstraction Carry out improvements as part of the as part of the Safeguard zone action Plan in the Whitbourne drinking water catchment while considering additional benefits associated with ecosystems and biodiversity.

Annex A : Additional documentation

The documents below are available on request.

Document title	Date	Comments
Draft Water Resources Management Plan 2019, Welsh Water	March 2018	Describes the water resources risks that need to be overcome between 2020 and 2050 to ensure we are able to meet our customers' long-term needs.
Brecon Beacons Mega Catchment Strategy	December 2017	Our long-term strategy for how we will work in partnership to mitigate water quality pressures and achieve resilience of supply using catchment management measures in the Brecon Beacons.
Making time for nature, Welsh Water		Our plan for maintaining and enhancing biodiversity in the work that we do.

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