AFW Securing Cost Efficiency

Appendices

March 2019

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Action ref AFW.CE.A1

Response to Ofwat’s IAP

Appendix AFW.CE.A1.1 - Totex Summary

	Spend Item	September Business Plan (£m)	IAP Allowed Expenditure (£m)	Revised business plan (£m)	IAP Response	Difference to Sept PlanPlan (£m)	Difference to IAP (£m)
1	Supply demand balance, of which						
a(i)	*2020-25 supply enhancement -*	*5.5*	*5.0*	*5.0*	Accept	-0.5	0.0
a(ii)	*2020-25 demand (non-leakage) enhancement -*	*63.5*	*57.5*	*48.9*	We have revised these costs to align with the WRMP.	-14.6	-8.6
a(iii)	***2020-25 SDB enhancement sub-total***	***69.0***	***62.5***	***53.9***	**Accept**	**-15.1**	**-8.6**
b	*2020-25 leakage enhancement -*	*35.1*	*0.0*	*48.2*	We are adopting a leakage target of 18.5% (30 ML/d).	13.1	48.2
c	*Long-term enhancement -*	*47.9*	*38.1*	*36.1*	Accept company efficiency challenge on Sundon. Revised Supply 2040 costs.	-11.8	-2.0
d	*Strategic regional solution development -*	*18.5*	*18.5*	*18.5*	Accept	0.0	0.0
e	*Internal interconnections -*	*-*	*-*	*-*	n/a		
f	*Investigations and future planning -*	*14.2*	*0.0*	*0.0*	We have absorbed this cost in base.	-14.2	0.0
g	*Regional Reservoir -*	*0.0*	52.4	*52.4*	Accept	52.4	0.0
	Subtotal	**184.7**	**171.5**	**209.2**		**24.5**	**37.7**
2	Drinking Water Protected Areas	0.0	0.0	*0.0*	Accept	0.0	0.0
3	Making ecological improvements at abstractions	21.1	19.9	*19.9*	Accept	-1.3	0.0
4	Eels regulations	0.0	0.0	*0.0*	Accept	0.0	0.0
5	Freeform	0.0	0.0	*0.0*	Accept	0.0	0.0
6	Growth	53.8	53.8	*53.8*	Accept	0.0	0.0
7	Improvement to river flows	0.5	0.5	*0.5*	Accept	0.0	0.0
8	Invasive species	0.4	0.4	*0.4*	Accept	0.0	0.0
9	Investigations	6.9	4.8	*6.3*	Double-counting removed; cost efficience reduction of 10%	-0.6	1.5
10	Lead Standards	9.2	8.4	*8.4*	Accept	-0.8	0.0
11	Low Pressure	2.5	0.0	*0.0*	Accept	-2.5	0.0
12	Metering	76.9	60.5	*60.5*	Accept	-16.4	0.0
13	Raw water deterioration	3.7	3.5	*3.5*	Accept	-0.2	0.0
14	Resilience	5.3	3.1	*3.1*	Accept	-2.2	0.0
15	Security	0.0	0.0	*0.0*	Accept	0.0	0.0
16	Taste, odour, colour	0.0	0.0	*0.0*	Accept	0.0	0.0
17	Water Framework Directive	65.0	48.8	*65.0*	We have provided further detail and evidence.	0.0	16.2
	Subtotal	**245.3**	**203.7**	**221.3**		**-24.0**	**17.7**
	Total enhancement	**430.0**	**375.2**	**430.5**		0.6	55.3
18	Modelled base totex wholesale total	902.1	871.1	902.1	Partially accepted.	0.0	31.0
19	Unmodelled base totex wholesale	105.8	101.0	103.5	Partially accepted.	-2.3	2.5
20	**Total base totex wholeasle**	**1007.8**	**972.1**	**1005.6**		-2.2	33.5
	TOTAL	**1437.8**	**1347.3**	**1436.1**		-1.7	88.8
	Check to Ofwat published figures	1438.7	**1347.3**	**1436.1**		-0.7	0.2
	Difference	0.9	0.0	*0.2*			
	Total	1438.7	**1347.3**	**1436.3**		-2.4	89.0

Appendix AFW.CE.A1.2

Action ref AFW.CE.A1

Strategic Supply Transfer Scheme _Supply2040

Supply 2040

PR19 Business Case

OFFICIAL SENSITIVE

March 2019

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Asset Strategy document control sheet

Document amendment history

Version	Status	Date	Amendment to this version
1.0	Final	15/03/19	First issue in support of business plan resubmission.
2.0	Final	18/03/19	Second issue following director review.

Document approval

Document title	Supply 2040 business case			
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1 Document Purpose

The purpose of a Business Case is to describe the reasons for the project and the justification for undertaking it, based on the estimated costs of the project, the expected business benefits, savings and risks.

This Business Case also presents the range of options that we have assessed that could deliver the project outcome. We set out our reasoning for the best value option selected.

During a project or programme, the Business Case is a major controlled document that is referenced on a regular basis to confirm that the project and its solution remains viable. It is maintained throughout the lifecycle of the project, being reviewed by key stakeholders at key decision points.

2 Executive Summary

2.1 Overview

Supply 2040 is our multi-phase strategic plan from 2020 to 2040 to ensure our available water resources (supply) meet our customers' needs (demand) in our Central region.

The primary benefit of Supply 2040 is to balance supply and demand as required by our PR19 Water Resources Management Plan (WRMP). We need to act now as we have supply / demand deficits in five of the six communities in our Central region. We have delivered 63.1Ml/d of sustainability reductions since privatisation. We will deliver another 36.31Ml/d in AMP7, of which 33.71Ml/d will be in our Central region. We have fewer water sources available to meet customer demand.

Please see **Figure 1** for a map of our supply area and our communities.

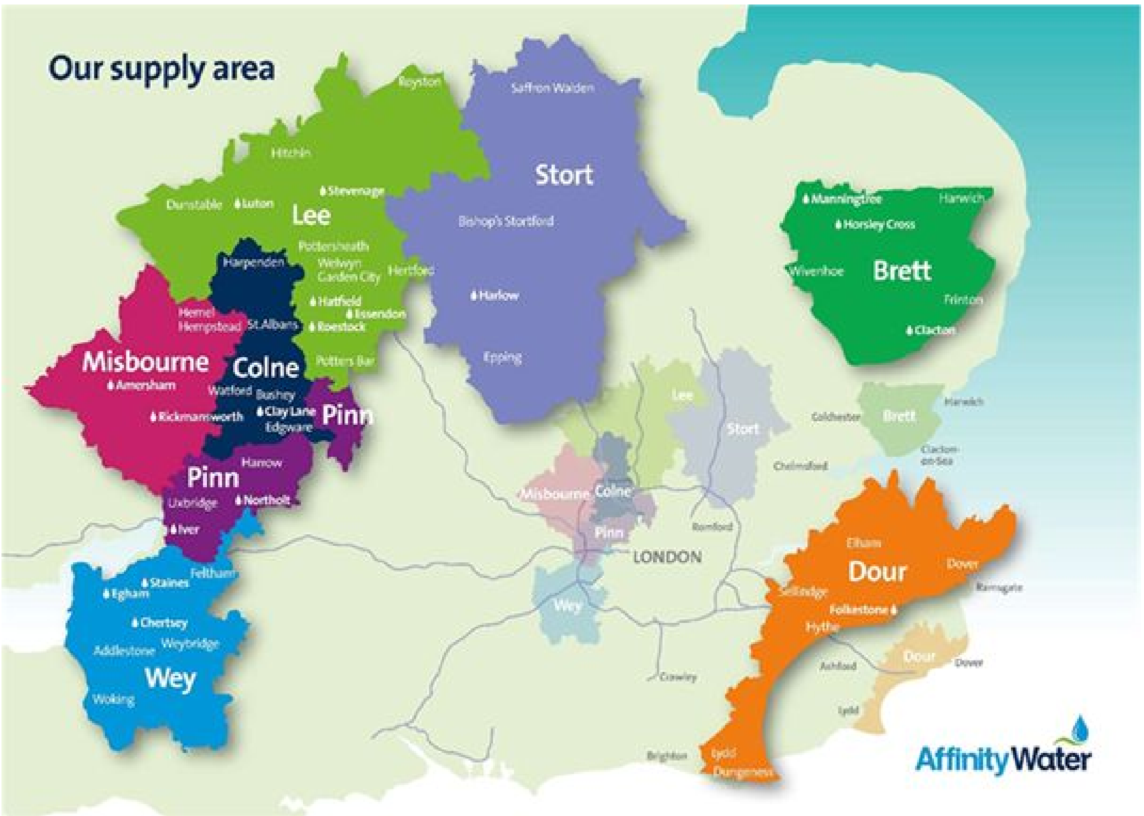

Figure 1: Affinity Water supply area and communities

2.2 Phase 1: AMP7

The driver for our Supply 2040 programme is to balance supply and demand. Our WRMP identifies the need to move a current surplus of water from our Wey community north. Our Supply 2040 programme includes intra-zonal projects to make use of this water within our Pinn community in AMP7. This creates a cascade effect to push our surface water further north into our Lee community to offset some of our groundwater sustainability reductions, so we can balance supply and demand.

Our Lee community has a supply / demand deficit from 2020 because of sustainability reductions and population growth. This deficit increases as we will deliver 15.9Ml/d of sustainability reductions in our Lee community in AMP7. We will increase our use of our shared supply with Anglian Water at Grafham to balance supply and demand. Our use of Grafham will be maximised under average conditions on completion of our conditioning treatment plant at Sundon in 2024. The compound effect of many AMPs of sustainability reductions in our Lee community means we have fewer sources to meet customer demand. Under Supply 2040, we will build additional storage and a booster pumping station in the north of our Lee community to transfer water from sources in the south of our Lee community, made available by the cascade of the Egham surplus into our Pinn community.

We are seeking funding for the AMP7 projects of our Supply 2040 programme. The costs associated with our AMP7 Supply 2040 programme are not double-counted with any other related programmes, such as our WRMP, sustainability reductions or Sundon conditioning.

2.3 Phase 2: AMP8

Ofwat has recognised the need for at least one new strategic supply solution in the next five to 15 years to balance supply and demand. In their Initial Assessment of Plans, they announced they will make available up to £360m through the PR19 period to facilitate the development of strategic water resources options for the south and south east of England. We need to prepare for those resources by ensuring we have the strategic infrastructure in place to receive and distribute water to meet customer demand. Our WRMP selects the Upper Thames reservoir in 2038/39.

The reservoir, if built, will be outside of our supply area. We have worked with Thames Water to develop the scheme. The likely entry point for the bulk import from the reservoir is to the west of our Misbourne community. We therefore need to prepare our strategic network to receive this import, and distribute it east, cascading through our Lee and Stort communities. This is the basis for the Supply 2040 projects we are considering for AMP8, which are under continuous review. We expect a key decision on the new strategic water resource in 2023 and will revise our plans accordingly.

2.4 Phase 3: AMP9

We will continue the works necessary to make use of the new strategic supply solution(s) to balance supply and demand across our Central region.

The AMP8 and AMP9 projects carry uncertainty as the scope will be dependent on the new strategic supply option(s). We have developed our Supply 2040 programme with enough flexibility, so we can adapt our approach when decisions are made in the future.

3 Supply 2040 programme

3.1 Driver

The primary driver for Supply 2040 is the need to **balance supply and demand** as defined by our WRMP.

Our WRMP forecasts supply / demand deficits from 2020 onwards under both dry year annual average (DYAA) and dry year critical peak (DYCP) conditions. These deficits are driven by population growth (increasing demand), together with sustainability reductions and climate change (reducing our water available for use).

In AMP7, in our Central region:

- We will supply 142,000 more people in 2025 than in 2020 (an increase of 3.7%);
- We will deliver 33.71Ml/d (average) of sustainability reductions in four of our communities (4% of our average daily distribution input);
- Climate change will reduce our deployable output (DO) by 4.7Ml/d (average).

Figure 2 presents our baseline supply / demand balance from our revised draft WRMP.

Figure 3 presents the surplus and deficits at community level for DYAA and DYCP, from our baseline supply / demand balance.

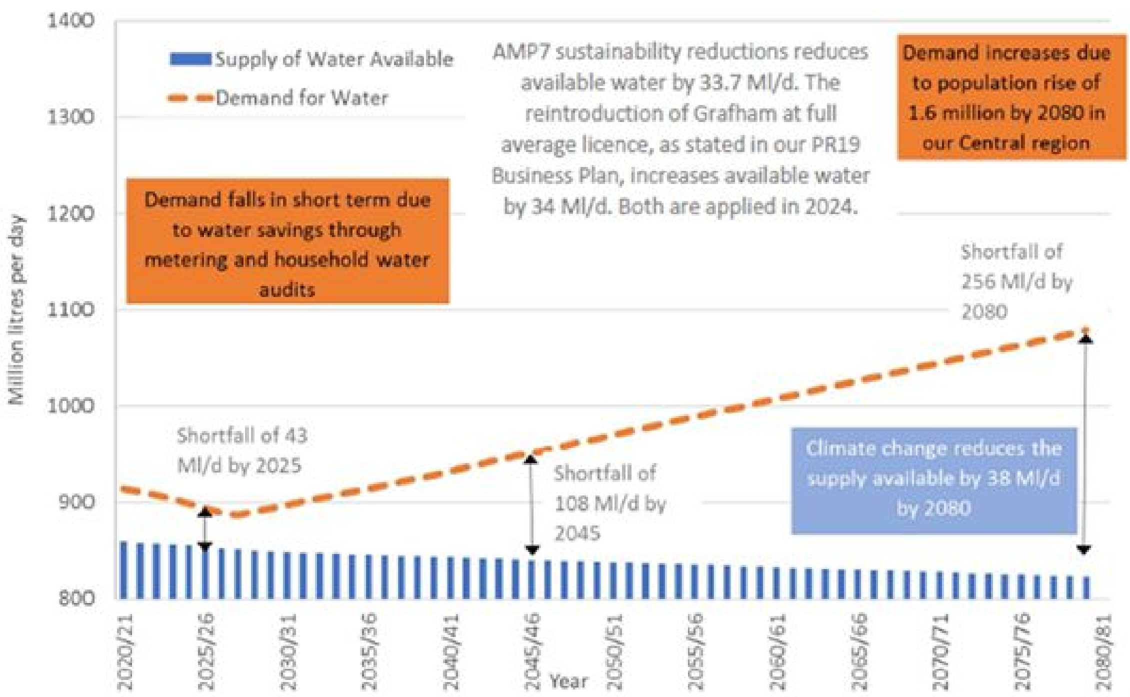

Figure 2: Baseline supply / demand balance at DYAA for our Central region (revised draft WRMP)

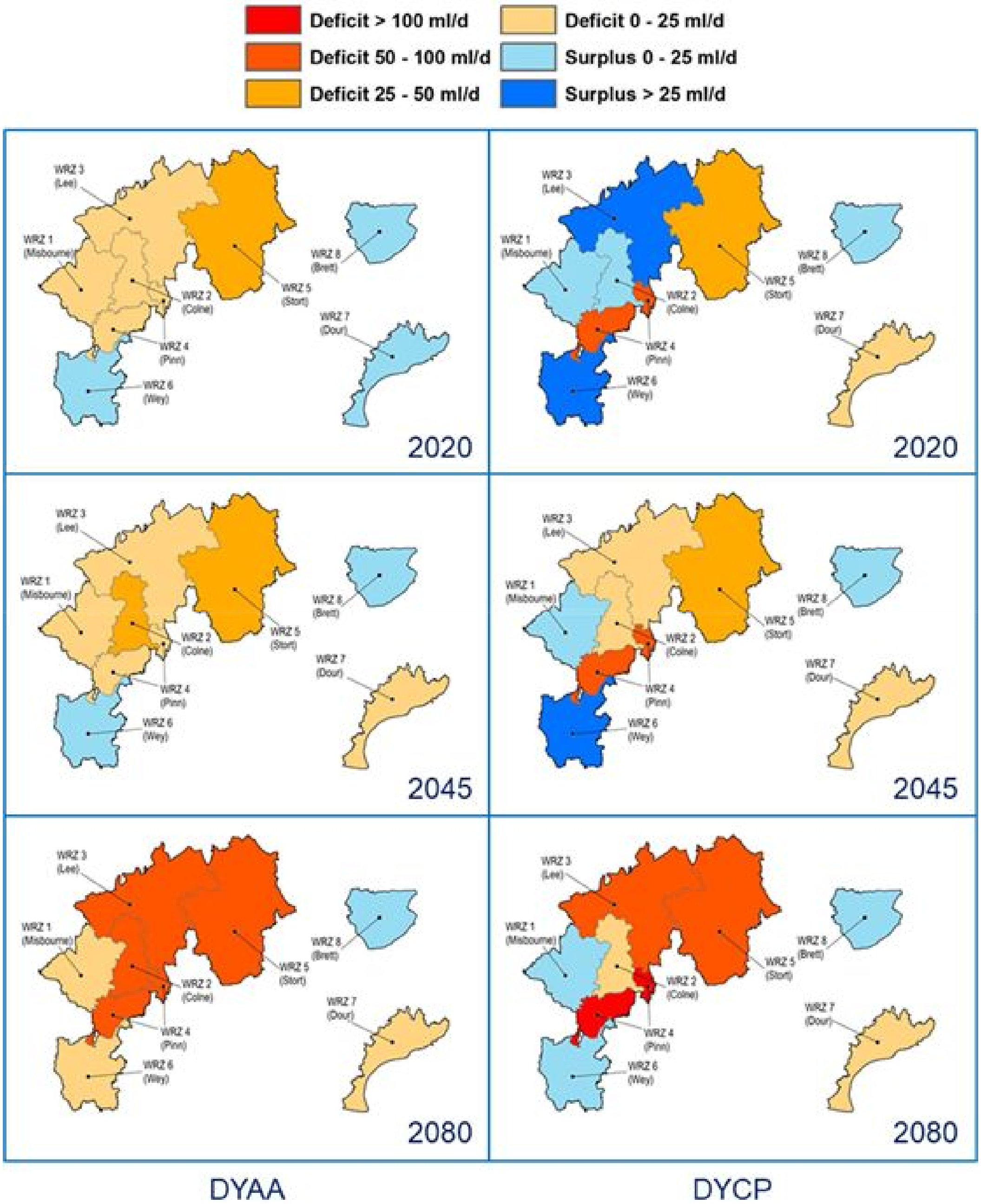

Figure 3: Zonal surplus and deficits (baseline) at DYAA and DYCP in 2020, 2045 and 2080

DYAA is the critical planning condition for our WRMP.

To balance supply and demand, in addition to other options, our WRMP identifies the need to transfer a 17Ml/d surplus from our Wey community. We need to create a cascade to transfer this surplus water north into our Pinn community and move that displaced water further north into our Colne and Lee communities. Our surface water sources are more resilient to the effects of climate change than our groundwater sources. Our groundwater sources are at risk of sustainability reductions if our abstractions are found to be damaging the environment. We are becoming more reliant on our surface water sources to meet our customers' demand for water.

3.2 Best value solution

We recommend the following projects to give best value for Supply 2040 phase 1:

- Egham to Iver: ST1a, use of existing 450mm main plus new booster to transfer 17Ml/d surplus at Egham.
- Network reinforcement in Pinn: ST2, intra-zonal Blackford to Ickenham trunk main to make use of Egham surplus within the community.
- Arkley: ST5, remove network restriction by laying c. 80m of trunk main to create a northward cascade.
- North Mymms: ST6, upgrade of existing booster pumping station at North Mymms to push water north.
- Bulls Green to Preston: ST9, new booster pumping station Bulls Green to Preston to push water further north into our Lee community.
- Preston to Sundon: ST10, new booster pumping station and make use of our existing strategic main to transfer water to the north of our Lee community.
- Chaul End storage: ST13, 20Ml cell at existing site to store transferred water surplus.
- Preston storage: ST14, 12Ml cell at existing site to store transferred water surplus.

The total cost of these eight options is £25,583.4k.

The options we have explored, and best value option justification are detailed in section 5.

3.3 Costs summary table

Table 1 presents a summary of the costs of the AMP7 phase of our Supply 2040 programme.

Table 1: Supply 2040 AMP7 phase 1 costs summary, £k

Best value Option	Y1	Y2	Y3	Y4	Y5	AMP7	WLC (40 years)
Costs (capex)	£9,272	£5,358	£4,694	£6,259	£0	£25,583	£25,583
Costs (opex) ^	£0	£0	£0	£0	-£1,812	£0	- £22,192
Total costs (totex)	£9,272	£5,358	£4,694	£6,259	£0	£25,583	-£39,647
NPV (£k)	-£9,012	-£14,074	-£18,385	-£23,972	-£22,400	-£22,400	£11,980

** Unit costs account for the baseline risk profile and final accounts of previous projects i.e. are inclusive of compensation events. An additional risk allowance would be adding a contingency fund on top of project costs that already include for risks that materialised.*

^ Please note: negative opex cost as these are cost avoidance.

3.4 Customer benefits

The primary benefit of our Supply 2040 programme is to **meet customer demand with our available water resources**. The delivery of our Supply 2040 programme allows us to balance supply and demand in all communities in our Central region. This ensures our WRMP is compliant as it has zero deficits.

Our Supply 2040 programme contributes to our outcome to **make sure you have enough water, while leaving more water in the environment**. The successful delivery of our Supply 2040 programme supports the delivery of several Performance Commitments:

- Sustainable abstraction
- Abstraction Incentive Mechanism
- Customers at risk of severe restrictions in a drought
- Unplanned outage

3.5 Methodology

Our value engineering process mirrored our water resources planning approach. We explored a range of options before developing a feasible list. Our best value approach was to make use of our existing strategic infrastructure where possible, with connections and boosters where necessary. We have proposed new pipelines only where the existing network is undersized for the transfer (i.e. it is already at capacity) and/or if there is a risk to customers or network stability. The feasible options have been priced using our Scheme Builder database (capital and operational costs) and modelled in MISER (our bespoke model that simulates transfers between hydraulic demand zones) to determine the best value solution.

Our approach is presented in **Figure 4**.

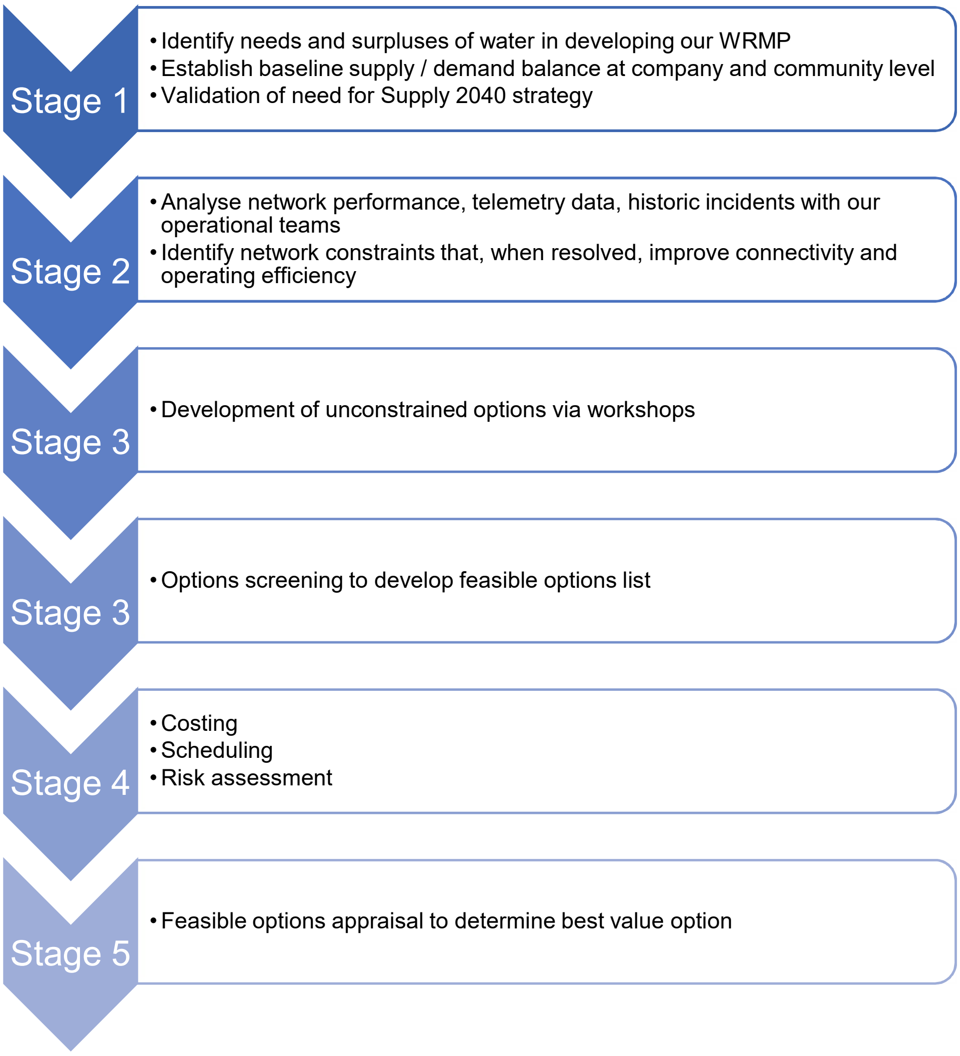

Figure 4: Visualisation of methodology

4 Defined Need and Dependencies

4.1 Defined Need

4.1.1 Introduction

Supply 2040 is our multi-phase strategic plan from 2020 to 2040 to ensure our available water resources (supply) meet our customers' needs (demand) in our Central region. This section of the business case provides further justification for our Supply 2040 programme.

The driver for our Supply 2040 programme is to balance supply and demand. Our WRMP identifies the need to move a current surplus of water from our Wey community north. Our Supply 2040 programme includes intra-zonal projects to make use of this water within our Pinn community in AMP7. This creates a cascade effect to push our surface water further north into our Lee community to offset some of our groundwater sustainability reductions, so we can balance supply and demand.

Our Lee community has a supply / demand deficit from 2020 because of sustainability reductions and population growth. This deficit increases as we will deliver 15.9Ml/d of sustainability reductions in our Lee community in AMP7. We will increase our use of our shared supply with Anglian Water at Grafham to balance supply and demand. Our use of Grafham will be maximised under average conditions on completion of our conditioning treatment plant at Sundon in 2024. The compound effect of many AMPs of sustainability reductions in our Lee community means we have fewer sources to meet customer demand. Under Supply 2040, we will build additional storage and a booster pumping station in the north of our Lee community to transfer water from sources in the south of our Lee community, made available by the cascade of the Egham surplus into our Pinn community.

4.1.2 Background and context

We have three significant sources of water in our Central region.

- Our four surface water works on the River Thames, together providing approximately 40% of our daily distribution input, to the south of our Central region.
- Our groundwater resources (boreholes).
- Our import from Grafham water treatment works, in the north-west of our Central region.

60% of our water supply is provided by 116 groundwater sources, spread across our region. Our Stort community has comparatively few sources. It is reliant on water cascaded through the neighbouring Lee community through our strategic network to meet customer demand.

Most of the aquifers we abstract groundwater from are classified as over-abstracted and over-licenced. We will deliver 36.31Ml/d of sustainability reductions (average) at our groundwater sources in AMP7.

Our PR19 draft WRMP forecasts supply / demand deficits in five of our six communities in our Central region at the beginning of the planning period (2020). This is driven by population growth (increasing demand), together with sustainability reductions and climate change (reducing our water available for use).

We have identified a 17Ml/d (at average) surplus in our Wey community. This surplus may increase in future, as South East Water has indicated they may reduce their bulk import from our Egham surface works. We cannot use this surplus to resolve supply deficits elsewhere in our Central region without additional investment.

In addition, we will be increasing the use of our shared supply with Anglian Water at Grafham to balance supply and demand in our Lee community. Our typical daily use rises from around 30Ml/d under normal conditions in AMP6 to 81Ml/d (dry year annual average) from 2024, when our Sundon treatment plant is commissioned. We maximise our licence under peak conditions in all years of the WRMP planning period.

Figure 5 presents a simplified schematic of our current strategic network in our Central region.

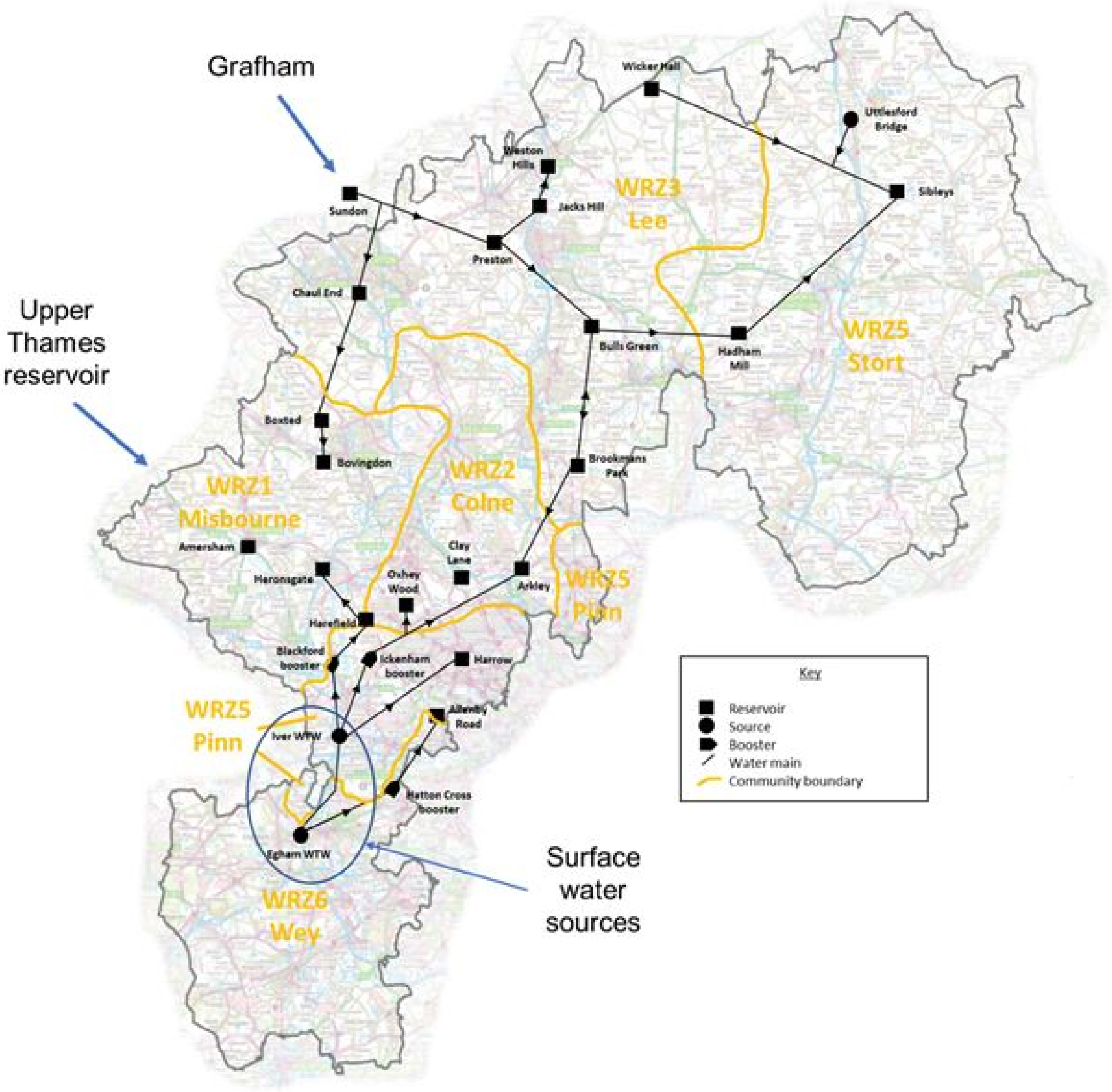

Figure 5: Our strategic network

Ofwat recognises that strategic water resources to serve the south and east of England will be needed in future. Our WRMP selects the Upper Thames reservoir in AMP10. This reservoir will be outside of our supply region. The most likely entry point for this resource is in the west of our Central region, in our Misbourne community. It is essential that we have our strategic infrastructure in place to accept the new strategic resource.

We have an extensive strategic network of infrastructure and non-infrastructure assets. For example, our Northern Link Main connects our Lee and Stort communities to distribute water from our sources in the far north of our operating region. We have a large trunk main from Sundon to Hadham to move Grafham water to our Stort community. We have connections between our surface water works, three of which are in our Wey community.

Our strategic infrastructure has developed organically over decades due to mergers and acquisitions of smaller companies in the creation of Affinity Water. Our higher-than-average population growth and a trend for reducing household occupancy (more single person homes) has highlighted some restrictions and constraints in our infrastructure. Recent operational experience, such as the high summer demand in 2018, has demonstrated the capability of our surface works. For example, we were able to supply South East Water with over 50Ml/d continuously during the summer from our Egham water treatment works to help meet their customer demand, without affecting our own supply to customers. The normal maximum export to South East Water is 36Ml/d. We have modelled and operationally verified that we have a surplus at Egham, but do not have the capability in our current infrastructure to move that surplus north.

Our Supply 2040 programme considers the restrictions in our ability to move water that prevent us from balancing supply and demand in the most efficient way. At community level, our WRMP confirms that the solutions proposed in this business case remove these restrictions. At hydraulic demand zone level, our MISER model confirms the intra-zonal projects allow us to move the Egham surplus water without restriction within our Pinn and Lee communities.

We will deliver our Supply 2040 programme in a planned and phased way to maintain the balance between supply and demand. This keeps the impact on customers' bills as low as possible. We will use our existing strategic infrastructure where it has enough capacity, with a modest programme of upgrades and connections. This will give our customers a 'grid' without the high capital cost of a completely new system.

4.1.3 Consequences of 'do nothing'

This option was rejected as we would be unable to deliver on our balance of supply and demand, as set out in our WRMP for AMP7 planning period.

4.2 Assumptions

- Where related to an option, our existing assets (pumps, surge protection systems, strategic mains etc.) are sufficiently sized to integrate with new assets (unless otherwise stated in the options appraisal).
- The purchase price of land per hectare is based on correspondence with our appointed land agent, Dalcour Maclaren, and assumes a willing seller.

- Sufficient land will be available or purchased on which to locate all of the new assets.
- Any necessary planning permissions will be granted.
- The new trunk mains can be built on the proposed routes.
- Delivery of AMP7 sustainability reductions will proceed in line with the planned programme.
- Delivery of the new Sundon conditioning treatment plant by December 2024.

4.3 Constraints

- Unforeseen additional costs and risks; limiting project scope and budget.
- Limited space on existing sites for new assets.
- We are constrained by the amount and cost of additional land available for purchase.
- Any suppliers of new technology systems or solutions must ensure that the materials in contact with water have all been approved by the DWI as per Regulation 31.
- We are constrained by the progress of Heathrow's expansion as our 450mm main running from Egham to Iver could potentially be diverted and the local network modified to accommodate Heathrow expansion proposed works.
- The existing capacity of the distribution system in terms of flow and pressure is as we have modelled.
- Progressive deterioration of the existing assets over time, which may result in reduced operating flow or pressure capability.

4.4 Dependencies

- Availability of resources from various Affinity Water teams to facilitate the Supply 2040's progress.
- The appointment of competent suppliers to deliver the projects within time and cost constraints, to the required standards.
- We are dependent on support and cooperation from the Heathrow expansion team to deliver any diversionary works associated with the Egham to Iver project.
- For later phases of work, we are dependent on the timely selection of a new strategic supply option(s) for the south east of England.

5 Options Appraisal

5.1 Options

5.1.1 AMP7: phase 1, release Egham surplus

Requirement

We have a water surplus of 17Ml/d at average, 30Ml/d at peak, at our Egham surface water treatment works. This water is in excess of our customer demand in our Wey community. This surplus cannot be moved north via our existing strategic infrastructure without further investment. The surplus was operationally verified during the summer of 2018 as we increased our export to South East Water to 50Ml/d without detriment to our customers or infrastructure.

We explored options to move the surplus north from our Wey community into our Pinn community. Iver, our largest surface water treatment works, is in our Pinn community. The Egham surplus would offset some of the Iver water supplying our Pinn community, freeing up Iver water to move further north This creates a cascade of water to progress further north towards our Lee community. We developed strategic options for our WRMP modelling. The most cost-effective option was to construct a booster and use our existing strategic network. Additional intra- and inter-zonal schemes are required to make use of this surplus and create a cascade northward.

Our WRMP model selected the ‘Egham to Iver’ booster project in every scenario at the earliest opportunity (2022/23).

We modelled the additional import to our Pinn community in our MISER model, which operates at a more detailed hydraulic demand zone level than our WRMP community-level model. Our Pinn community will need some network reinforcement to avoid over-pressurising the network around Iver, Blackford and Ickenham. We scheduled this work to complete before the Egham to Iver booster to prevent bursts and the increased risk of supply interruptions.

With Iver water now capable of being pushed further north, we identified an opportunity to redirect the water from our North Mymms works in our Lee community. North Mymms has a DO of 30Ml/d. It sends treated water south into the Pinn community. Iver water freed up from the Egham surplus can be used to offset North Mymms. North Mymms can then send its water north, subject to the necessary above and below ground works.

Table 2 summarises the five schemes of phase 1 of Supply 2040 to release the Egham surplus. We selected them from a range of options to represent best value for customers.

Figure 6 presents the same five schemes on a map of our Central region.

Table 2: Summary of Supply 2040 phase 1 projects to release Egham surplus

Project ID	Project name	Outcome
ST1a	Egham to Iver	Transfer 17Ml/d (average) surplus from Wey community to Pinn community.
ST2	Network reinforcement in Pinn	Reinforce the existing network to redistribute surface water within our Pinn community with additional 17Ml/d from Egham.
ST5	Arkley North	Removal of network constraint to improve flows between Pinn and Lee communities.

Project ID	Project name	Outcome
ST6	North Mymms	Upgrade pumping station to enable automated flow control to redirect flow north into our Lee community.
ST9	Bulls Green to Preston	Booster to make greater use of North Mymms water further into our Lee community.

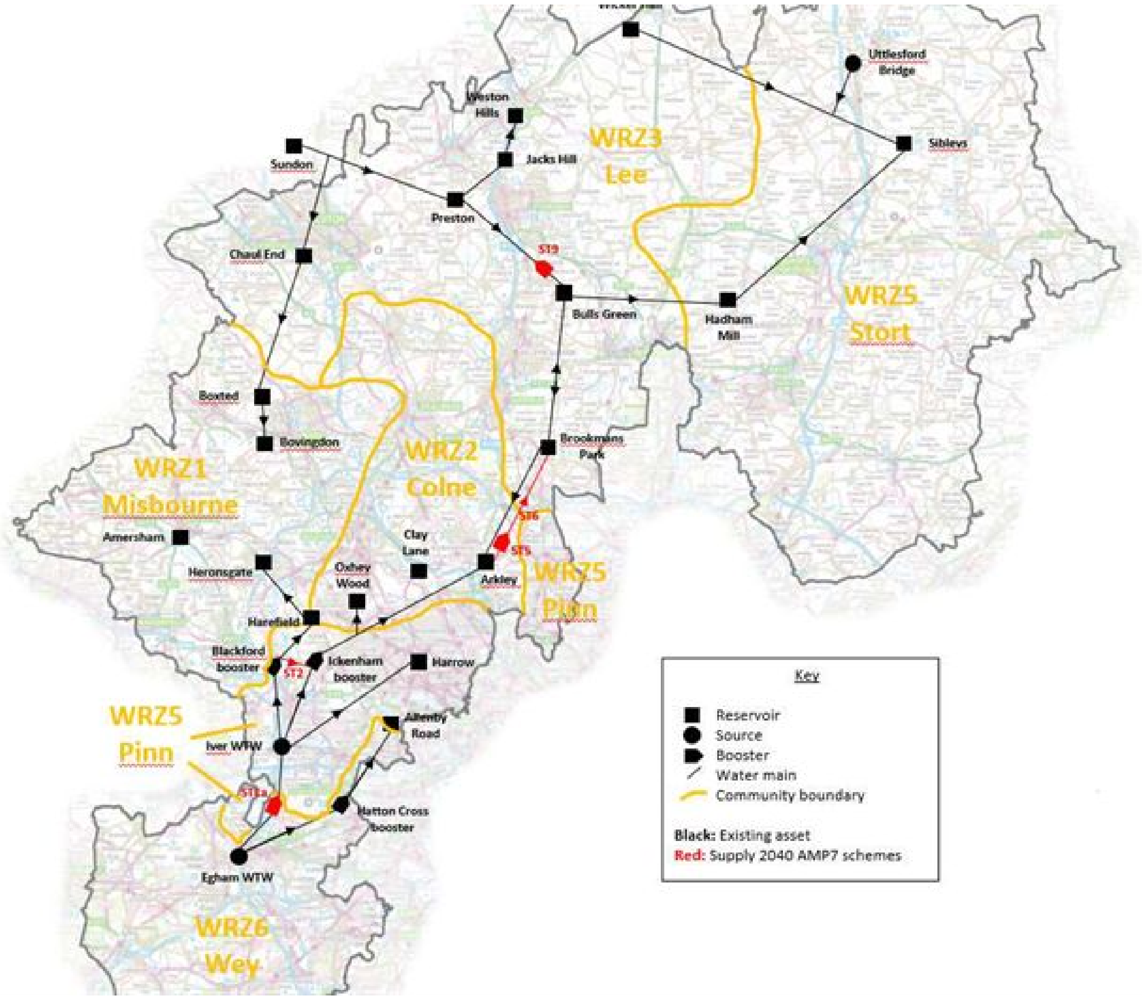

Figure 6: Map of Supply 2040 AMP7 phase 1 projects to release Egham surplus

Options appraisal: phase 1, Egham to Iver

'Do nothing' is not an option, as we will be unable to meet the supply / demand balance. This was explored further in section 4.1.3.

We identified six options to transfer the surplus at Egham. Four of these options facilitate the transfer with the proposed Heathrow expansion. See **Table 3**.

This project is complicated by the planned expansion of Heathrow airport. A 450mm strategic main transfers water from our Wey community to our Pinn community. It is within the site of the airport expansion. We expect to be requisitioned for a diversion for the duration of construction. The Heathrow developer anticipates construction between 2022 and 2026. For this period, we will be unable to use our 450mm strategic main. Consequently, we have explored alternative options with the Heathrow developer, and have identified these options in **Table 3**. We await the developer's requisition and will respond accordingly.

Table 3: Supply 2040 phase 1 costs, Egham to Iver

Option ID	Description	Discussion	Decision	Cost, £k
1a	Use of existing 450mm main plus new booster to transfer 17Ml/d average / 30Ml/d peak	Existing main has capability to transfer the surplus, but a booster is needed to pump it.	**This is our recommended option for AMP7.** High benefit (per Ml/d) for relatively low capex costs.	972.9
1b	A new booster (per 1a) plus reinforcement of existing 450mm main (8.2km of 800mm) to get future transfer capability (up to 50Ml/d)	As option 1a but improving the transfer capacity of the pipe network to move greater volumes of water. South East Water has indicated they may reduce their need for their Egham import in future.	Assuming reduction of South East Water export and / or increase of surface works DO, proposed option for AMP8.	18,881.4
2a	Do nothing now and delay construction of booster and new diverted pipeline to after Heathrow expansion works are complete (see section 6)	In detailed discussions with Heathrow developer, but not yet sure what requisitions will be made. 'Do nothing' means surplus remains at Egham and cannot balance supply and demand.	Not a viable option as supply / demand balance will be in deficit. Continue discussions with Heathrow developer to mitigate the risk of stranded assets post-expansion.	0
2b	Western diversion of 450mm (14km) main to allow for Heathrow expansion	The proposed route is challenging and expensive due to motorway crossings and the avoidance of obstacles (e.g. river crossings). The route lays the main in Thames Water's area. The construction programme is longer than Heathrow could allow. We would be left with an undesirable asset, inaccessible for sections of the route.	Agreed with Heathrow developer that this option is not viable, so will not be progressed. Other options to be explored.	43,400.0
2c	Booster station site plus reinforcement at minimum pipe size (14km of 450mm) to the east to accommodate Heathrow expansion 2022 to 2026 (17Ml/d average)	Will meet the immediate supply / demand requirements but is not sustainable in the long term if a greater surplus of water becomes available in our Wey community. More expensive than option 1a.	Likely to be the proposed solution when we are requisitioned for a diversion. Heathrow to pay the appropriate contribution.	19,955.9

Option ID	Description	Discussion	Decision	Cost, £k
2d	Booster station site plus shorter reinforcement of larger diameter (13km of 600mm) to the east to allow for future phases of supply (30Ml/d transfer) - booster allowance for upgrade	Accounting for Heathrow's expansion, this meets current needs and flexible to further increase transfer capacity. Dependent on South East Water's reliance on our Egham export and/or additional water from our surface works.	Will explore betterment costs in conjunction with South East Water's needs closer to the time of requisitioning.	34.974.9

Options appraisal: phase 1, network reinforcement in Pinn

'Do nothing' is not an option, as we will be unable to make use of the surplus water within our Pinn community. This was discussed further in section 4.1.3.

We identified three options to make use of the additional water in our Pinn community, realised by the Egham to Iver transfer. See **Table 4**.

Table 4: Supply 2040 phase 1 costs, network reinforcement in Pinn

Option ID	Description	Discussion	Decision	Cost, £k
1	New main, Iver to Ickenham, 10.5km of 700mm	Dedicated main Iver to Ickenham, new strategic main. Existing network is at capacity during peak conditions, so infrastructure needed to make use of surplus at Iver created by Egham.	This option has a slightly lower opex cost than Blackford to Ickenham as the route is slightly shorter, but a much higher capex.	30,757.8
2	New main, Blackford to Ickenham, 3.8km of 700mm	Controlled export between existing strategic mains from Blackford to Ickenham. Existing network is at capacity in peak conditions, so infrastructure needed to make use of surplus at Iver created by Egham. The route is longer than a dedicated Iver to Ickenham main, so marginally higher pumping costs.	**This is our recommended option.** The same benefits are derived as the Iver to Ickenham option, for significantly lower capex costs.	10,678.0
3	Upgrade Ickenham booster pumping station and Harefield High Lift, no network reinforcement	Upgrade the pumps to push more water using the existing network. Will work under average conditions where there is capacity in the network.	The network is at capacity in peak conditions. The pressure rating of the pipe would be exceeded. Not a viable option.	30,000.0

Options appraisal: phase 1, Arkley

We have three strategic storage reservoirs at our Arkley site. The water in these storage reservoirs is used to meet customer demand to the south of our Pinn community. With Egham and Iver water released, we want to push Arkley north. The hydraulic gradient of the network at Arkley creates a restriction that needs to be removed.

'Do nothing' is not an option, as we will be unable to make use of the surplus water within our Pinn community. This was discussed further in section 4.1.3.

The solution to remove the network restriction is to lay a short section of new mains. The existing mains are 30 inch cast iron. We would lay 700mm ductile iron. We identified the shortest possible route of c. 80m, with as much of the route in our land as possible. The cost of this option is estimated to be £664.0k. Other routes would be longer and therefore more expensive.

Options appraisal: phase 1, North Mymms

'Do nothing' is not an option, as we will be unable to divert surplus water at our North Mymms treatment works north into our Lee community, offsetting some of our groundwater sources. This was discussed further in section 4.1.3.

We identified two options to divert North Mymms water north. See **Table 5**.

Table 5: Supply 2040 phase 1 costs, North Mymms

Option ID	Description	Discussion	Decision	Cost, £k
1	New booster pumping station at Arkley	Pushes Arkley water north but only to North Mymms works. May restrict flow from the sources at North Mymms.	Will reduce the output from North Mymms and unable to push water north into our Lee community.	983.8
2	Upgrade of existing booster pumping station at North Mymms	New control valve, hardware and software. Provides the ability to push both North Mymms sources and Arkley water north into our Lee community with automated bi-directional control.	**This is our recommended option.** Lower cost option and enables northward distribution of surplus into our Lee community.	902.7

Options appraisal: phase 1, Bulls Green to Preston

'Do nothing' is not an option, as we will be unable to make better use of North Mymms water within our Lee community. This was discussed further in section 4.1.3.

We identified three options to make use of North Mymms water in our Lee community. See **Table 6**.

Table 6: Supply 2040 phase 1 costs, Bulls Green to Preston

Option ID	Description	Discussion	Decision	Cost, £k
1	New dedicated trunk main plus booster pumping station to	Option is a main dedicated to pushing water north, no change to existing strategic	Very high capex costs. Option bypasses Preston reservoir (costly to include	80,000.0

Option ID	Description	Discussion	Decision	Cost, £k
	push from Bulls Green to Sundon, 27km of 700mm	network. Allows us to offset Grafham and supply Luton from a cascade of water at our surface works in the south of our Central region.	and control) and reduces operational flexibility to export water east compared to other two options.	
2	New dedicated trunk main plus booster pumping station to push from Bulls Green to Preston, 12.3km of 630mm	Option is a main dedicated to pushing water north, no change to existing strategic network. Direct connection to Preston. Allows us to export water east.	High capex costs. Case for a third strategic main when capacity exists in existing network is weak.	22,600.0
3	New booster pumping station to push from Bulls Green to Preston	Makes use of existing capacity in our strategic network. Booster allows the network to be bi-directional (currently only moves water south).	**This is our recommended option.** We have two strategic mains from Bulls Green to Preston that have sufficient capacity.	926.7

Best value option: AMP7 phase 1, release Egham surplus

The best value combination of options for phase 1 to release the 17Ml/d surplus at Egham is:

- Egham to Iver: ST1a, use of existing 450mm main plus new booster
- Network reinforcement in Pinn: ST2, Blackford to Ickenham trunk main
- Arkley North: ST5, remove network restriction by laying c. 80m of trunk main
- North Mymms: ST6, upgrade of existing booster pumping station at North Mymms
- Bulls Green to Preston: ST9, new booster pumping station Bulls Green to Preston

5.1.2 AMP7: phase 1, Lee community supply / demand

Requirement

The majority of our chalk abstractions in our Central region are in our Misbourne, Colne and Lee communities. We delivered sustainability reductions at Friars Wash in 1993. By the end of AMP5, we completed 21Ml/d of sustainability reductions. We have already met our AMP6 target to reduce our abstractions by 42.09Ml/d (at average) in our Central region.

We have become reliant on imports and inter-zonal transfers to meet customer demand, notably in our Misbourne, Colne, Lee and Stort communities. In our Lee community, in AMP6, we delivered 25.27Ml/d of sustainability reductions. We will deliver a further 15.9Ml/d of sustainability reductions in our Lee community in AMP7. As a result, we have insufficient resources within the community to meet demand. We balance supply and demand by relying on imports from the neighbouring Misbourne community and, increasingly, Grafham via Sundon.

We estimate that 19,000 properties receive Grafham water on a daily basis under average conditions in AMP6. This will rise to 24,000 properties by the end of AMP7 as a result of further sustainability reductions and anticipated growth. Under peak conditions in a dry year, the corresponding figures are 111,500 properties (end of AMP6) and 122,000 properties (end of

AMP7). The pumping costs to cascade the water northwards from surface works on the Thames to the far north of our Central region are cost beneficial. We will be unable to meet customer demand in our Lee community if the Grafham import is not available.

Our WRMP requires the increasing use of the Grafham import to balance supply and demand.

Grafham is restricted by its water quality. We have had undertakings in previous AMPs. Under the ‘no deterioration’ principle, we have been restricted to supplying Grafham water only to areas that have previously received it. As noted in our revised draft WRMP, although the import has a capacity of 91Ml/d, the benefit it has to water available for use is only 50Ml/d and has effectively been limited to this value since before privatisation. This constraint is reflected in our baseline modelling for our revised draft WRMP. Our AMP7 investment portfolio includes the construction of a treatment plant at Sundon to remove the restriction on our use of Grafham. On completion of our Sundon treatment plant in 2024, we maximise our use of Grafham under dry year annual average conditions.

We have insufficient headroom in our groundwater sources and our limited storage is inadequate to meet customer demand in the event of an outage of Grafham. Our Lee community is also set to experience an above average population growth.

A booster to move water north from Preston to Sundon (freed up by the cascade initiated by the surplus at Egham) ensures we maintain the supply / demand balance in the event of an outage at Grafham. Our existing strategic mains have the capacity to transfer more water, so no further investment is needed. Our early working proposals included for a new reservoir at Sundon as strategic storage to balance supply and demand. Through our optioneering, we identified that new cells at our existing reservoirs at Chaul End and Preston would be cheaper and provide greater operational flexibility in the event of an outage or burst on our strategic mains network within our Lee community, while providing the same benefits to the supply / demand balance. Their completion is scheduled to coincide with Sundon’s commissioning. These new cells are included in our Supply 2040 programme.

Table 7 summarises the three schemes of phase 1 of Supply 2040 to address our Lee community’s supply / demand balance. **Figure 7** presents the same three schemes on a map of our Central region.

Table 7: Summary of Supply 2040 phase 1, Lee community supply / demand

Project ID	Project name	Outcome
ST10	Preston to Sundon	Booster to push water north and west into the Lee community where a cascade has been created by Egham surplus (projects ST1a, ST2, ST5, ST6 and ST9). Also provides bi-directional flow via existing strategic main.
ST13	Lee storage (Chaul End)	New cell at our existing site. Provides storage for surplus water transferred into our Lee community from the Egham to Iver cascade. Sized to provide 24 hours storage to restore supply resilience for customers, eroded as a consequence of sustainability reductions. Provides operational flexibility in the event of an outage at Grafham or Sundon.
ST14	Lee storage (Preston)	New cell at our existing site. Provides storage for surplus water transferred into our Lee community from the Egham to Iver cascade. Sized to provide 24 hours storage to restore supply resilience for customers, eroded as a consequence of sustainability reductions.

Project ID	Project name	Outcome
		Provides operational flexibility in the event of an outage at Grafham or Sundon.

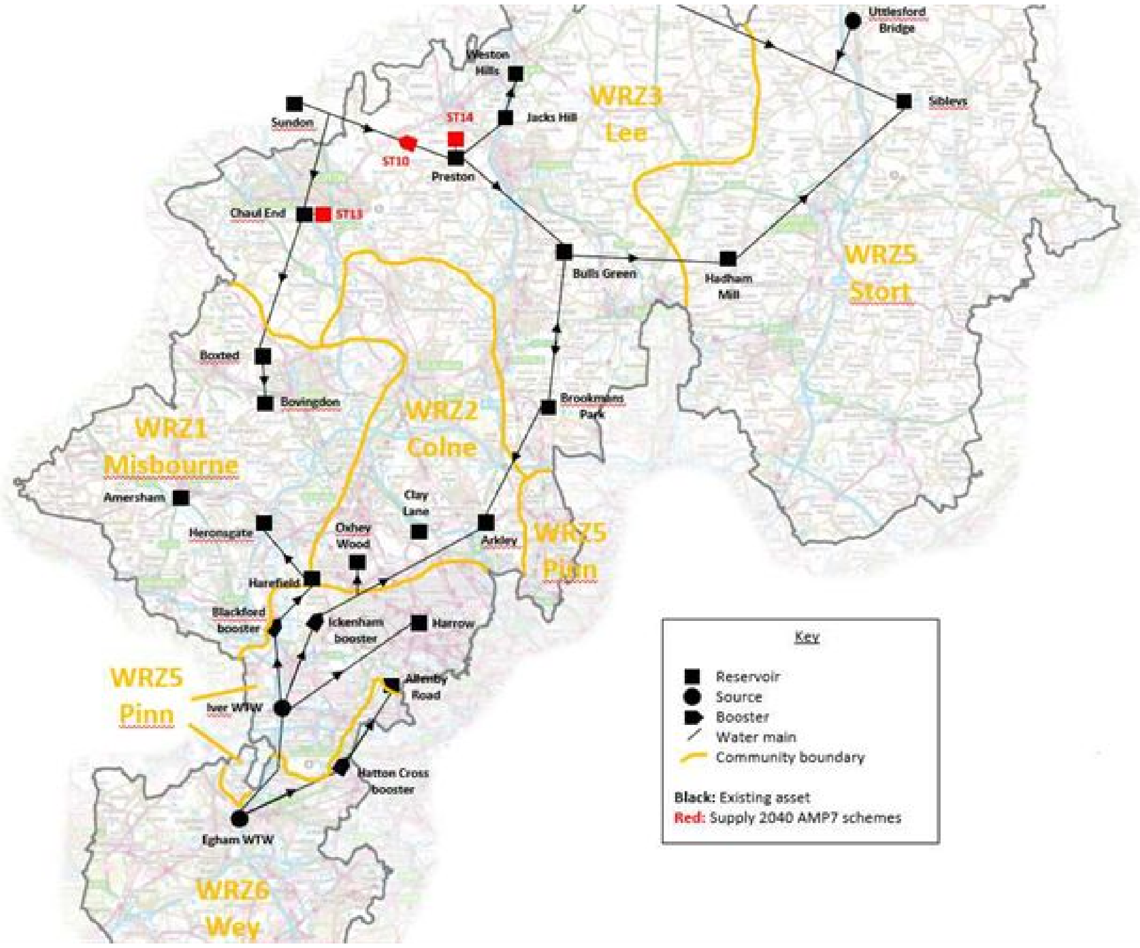

Figure 7: Map of Supply 2040 AMP7 phase 1 projects, Lee community supply / demand

Options appraisal: phase 1, Preston to Sundon

‘Do nothing’ is not an option as we will be unable to move water from the eastern part of our Lee community (Stevenage) to the west (Luton).

We identified two options to facilitate the movement of water further west into our Lee community. See **Table 8**.

Table 8: Supply 2040 phase 1 costs, Preston to Sundon

Option ID	Description	Discussion	Decision	Cost, £k
1	New main dedicated main (14.6km of 630mm) and new booster to push from Preston to Sundon	Option to twin an existing main. Booster would provide bi-directional flow.	Would provide additional redundancy in the event of a burst. Much higher capex.	26,663.7
2	New booster pumping station to push from Preston to Sundon using existing main	Booster would provide bi-directional flow.	Lower capex and provides the same benefit. **This is our recommended option.**	946.3

Options appraisal: phase 1, Lee storage

'Do nothing' is not an option, as our customers will continue to be exposed to greater levels of risk caused by many AMPs of sustainability reductions. This was discussed further in section 4.1.3.

We identified two options to make use of the additional water in the south of our Lee community, realised by the Egham to Iver transfer and subsequent cascade north.

Table 9: Supply 2040 phase 1 costs, Lee storage

Option ID	Description	Discussion	Decision	Cost, £k
1	New storage, similar size to reduction in daily licence at Sundon at the new conditioning plant	60Ml based on 12 hours of storage for flow of 109Ml/d (peak) from Grafham. 60Ml/d provides approx. 24 hours storage for our typical use of Grafham under average conditions.	Would provide supply continuity of supply in the event of an outage at Grafham, but not if a problem occurred in the network south of Sundon.	14,916.4
2	Additional reservoir cells at existing sites	20Ml at Chaul End and 12Ml at Preston. In-combination benefit with existing storage provides similar benefit to single cell at Sundon. Permits storage of water transferred from the south of our Lee community.	**This is our recommended option.** Lower capex cost than larger reservoir at Sundon. Significant additional benefit to enable existing single-celled reservoirs at Chaul End and Preston to be taken out of service for planned inspection and maintenance without increasing the risk to customers.	6,214.6 + 4,278.3

Best value option: AMP7 phase 1, Lee community supply / demand

The best value combination of options for this phase is:

- Preston to Sundon: ST10, new booster pumping station using existing main
- Chaul End storage: ST13, 20Ml cell at existing site
- Preston storage: ST14, 12Ml cell at existing site

5.1.3 AMP8: phase 2

Once the strategic regional resource(s) is decided, we can prepare our network to receive the import. We assume an entry point in the west of our region, likely our Misbourne community, for the Upper Thames reservoir. We will ensure we can move the imported water north and east to our Lee and Stort communities, where deficits are expected to increase (please refer to **Figure 3**). We have explored the infrastructure options that would be needed to move the necessary volumes to meet customer demand across our Central region.

We will continue our discussions with South East Water about their longer-term use of the export we provide from our surface water works at Egham. South East Water has indicated they may not need as much in future if their demand management programme is successful. We would ensure our strategic infrastructure is sized to move any additional surplus water north to balance supply and demand. We have developed outline designs for the options that would allow us to make use of surpluses up to 40Ml/d (average) at our Egham works.

5.1.4 AMP9: phase 3

We will continue the works necessary to make use of the new strategic supply solution(s) to balance supply and demand across our Central region.

The AMP8 and AMP9 projects carry uncertainty as the scope will be dependent on the new strategic supply option(s). We have developed our Supply 2040 programme with sufficient flexibility, so we can adapt our approach when decisions are made in the future.

5.2 Cost Benefit Analysis

We built cost estimates for each option in our Supply 2040 programme using our cost models. We have cost models for different types of assets. In developing cost estimates for all items in our AMP7 investment portfolio, we have:

- Analysed and utilised final account project costs from AMP5 and AMP6, rebased to financial year 2017 /18, to derive unit costs.
- Carried out benchmarking exercises to ensure that costs produced align with framework contracts and accessible outturn cost data.
- Used costs to build 260 cost models for different types of assets, estimate over 12,000 individual unit costs and derive cost curve formulae used to price the projects in our Business Plan.
- Had our costs independently audited and benchmarked by Atkins Limited and PricewaterhouseCoopers. Our Board and Customer Challenge Group were provided with their due diligence and risk report.

Further information on our approach to costing is presented in section 8.2 of Appendix 6 of our Business Plan, the Wholesale Technical Support Document.

We have explored options for each component of our Supply 2040 AMP7 programme. We have justified the best value option in each case to build our proposed programme of work. We have identified opportunities to make use of our existing strategic infrastructure, proposing to reinforce only where it is at capacity.

Our proposals for AMP8 and AMP9 are dependent on the timely decision for a new strategic water resource(s) for the south east of England. We have assumed a key decision point in 2023. We will review and revise our proposals for AMP8 and beyond after this decision point.

5.3 Recommendation

Our Supply 2040 programme was constructed from a clear need to make use of the surplus at our Egham surface works, as selected in our PR19 WRMP.

We have explored multiple options to achieve our aim to ensure our available water resources (supply) meet our customers' needs (demand) in our Central region. We have kept costs low by creating a grid from our existing strategic infrastructure.

We have a key date in 2023 when we will know more about the strategic supply option(s) that will be needed in the next five to 15 years.

We are seeking funding for the AMP7 projects of our Supply 2040 programme. **Table 10** presents a summary and costs of the eight projects of our Supply 2040 AMP7 programme, totalling £25,583.4m.

The costs associated with our AMP7 Supply 2040 programme are not double-counted with any other related programmes, such as our WRMP, sustainability reductions or Sundon conditioning.

Our Supply 2040 programme for AMP8 onwards will be reviewed and adjusted as necessary to accommodate the strategic water resource option(s).

Table 10: Summary and costs of our Supply 2040 AMP7 programme

Phase	Project ID	Project name	Outcome	Cost, £k
1	ST1a	Egham to Iver	Transfer 17Ml/d (average) surplus from Wey community to Pinn community.	972.9
1	ST2	Network reinforcement in Pinn	Reinforce the existing network to redistribute surface water within our Pinn community with additional 17Ml/d from Egham.	10,678.0
1	ST5	Arkley	Removal of network constraint to improve flows between Pinn and Lee communities.	664.0
1	ST6	North Mymms	Upgrade pumping station to enable automated flow control to redirect flow north into our Lee community.	902.7
1	ST9	Bulls Green to Preston	Booster to make greater use of North Mymms water further into our Lee community.	926.7
1	ST10	Preston to Sundon	Booster to push water north and west into the Lee community where a cascade has been created by Egham surplus (projects ST1a, ST2, ST5, ST6 and ST9). Also provides bi-directional flow via existing strategic main.	946.3
1	ST13	Lee storage (Chaul End)	New cell at our existing site. Provides storage for surplus water transferred into our Lee community from the Egham to Iver cascade. Sized to provide 24 hours storage to restore supply resilience for customers, eroded as a consequence of sustainability reductions. Provides operational flexibility in the event of an outage at Grafham or Sundon.	6,214.6
1	ST14	Lee storage (Preston)	New cell at our existing site. Provides storage for surplus water transferred into our Lee community from the Egham to Iver cascade. Sized to provide 24 hours storage to restore supply resilience for customers, eroded as a consequence of sustainability reductions. Provides operational flexibility in the event of an outage at Grafham or Sundon.	4,278.3
				25,583.4 *

** Please note, sum total is correct, project costs are rounded to the nearest £k.*

6 Risks and Issues

We are in detailed discussions about the planned Heathrow expansion. We are using our existing strategic infrastructure to move the Egham surplus via the new booster (scheme ST1a). We expect to be requisitioned for a diversion, as a minimum for the duration of construction. We are uncertain of the timing at this stage. We will continue to work with the scheme's developers as they firm up plans. We expect the costs of the diversion to be funded by Heathrow.

We identify the delivery related risks to the programme with our proposed mitigation in **Table 11**.

Table 11: Delivery risks and mitigation

Risk/Issue	Mitigation
Disruption to local community whilst construction works are ongoing.	Careful planning of works to minimise disruption. Stakeholder engagement. Good communication with customers and communities and to keep informed of works and manage situation.
Additional land purchase, easements and permissions / consents are required to allow construction of required assets.	Early identification of routes for new mains to minimise risk and disruption required. Any land purchase or easements required to be identified early in concept phase and supporting resource made available to progress.
Timescales for procurement of equipment and installation and other operational outages.	Detailed programme planning to ensure works are planned in advance and other planned operational outages are considered.
Power requirements for new / modified assets not met and require upgrading, as found to be insufficient during project definition phase.	Early designer / contractor involvement to ensure requirements are understood as early as possible. Potential to look at alternative/renewable energy options where appropriate.
Additional modelling / detailed investigations lead to increase in scope / costs.	Ongoing engagement with modelling teams and stakeholders.
Getting the right people in the project team with correct skill set to deliver best value option within time and budget whilst ensuring quality.	Programme Manager to identify required resources early to ensure correct team in place with correct skillset for effective and efficient delivery.

7 Procurement Strategy

We will follow our normal procurement strategy. Our procurement procedures ensure compliance with statutory requirements of the European Union, Ofwat and other legislation.

We have Framework Agreements in place with Principle Contractors for the design and construction of mechanical, electrical and civil engineering works for above and below ground assets. We also have Framework Agreements in place with Tier 2 suppliers for the provision of pumps, valves, pipework, security etc. to encourage standardisation and cost certainty. We continue to refine our procurement approach to take advantage of best practice. We regularly review the most cost-effective way procuring projects. We consider:

- Early engagement beginning in the concept stage to drive innovation;
- Grouping projects to benefit from economies of scale;
- The use of incentivisation in contracts, to achieve early completion and lower project costs;
- Competitive tendering (where appropriate) and key performance indicator driven allocation to improve the level of competitive tension.

Appendix AFW.CE.A1.3

Action ref AFW.CE.A1

Catchment management: Drinking Water Quality Plans

Catchment management: Drinking Water Quality Plans

PR19 Business Case

March 2019

Asset Strategy document control sheet

Document amendment history

Version	Status	Date	Amendment to this version
V5	Draft	01/03/2019	Revised BC in new template for re-submission
V6	Draft	06/03/2019	Revisions based on initial review with Marie Whaley
V7	Final	22/03/2019	Final version

Document approval

Document title	Catchment management: Drinking Water Quality Plans PR19 Business Case			
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	Name	**Signature**	**Title**	**Date**
Author/originator	Alister Leggatt		Asset Manager	22/03/2019
Technical Reviewer	Ellie Powers		Senior Asset Manager	22/03/2019
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Approver 2 Legal (external use)				
Approver 3 AS Director following EMT review (external use)	Marie Whaley		Director of Asset Strategy, Data and Innovation	22/03/2019

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1 Document Purpose

The purpose of the Project Business Case is to describe the reasons for the project and the justification for undertaking it, based on the estimated costs of the project, the expected business benefits, savings and risks.

The Business case will also present all the options that have been assessed to deliver the project outcome and will indicate the preferred option out of all considered.

During the project a Business Case is a major controlled document that is referenced on a regular basis to ensure and confirm that the project remains viable. It is maintained throughout the lifecycle of the project, being reviewed by key stakeholders at key decision points, i.e. at the end of a phase.

2 Executive Summary

2.1 Introduction

The Drinking Water Inspectorate (DWI) quote in the Water Safety Plan guidance document: "The quality of raw water is a key element for any drinking water supply system. Water use, land use and polluting human activity in the catchment area have significant impacts on surface and groundwater quality, and thus the level and complexity of treatment plant necessary to ensure that the water leaving the works is safe and acceptable to consumers. Understanding catchment characteristics and/or activities potentially impacting on raw water quality and availability is thus of paramount importance to ensuring drinking water safety."

The Drinking Water Quality Plans catchment management project was initially established in 2010 to undertake a detailed risk assessment of the land use within our water catchments known as Source Protection Zones for 116 Affinity Water groundwater sources. The Catchment Team has developed and refined the catchment risk assessment process through AMP5 and AMP6 in line with DWI guidance on the development of Water Safety Plans. The outputs from this project are used to define the Water Industry National Environment Programme (WINEP) water quality investigations through the ‘no deterioration’ driver of the Water Framework Directive (WFD).

This document sets out the justification for proposed continuation and enhancement of the Drinking Water Quality Plans catchment management for AMP7.

2.2 Drivers

Drinking Water Safety Plans (DWSP) are a mandatory business regulatory requirement under Regulations 27 and 28 of Water Supply (Water Quality) Regulations 2016 and this project has been developed to facilitate the 'Catchment' element of the DWSP for Affinity Water. This project provides an internal lead on pollution investigations that pose a risk to public water supply and provides relevant information to support business and operational decision-making both in incident response and subsequent source/pathway investigation. The project will also require liaison with Environment Agency and other key stakeholders on matters posing actual or potential risk to water quality and meets the requirements stipulated by the DWI set out in the 'DWI Guidance Note: Long term planning for the quality of drinking water supplies' issued September 2017 (Appendix 2).

- Outputs of this project define Affinity Water’s WFD ‘no deterioration’ investigations for the Water Industry National Environment Programme (WINEP) for AMP8.

- Collaborate with multiple agencies (EA, Local Authorities) to identify the polluter(s) and seek to recover costs to our customers under the Polluter Pays Principle (e.g. Chromium impacting WHSD, Cryptosporidium affecting EGHS and HWFS and Bromate impacting on ESSE).
- To meet the regulatory requirement for Drinking Water Safety Plans (catchment element) under Regulations 27 and 28 of Water Supply (Water Quality) Regulations 2016.
- To provide greater resilience to our assets through proactive risk assessment, pollution incident response and mitigating the risks posed by major land use change.
- Support the achievement of Customer Outcome 3: supplying high quality water that customers can trust.
- To meet the expectations specified in the DWI Guidance Note: Long term planning for the quality of drinking water supplies issued September 2017.
- Provide catchment intelligence to support business and operational decision-making both in incident response and subsequent source/pathway investigation and investment options appraisals.
- Assess the risk to public water supply of developments within our Source Protection Zones, provide technical support/guidance to developers/consultants and coordinate technical responses for planning applications focusing on water quality risks to ensure appropriate mitigations are implemented or objections raised (including highlighting risks to the business internally).

2.3 Best value option

Option 3 - DWQP catchment management enhanced revised based on efficiencies agreed by Steer Co.

The revised ‘Enhanced’ option for developing and implementing catchment-focused Drinking Water Quality Plans includes a continuation of the current DWQP catchment survey and risk assessment approach for 116 catchment survey and risk assessments for our groundwater sources and the Lower Thames surface water catchment (focus on pesticides, nutrients and cryptosporidium risk). The best value option is an enhancement of this approach, with development of a refined and dynamic risk approach which continually reviews and revises the risk assessments and communicates the outputs to the business and our regulators.

This option also includes provision to develop and implement action plans to proactively investigate issues (e.g. contaminated land, long term pollution incidents) and work with multiple agencies to seek recovery of costs under the Polluter Pays Principle (e.g. chromium impacting WHSD, cryptosporidium impacting River Thames abstractions).

The best value option has been selected as it provided the best cost benefit alongside meeting regulatory expectations and providing greatest value to the business. It has been developed based on proactive approach to current and future point source pollution risks (e.g. WHSD Chromium, Cryptosporidium impacting River Thames abstractions) and work to identify and seek recovery of costs from the polluter, and where possible, in-catchment remediation options that reduce the need for future treatment investment and reduce ongoing opex costs in dealing with pollution.

In addition to carrying out the programme of catchment risk assessments, the scope of this project includes:

- Identifying, assessing and responding to planning applications that may pose a risk to water quality.
- Responding to, investigating and acting as liaison between AWL and other stakeholders for pollution incidents notified through the Environment Agency POLWARN process.
- Working with landowners, developers and consultants on mineral extraction, fracking, contaminated land remediation and communicating to AWL to inform operational and investment decisions.
- Developing action plans where significant risks or increasing trends in water quality risk based on the outputs of the catchment risk assessments.
- Developing and working within AWL to implement pollution prevention and mitigation guidance (e.g. following burst mains) within Wholesale Ops and Asset Delivery.
- Identifying and assessing future risks to water quality (e.g. new or reformulated pesticides) and developing monitoring protocols.

This project aims to develop a stronger understanding of the catchments we operate in and develop positive working relationships with landowners, developers, Local Authorities, regulators and our communities to mitigate the risk of present and future issues affecting our ability to supply wholesome drinking water.

There is an expectation from Defra, DWI and the EA for water companies to increase their focus on catchment management and incorporate this into the long-term planning for managing water quality in line with the Water Framework Directive (WFD). Article 7 of WFD stipulates a move away from end of pipe treatment solutions to managing risks and issues at the source. This option facilitates the development of catchment action plans where emerging risks are identified to further investigate catchment based solutions to support options appraisal for future catchment pollution mitigation schemes.

By developing a better understanding of the catchments that supply raw water to our assets and the land use that poses a risk to water quality, this project facilitates moving from a reactive approach (treatment, blending and imports) to a proactive approach of identifying and mitigating pollution risks at the source providing a greater level of resilience for our treatment and distribution.

This project will utilize a range of emerging technologies such as remote sensing and satellite imagery as well as reviewing long term trends in water quality to identify risks to public water supply and support options appraisal for both treatment investment and catchment mitigation plans.

2.4 Cost summary table

Table 1 Costings for the Preferred Option

Preferred Option:	Y1	Y2	Y3	Y4	Y5	Y10	Y20
Costs (capex)	£100,000	£135,000	£135,000	£135,000	£100,000		
Costs (opex)	£15,000	£15,000	£15,000	£15,000	£15,000		
Total costs (capex, risk + opex)	£115,000	£150,000	£150,000	£150,000	£115,000	£0	£0
Total revenue							
Funding requirement (capex + opex – revenue)	£115,000	£150,000	£150,000	£150,000	£115,000	£0	£0
NPV (£k)	-83.6	-145.6	-145.6	-149.6	-99	-248	278

Please see section 4.3 for commentary around the NPV assessment.

2.5 Customer benefits and resilience benefits

The primary purpose of this investment is meet our mandatory business regulatory requirement to develop source to tap risk assessments under Regulations 27 and 28 of Water Supply (Water Quality) Regulations 2016. In addition, the Drinking Water Quality Plans.

- Pro-actively investigates pollution risks, impacts of development and major land use change to reduce the impact to Affinity Water and its customers from current and future incidents (e.g. Buncefield, HATR, WHSD).
- Develops a better understanding of our catchments where raw water is sourced including the risks identified and appropriate mitigation measures.
- Supports a longer-term strategy of reducing diffuse and point source pollution at the source in order to prevent further deterioration of water quality and associated treatment needs/costs.
- Supports achievement of Customer Outcome 3: Supplying high quality water that customers can trust.
- Supports achieving our performance commitment 'Water Quality Compliance, Compliance Risk Index (CRI)' target performance.
- Informs the operational monitoring programme to ensure effective monitoring protocols and frequencies for a range of pollutants including appropriate timing for monitoring.
- Long term objective of reducing capex and opex costs for future treatment investment and ongoing operational costs.
- Changing our approach to managing pollution risks from reactive to proactive.

2.6 Methodology

The development of DWSP's is a legal requirement regulated by the Drinking Water Inspectorate (DWI). The DWQP catchment management project has been developed as a rolling programme of land use surveys, long term (minimum 10 years) water quality trend analysis and risk assessments for every source carried out every 5 years (as a minimum), or if an incident or major change in land use has occurred.

The methodology has been under continual development since 2010 and has been developed using a combination of guidance from the DWI as shown in Appendix 3, experience gained during AMP5 and AMP6, exploration of available technologies (e.g. satellite imagery) and liaison with other water companies. The current methodology which has been used to define this project is documented in AM739 - DWSP Catchment Survey and Risk Assessment Methodology (Appendix 4). Current pollution risks and emerging trends in water quality identified during the AMP6 DWSP project (P019405) have been utilized to support development of Water Industry National Environment Programme (WINEP) investigations and schemes delivered under the Water Framework Directive (WFD) and support operational decision-making both for capital investment and during pollution events.

3 Defined Need and Dependencies

3.1 Defined need

The Drinking Water Quality Plans catchment management project was initially established in 2010 to undertake a detailed risk assessment of the land use within our water catchments known as Source Protection Zones for 116 Affinity Water groundwater sources. The Catchment Team has developed and refined the catchment risk assessment process (Appendix 4) through AMP5 and AMP6 in line with DWI guidance on the development of Water Safety Plans (Appendix 3). This project sets out the business case for continuation of this with a further risk assessment of each source which is currently undertaken on a 5-year rolling programme, or where an incident or major change in land use has occurred. There is also a need for coordination in investigating pollution events including: current pollution incidents, historic groundwater contamination and emerging pollution trends. The impacts of such events pose a significant risk to public water supply and can also incur significant long-term costs for our customers and reduce resilience of our supply. This project also sets out the business case for proactive investigation of these issues to seek recovery of costs and effective mitigation measures under the Polluter Pays Principle.

3.2 Assumptions

- DWSPs will remain a mandatory requirement
- The outputs of Drinking Water Quality Plans project will be used to define the WINEP WQ investigations for AMP8
- The business will implement the new online DWSP reporting tool currently commissioned by Water Quality Services.
- Current guidance and requirements for DWSPs will remain consistent.
- The catchment element of water safety planning responsibility will sit within Asset Strategy providing outputs to Water Quality Services.

3.3 Constraints

- Water companies are not a statutory consultee within the planning process. We will work alongside AW's Spatial Planner to proactively identify planning applications with the potential to impact on water quality.
- Lack of relevant information provided in a timely manner by the competent authority for environmental protection, local authorities and other key stakeholders limiting ability to proactively respond to pollution incidents, contaminated land investigations. This will be managed through regular engagement with the EA groundwater and contaminated land teams. Where required, the Catchment Team will work with the Legal Services Team to submit Freedom of Information Act requests where data/information is not forthcoming.
- Current NPV assessment does not include an assessment of Natural Capital and the outputs will not reflect the additional value derived from this scheme.

3.4 Dependencies

- Working alongside Water Quality team to provide outcomes of catchment risk assessments to support treatment and distribution risk assessments. The Catchment Team has regular liaison meetings with Water Quality Services and work is ongoing in AMP6 to align DWSP risk assessment processes.

- Identifying effective, high quality remote sensing technology to advance the land use risk assessment. The Catchment Team have purchased remote sensing consultancy services, purchased land cover data and are building experience on other remote sensing techniques.

- Working with the GIS Team (Internal) to process remote sensing and other GIS related datasets. Where additional expertise is required in data purchasing, processing and interpretation is required, we have worked with specialist consultancies who could provide this service as required. There is an option to recruit a specific internal resource if there is a need across other projects/programmes.

- Collaborative working arrangements with neighboring water companies e.g. upstream pollution risks and biosolids spreading in groundwater catchments. The Catchment Team work closely with neighboring water company catchment teams and meet regularly to discuss water safety planning and other catchment management activities.

4 Options Appraisal

4.1 Approach

All schemes and investigations within the Environmental Enhancements programme were defined through their respective regulatory driver(s) and aligned to the associated customer outcome(s) and business need. Each scheme/investigation then underwent an options appraisal exploring the mitigation options, costs and resource requirements to address the need and meet the associated regulatory requirements. This appraisal was supported by the business requirements MoSCoW method documented in Appendix 13.

Several options were developed for each scheme/investigation using a bespoke WINEP Unit Cost Model for PR19 developed for the Environmental Enhancements programme by consultants Mott McDonald. The Unit Cost Model compiled all unit costs and staff hours for catchment management projects based on historic proposals and quotes from schemes and investigations delivered during AMP6. The 'Project build' tool incorporated into the model enabled the user to build up an estimate of the total project cost using pre-defined 'tasks' from drop down menus. The number of 'units' against each task was inputted, which produced a cost for each of the option developed per scheme/investigation. An audit trail was prepared for contractor and other (e.g. infrastructure and farmer incentive payment) unit costs. All costs are including company overheads. They are then indexed to 17/18 price base (an uplift of 15%). The detailed cost model for each scheme can be provided on request. All files that provided evidence of the unit costs were subject to an internal audit to check their accuracy.

The Unit Cost spreadsheet for each option in this business case is available in Appendix 1.

4.2 Options

Table 1 Costings for the options appraisal

	Option 1	Option 2	Option 3
Year 1	£150,000.00	£96,522.00	**£100,000.00**
Year 2	£196,000.00	£96,522.00	**£135,000.00**
Year 3	£196,000.00	£96,522.00	**£135,000.00**
Year 4	£201,000.00	£96,522.00	**£135,000.00**
Year 5	£164,300.00	£96,522.00	**£100,000.00**

4.2.1 Do nothing

The do nothing option will not proceed with the Catchment element of the DWSP process in AMP7 and rely on risk assessments and supporting information from AMP6 to feed into the next stages of Water Safety Plans.

Benefits

- low cost.

Risks

- Will not meet our regulatory obligations under Regulations 27 and 28 of Water Supply (Water Quality) Regulations 2000 (Drinking Water Safety Plans).

- Will not allow for catchment-based investigations into pollution incidents, emerging contaminant trends and large-scale planning applications documented within this business case. Additional resourcing in Asset Strategy would be required under Opex.

- Defra, EA, DWI and Ofwat all have stated expectations that water companies will undertake increased catchment management activities as part of long term plans for water quality.

4.2.2 Option 1 - DWQP catchment management enhanced inc. remote sensing and proactive recovery of costs under Polluter Pays Principle

Option 1 includes a continuation of the current DWQP catchment survey and risk assessment approach with purchasing of applicable satellite imagery data for medium/low risk sites. This option also includes provision to develop action plans to proactively investigate issues e.g. contaminated land, long term pollution incidents and seek recovery of costs through detailed investigations under the Polluter Pays Principle.

<u>Benefits</u>

- Adopts a proactive approach to managing pollution risks.

- Will facilitate recovery of costs of additional treatment/blending/distribution investment arising from pollution events (e.g. Chromium affecting WHSD PS).

- Supports a more effective Water Safety Planning approach and guidance from DWI on long term planning for water quality.

- Remote sensing imagery may lead to capex and opex savings by reducing physical land use surveys and associated resource requirements.

- Will meet our regulatory obligations under Regulations 27 and 28 of Water Supply (Water Quality) Regulations 2016.

- Provide robust evidence to support decision making for AMP8 business planning and beyond.

<u>Risks</u>

- Most expensive option.

4.2.3 Option 2 - DWQP catchment management basic

Option 2 includes a continuation of the current DWSP catchment survey and risk assessment approach with no enhancement. This option provides costs for each catchment survey and risk assessment plus a limited number of pollution investigations and planning application review and responses. It does not include the development of action plans and more detailed source/pathway investigations

Benefits

- Will meet our regulatory obligations under Regulations 27 and 28 of Water Supply (Water Quality) Regulations 2000 (Drinking Water Safety Plans).

- Cheaper capex option.

Risks

- Could lead to increased opex costs for further investigations and recovery of costs under the Polluter Pays Principle beyond the proposed budget.

4.2.4 Option 3 - DWSP Enhanced option with costs revised based on efficiencies determined by Steer Co. (Preferred option)

Option 3 will implement the activities detailed in Option 1, but an assessment of available remote sensing data will need to be undertaken based on the reduction in Totex funding agreed by the EMT. This option also assumes a reduction in available resource to investigate and seek recovery of costs for pollution events compared to option 1.

Benefits

- Adopts a proactive approach to managing pollution risks

- Supports a more effective Water Safety Planning approach and guidance from DWI on long term planning for water quality

- Will meet our regulatory obligations under Regulations 27 and 28 of Water Supply (Water Quality) Regulations 2016

- Provide robust evidence to support decision making for AMP8 business planning and beyond

Risks

- reduced funding compared to option 1 increases the available resource to seek recovery of costs for pollution events, respond to planning applications and minerals plans leading to an increased risk of future impacts to public water supply and potentially more expensive long-term mitigation options.

- Reduced use of remote sensing technology will not realise efficiencies in human resource time leading to delays in delivering all catchment risk assessments, response to planning applications and consultations.

4.3 Cost Benefit Analysis

A high-level assessment of NPV for the preferred option has been carried out. This investment is primarily driven by regulatory requirements under the Water Supply (Water Quality) Regulations 2016 and supporting the definition of future WINEP investigations under the WFD ‘no deterioration’ driver.

The primary method of calculation for this assessment was calculated by estimating the DWSP catchment risk assessment and engagement with planning and pollution incident response leading long-term reduction in PCV failures. Also considered in the calculation was an estimate of a failure to comply with legislation leading to prosecution by DWI for not showing evidence of effective Water Safety Plans in place. The confidence grade for this calculation is 50%.

The results based on these factors have determined a payback period of 15 years. There is currently a lack of evidence to support the quantification of benefits from catchment management activities. To improve this quantification of the benefits of catchment management. the wider ecosystem services benefits of implementing the AMP7 Drinking Water Quality Plans catchment management scheme will be given further quantification using a Natural Capital approach. This approach is currently being developed using the data collected post AMP6 catchment management schemes as a baseline. This method will allow us to use real data linked to indicators of environmental improvements to calculate financial benefits with increased confidence.

The full NPV assessment can be made available on request. A summary of the outputs is shown in Appendix 2.

4.4 Recommendation

The recommended option proposed is Option 3 - DWQP catchment management enhanced. (revised costs based on efficiencies determined by Steer Co.).

This option has been selected as it has been developed based on the experience gained from the DWSP catchment survey and risk assessment process developed during AMP5 and AMP6 (Appendix 4). This option has also been developed incorporating the guidance for developing a catchment water safety plan (Appendix 3) and takes into account the recent guidance note issued in September 2017 on long term planning for the quality of drinking water supplies (Appendix 2).

There is an expectation from Defra, DWI and the EA for water companies to increase their focus on catchment management and incorporate this into the long-term planning for managing water quality in line with the Water Framework Directive. Article 7 of WFD stipulates a move away from end of pipe treatment solutions to managing risks and issues at the source. This option facilitates the development of catchment action plans where emerging risks are identified to further investigate catchment based solutions to support options appraisal for future catchment pollution mitigation schemes.

5 Risks and Issues

- Future changes from the DWI on guidance around Drinking Water Safety Plans. not accounted for in this proposal.
- Significant unassessed pollution risks e.g. HS2 could require significant resource impacting on DWSP risk assessment programme.
- Reductions in Environment Agency budget leading to lack of action and visibility on pollution incidents and a greater dependency on water companies to fill the gap.
- Water companies are not a statutory consultee in the planning process resulting in lack of awareness/information on developments that pose a risk to water quality. We will work alongside our Legal team to proactively identify planning applications with the potential to impact on water quality.
- Fracking / Coalbed methane extraction licences granted in the Dour community. This will require significant investment in investigation to assess the risk of future applications. The current licences for this area have been withdrawn in 2015, but could be reinitiated.
- Impacts of climate change and poorly managed large-scale development resulting in greater diffuse pollution challenges.
- Lack of awareness on registered contaminated land sites within our region and fragmented management of these sites with limited funding by Local Authorities.
- Market reform leading to complexities in engaging with commercial businesses around pollution investigations.

6 Procurement Strategy

This project will be delivered primarily by in-house expertise through the Catchment Management team. Where specialist expertise is required (e.g. remote sensing data and interpretation) then the preferred option will seek to appoint specialist consultants to deliver aspects of the project and provide administration services for the farmer incentive payments.

The preferred option will also seek specialist consultancy services for such aspects as remote sensing and observation borehole drilling.

As this builds on work undertaken in AMP6, suitable suppliers have been trialled and identified. Many of these are already on the Approved Suppliers list and subject to consultancy services agreements. Where required, a framework contract can be implemented based on the size and scale of the aspects of delivery proposed. These are not in place currently, but can be implemented in advance of AMP7 based on the preferred option being accepted to ensure that no time is lost for delivery at the start of AMP7.

Your local supply, on tap

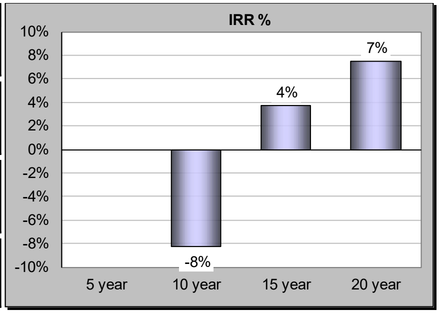
Appendices

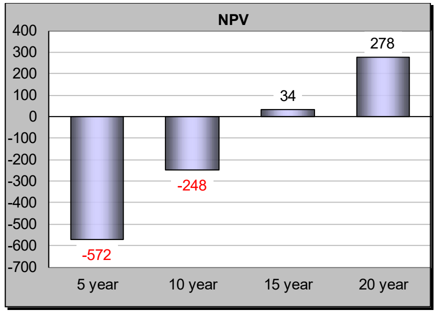
7 Appendices

7.1 Appendix 2: NPV assessment summary

******* The Unit Cost Spreadsheet (Project Build) for each option has been included in this appendix. The master Unit Cost Spreadsheet also contains QA, audit trail, methodology and supporting evidence. This can be provided on request *******

5 year		
Financial internal rate of return (IRR)	%	
Financial net present value (NPV)	£'000	-572
10 year		
Financial internal rate of return (IRR)	%	-8%
Financial net present value (NPV)	£'000	-248
15 year		
Financial internal rate of return (IRR)	%	4%
Financial net present value (NPV)	£'000	34
20 year		
Financial internal rate of return (IRR)	%	7%
Financial net present value (NPV)	£'000	278





POSITIVE NPV IN YEAR: 15

3.1 ASSUMPTIONS, DATA AND CONFIDENCE LEVEL OF COST BENEFIT ANALYSIS (CBA)

- Cost avoidance		Method of Calculation	How can the cost avoidance be monitored?	When?	Contact Person or Department
Drinking Water Safety - One off/occasional PCV	50%	DWSP catchment risk assessment and engagement with planning, pollution incident response etc… leading long term reduction in PCV failures. Estimated at 20 per year at £530 per incident = £10,600	Water quality monitoring at the point of abstraction	ongoing	Alister Leggatt / Water Quality Services
Failure to comply with legislation leading to pros	50%	Failure to comply with legislation leading to prosecution by DWI for not showing evidence of effective Water Safety Plans in place. Estimated at 1 per year in perpituity. £70,760 per year	Through DWI liaison and reporting	ongoing	Water Quality Services

7.2 Appendix 3: Guidance Note: Long term planning for the quality of drinking water supplies. Drinking Water Inspectorate Guidance to Water Companies (Issued September 2017)

***** The rest of this document can be made available on request *****

GUIDANCE NOTE ON LONG TERM PLANNING FOR THE QUALITY OF DRINKING WATER SUPPLIES

1. **Purpose**

1.1. The purpose of this Guidance Note is to provide water companies and other stakeholders with guidance on long term planning for the quality of drinking water supplies.

1.2. This long term planning guidance note is not intended to be a comprehensive review of water supply practice. There are no new policy initiatives set out herein, and no new legal obligations. The focus is on delivery of existing obligations, including recent and imminent legislative changes, using current good practice within a long term planning context.

1.3. The guidance note also provides advice on how the Inspectorate might assist companies in the periodic review process for setting of prices, led by Ofwat, including details of arrangements for information submissions to the Inspectorate; the Inspectorate's assessment processes; and a timeline for supporting current expectations of PR19 requirements. It takes account of current draft Ministerial guidance to Ofwat on strategic priorities and objectives from both the Welsh Government and the UK Government.

1.4. We will update this document as necessary to take account of developments in legislation, policy and industry good practice and future periodic reviews. The Inspectorate welcomes comments on the document, including suggestions for areas or matters not currently included.

1.5. The regulatory framework that sets the context for this Guidance Note is summarised in our Guidance on the Regulations: Introduction to the Public Water Supply Regulations in England and Wales.

2. Content summary

7.3 Appendix 4: Drinking water quality management from catchment to consumer. Chapter 4 - Developing a catchment Water Safety Plan

4

o Developing a catchment water safety plan

o *José Vieira, Bob Breach and Ricardo Hirata*

4.1 FACTORS UNDERPINNING CATCHMENT WATER SAFETY PLANS

(1) 4.1.1 Introduction

The quality of raw water is a key element when selecting a source for any drinking water supply system. Water use, land use and polluting human activity in the catchment area have significant impacts on surface and groundwater quality, and thus the level and complexity of treatment plant necessary to ensure that the water leaving the works is safe and acceptable to consumers.

Understanding catchment characteristics and/or activities potentially impacting on raw water quality and availability is thus of paramount importance to ensuring drinking water safety. Successful integrated water resources management must include all the driving forces and pressures acting in the catchment water cycle and requires the commitment and cooperation of a number of institutions and organisations who are directly or indirectly responsible for drinking water source protection within the catchment (e.g. health, environment, agriculture, industry, waste management). In most countries, management of catchments and raw water sources are outside the direct responsibility of the water suppliers. Nevertheless, it is essential that water suppliers play an important role in contributing to a preventive, integrated management approach in collaboration with all relevant stakeholders.

Protection of raw water sources should be seen as the first and sometimes the most important barrier to prevent microbial, chemical and radiological contamination as well as to guarantee the required quantity for a drinking water supply system.

Identification of health hazards, risk assessment and risk management at the catchment level are essential elements to implement a strategy for protecting a drinking water source. This protection strategy should be based on catchment management plans, which include monitoring requirements, corrective actions for dealing with routine and unexpected incident conditions, and communication strategies. Contingency procedures are essential to mitigate the impact of both natural disasters (e.g. floods, droughts, extreme meteorological conditions) and man made actions (e.g. bad practice, sabotage, vandalism).

The development of catchment Water Safety Plan (WSP) based on risk assessment and management procedures are heavily dependent on the quality and quantity of relevant information available. Special effort is required to collect information on catchment characteristics (e.g. geology, hydrology, meteorology, land use, competing water uses), surface water – rivers, lakes, and impounding reservoirs (e.g. flow rate, water quality, and seasonality variability), and groundwater (e.g. aquifer flow rate, flow direction, and aquifer vulnerability to pollution characteristics).

(2) 4.1.2 Characteristics of different type of catchments

The characteristics of different types of catchment vary considerably, including the response to different polluting activities or events, the time taken for pollution to reach the water abstraction point and the ease and timescale with which pollution prevention can be realistically carried out. Additionally, the pathways by which pollutants move from the pollution source to the abstraction point can be complex and need to be fully understood before the risks can be fully assessed and effective mitigation options pursued. All of these factors and others need to be taken into account when developing a catchment WSP. The phrase "know your catchment" is a vital one for any water supplier.

The majority of catchments can typically be divided into three main types, but within each type there can still be considerable variation in characteristics and behaviour:

(3) 4.1.2.1 Groundwater

The passage of water through the soil layer and underlying rock strata to the water table can attenuate some but not all types of pollution and thus treatment for groundwater tends to be simpler than for surface water. Deep groundwater typically has a much slower response to polluting activities on the surface, often many years. For some shallow or fissured groundwater sources, however, the response can be much faster sometimes as little as a few days.

(4) 4.1.2.2 Upland Reservoirs

In some countries water is captured from upland (mountainous) areas and held in reservoirs before treatment. Typically the less developed nature of these catchments means that the raw water can be less prone to man made pollution than other surface water sources but still requires more treatment than groundwater. However if pollution occurs, then the reservoir can remain contaminated for a long period.

(5) 4.1.2.3 Lowland surface sources

This can include rivers or canals either with or without raw water storage. Raw untreated surface water, particularly from rivers, is normally of lower quality than groundwater due to naturally occurring pollutants (e.g. natural organic matter from soil and plant degradation), although sometimes this can be made worse by the impact of man's activities. Additionally there are a wide range of pollutants that can arise primarily from man's activities, and which if not controlled could require additional treatment specifically for their removal at waterworks. For this reason surface water normally requires higher levels of treatment to meet drinking quality standards, when compared to groundwater. Typically this would include coagulation, filtration and disinfection, sometimes coupled with additional treatment by activated carbon or other more specialised processes.

(6) 4.1.3 Objectives for catchment WSPs

There are a number of inter-related objectives for developing catchment WSPs. All rely on a good knowledge of the catchment (Figure 13).

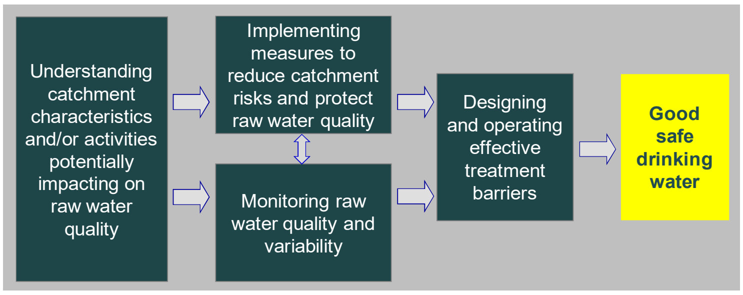


Figure 13 Objectives of catchment WSPs

(7) 4.1.3.1 Monitoring raw water quality and its variability

Design of raw water monitoring programmes is considerably helped by having a detailed knowledge of the catchment. This ensures that sampling and analysis, which can be very expensive, are cost effectively targeted at those parameters most likely to be of significance.

(8) 4.1.3.2 Designing effective treatment barriers

Knowledge of the catchment coupled with routine risk based monitoring programmes can help to build up a picture of expected raw water quality and the extent of any quality variability. This allows the treatment plant to be designed and operated with sufficient spare capacity to deal adequately with predicted worst raw water quality. Groundwater is commonly pumped into water supply systems with no treatment other than simple disinfection with chlorine. In this situation, catchment risk monitoring, assessment and management becomes even more important.

(9) 4.1.3.3 Designing effective pollution warning systems

Unexpected deterioration in raw water quality can pose a risk to treated water quality, even in well designed treatment plants. Thus, pollution early warning systems must be developed in all catchments, to allow water suppliers to be notified as soon as possible about pollution events within the catchment in order that emergency procedures can be instituted. This is even more important in the case of groundwater with no or only limited treatment. In such situations early warning systems based on periodic sample analysis and inspection of the well network is essential.

(10) 4.1.4 Impact of raw water pollution on drinking water treatment

Knowledge of land use or activities which might pose a risk to raw water quality allows catchment managers in conjunction with water suppliers to introduce pollution prevention measures to reduce such risks. Risks can impact water suppliers in a number of different ways.

- Where installed treatment can cope with the normal variation in raw water quality, then catchment protection can avoid the likelihood of unexpected pollution events posing a risk to treated water quality.
- Where water quality has already deteriorated or is deteriorating to the extent that additional treatment is or may be necessary in the future then catchment protection may reduce or eliminate the need for new treatment. In this context it is important to recognise that the time response for groundwater from contaminant source reduction or elimination is much longer than that observed for surface water.
- Where a works has been abandoned completely because of poor raw water quality, improved catchment protection may allow the source to be cost effectively brought back into use. This might be of particular importance in areas of severe water resource shortage.

(11) 4.1.5 Categories of pollution risk

There are a wide variety of potential catchment pollutants and mitigation options. More information is given later in Section 4.5. Their origin can typically be categorised into three main types:

(12) Point sources
This is where the pollution derives from a single point of discharge such as from sewage works, factory waste outlet or solid waste disposal facilities. This can be mitigated through suitable risk management techniques to avoid leaks or spillages, and appropriate wastewater treatment. Depending on local legislation, this can be enforced through pollution prevention requirements (e.g. bunding of tanks) and use of regulatory “permits to discharge” for example specifying maximum pollution loads. In the case of groundwater catchments, pollution prevention may require on site remediation or hydraulic containment of the aquifer contamination plume, as well as the removal of the contaminating activity.

(13) Diffuse sources
This is where the pollution arises from a multiplicity of small sources such as run off from land, roads or area without coverage to mains sewerage, or also from agricultural land use. This can be much harder to control since by definition many different land users may be required to implement significant change in practice.

(14) Naturally occurring sources
Natural contamination can occur due to local geology and/or soil types and is associated with chemical dissolution of minerals and organic matter.

4.2 DEVELOPING A CATCHMENT WATER SAFETY PLAN

(15) 4.2.1 A framework for Catchment WSP

Many water supply catchments are complex, and water suppliers do not normally have the responsibility, the powers, and often the expertise to directly control activities within the catchment. Development of a catchment WSP is therefore usually much more difficult than that for treatment or distribution networks WSPs. This section summarises an approach to developing a catchment WSP based on a modified version of the classic WSP cycle of activities (Bartram et al. 2009, Vieira & Morais, 2005).

Experience shows that the larger and more complex is the catchment the more difficult it is to ensure completely effective catchment protection. Water suppliers will thus need to realistically assess the likelihood that catchment protection will be fully effective and the timescale over which this could occur. Although catchment protection is by far the best option, if this is not possible within a reasonable timescale then additional treatment or other measures may need to be considered in order to ensure the quality of treated water.

Most, if not all, of the catchment based activities should be incorporated in a catchment management plan which is developed and jointly owned with all other key stakeholders in the catchment. The plan should encompass a range of activities which are kept under regular review and include the essential elements of risk assessment and risk management as shown in Figure 14.

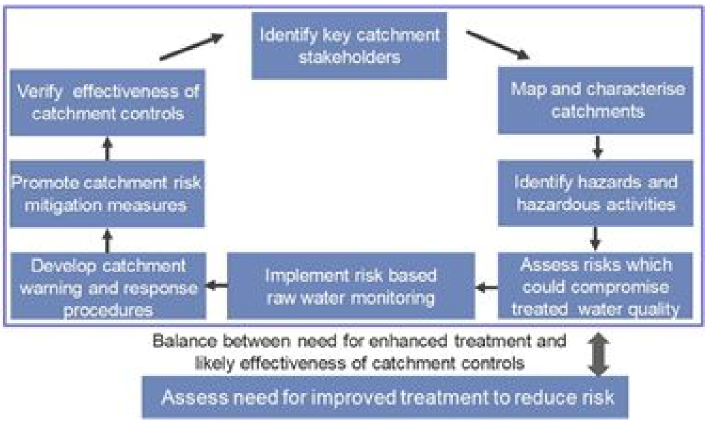


Figure 14 Framework for preparing a catchment WSP

(16) 4.2.2 Identifying key catchment stakeholders

Although water suppliers do not normally have powers or the responsibility to directly control activities within the catchment, it is essential that they work in conjunction with relevant government agencies, local catchment managers and land users to identify ways that pollution risks can be most cost effectively managed.

There are a wide range of catchment stakeholders with whom water suppliers may need to develop partnerships to protect water abstractions. They can be broadly divided into (1) regulatory authorities and catchment managers (2) land users carrying out activities which could pose a pollution risk. The institutional arrangements and legislative framework for managing catchments will vary considerably between countries and this will impact on the way in which such partnerships can be developed. It also means that partnerships often need to be developed at both national/regional and local levels (see Figure 15).

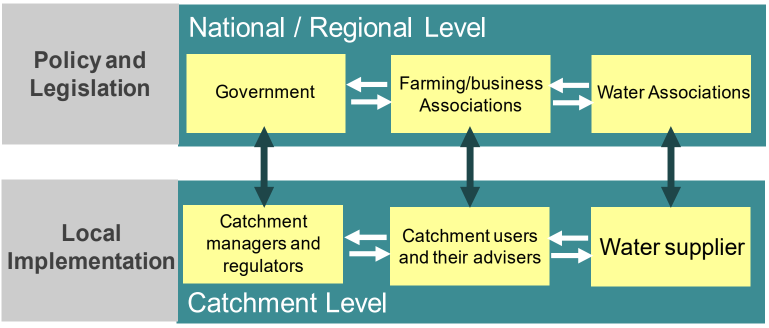


Figure 15 Catchment partnerships at different levels.

(17) 4.2.2.1 National/regional level partnerships

Since pollution control policy and legislation is usually developed and promoted at national or regional level then water suppliers will need to work together through their national or regional water supply associations to make sure that the interests of water supply protection are properly taken into account. The requirements of water supply protection may be different to that for protection of aquatic biodiversity and this often needs to be explained to policy makers.

As well as policy partnerships with Government and regulatory bodies, catchment protection can also be enhanced if water supply associations work directly with national or regional farming or business trade associations to jointly develop best practice codes of practice or certification systems. Local catchment users are much more likely to adopt such measures if they have been developed in close cooperation with their representative professional associations.

(18) 4.2.2.2 Local catchment partnerships

Effective local partnerships between water suppliers and land users/ catchment managers normally benefit from being developed as part of any broader national/regional policy and legislative framework, although successful local partnerships can also be developed on their own. Within this framework the purpose of local partnerships is to engage, educate and persuade catchment users to adopt pollution control and mitigation measures specifically designed to protect water abstractions. This is particularly the case when the area involves a large number of small and/or private wells. Particularly in developing countries the majority of such wells do not have any legal permit to exploit the aquifer or and the catchment management organisation may not even know of their existence.

(19) 4.2.3 Developing catchment partnerships

The approach to working with stakeholders can vary depending on whether they are more likely to give rise to point source or diffuse sources of pollution risk. This will need to be taken into account in developing a catchment management plan.

For example, point source discharges from industrial premises or sewage works are often covered by statutory discharge controls which limit the type, quality and quantity of effluent that can be discharged. Where such legislation is properly enforced then pollution mitigation measures may need to focus primarily on avoiding accidental pollution (e.g. as a result of spillage). Where the risk mainly relates to diffuse pollution then many more stakeholders need to be involved and this can increase the difficulty of developing effective partnerships.

It is also important to make a realistic assessment about the cost and complexity of the mitigation measures that are being promoted, since this will determine the approach which needs to be adopted. For example, although many pollution mitigation measures involve simple best practice which can be implemented without significant cost, many other measures could require substantial investment in pollution prevention technology and/or costly change in land use. Without legislation and/or some form of financial incentive the likelihood may be low for expensive or complex pollution mitigation measures to be widely taken up on a voluntary basis.

Irrespective of the size of the catchment and local institutional arrangements, water suppliers can often demonstrate a pivotal leadership role in promoting effective catchment protection as shown in diagram of Figure 16.

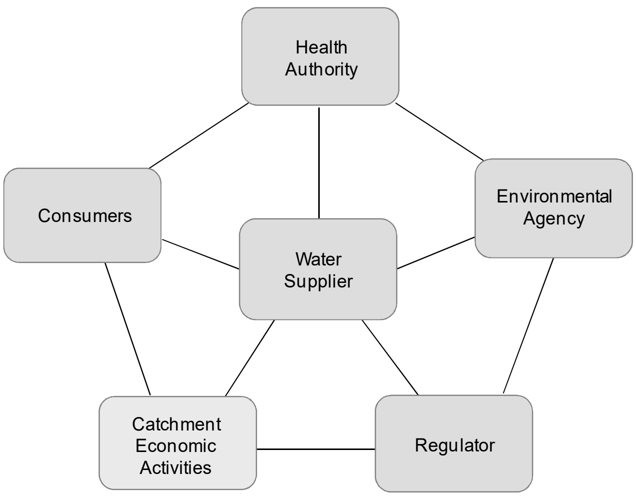


Figure 16 Pivotal role of water supplier in developing catchment partnerships

In working with local catchment partners, a number of different approaches will need to be considered. A key feature of any such partnership will be education and awareness campaigns to alert catchment users to the risks that they can pose to water abstractions and what measures can be taken to reduce risk. Those which are likely to be most effective will vary considerably depending on many local factors but typically could involve:

- *Obtaining contact details*
  It is important to be able to contact all relevant land users within the catchment who might impact on the water supply abstractions, including private groundwater self-supply users. Depending on the sector involved this can be time consuming and difficult particularly in larger or more complex catchments, and for diffuse pollution risks.
- *Communication mechanisms*
  This depends on the sector and number of people involved. For small catchments or major land users/premises within larger catchments, personal visits are most likely to be effective. Where larger numbers of people need to be contacted then personal visits may be impractical and thus other means such as mail, newsletters, and invitations to meetings will need to be considered. It is has been found that holding meetings at the waterworks can help to explain to land users the impact of pollution in the catchment can have on water treatment.
- *Data and information*
  Key to effective communication with land users is provision of relevant information and data including:
  - local maps showing the water supply catchment in relation to the potential sources of pollution
  - data showing the level and variability of pollutants impacting the supply intake
  - evidence to show the origin and cause of the pollution
  - practical measures that land users can take to reduce pollution or the risk of pollution
- *Local champions*
  It is often found that farmers and other land users are often much more responsive to catchment management messages if they come from people within their own business sector. Thus first seeking to actively engage the support of local business sector "champions" who can promote catchment protection messages on behalf of the water supplier can be a very effective approach.
- *Other "influencers"*
  In some cases, land users such as farmers closely follow professional advice from specialist agronomists, or manufacturers/suppliers of agricultural chemicals and machinery. Thus it is also important to ensure that such "influencers" of behaviour are also fully and actively involved in the catchment partnership. Indeed in some cases their active support may be an important pre-requisite of best practice take up by farmers and other land users.
- *Ongoing support and advice*
  Whatever partnership is initiated it is important that support and advice is seen as an ongoing process so that land users are actively involved and have a sense of ownership.

(20) 4.2.4 Mapping and characterising the catchment

A crucial early step in management of catchments, whether ground or surface, is to ensure that the catchment is properly mapped hydrogeologically. This is usually straightforward for smaller surface catchments but for large complex surface water and most groundwater catchments this may require additional specialist expertise. Catchment maps may be in paper format but modern GIS (geographic information system) technology now provides a much improved and usually cost effective option. However this does depend on the availability of reliable land use, soil type and other spatial datasets.

Geographic information systems (GIS) are powerful and efficient tools that can be used for electronically interpreting and manipulating the large amount of data necessary for catchment risk analysis. This can be done by creating maps and displaying a variety of spatial information allowing easy visualisation of main catchment characteristics for risk analysis including physical data (e.g., water bodies, elevation, land use, soils), and monitoring or environmental information (e.g., gauge sites, monitoring sites, pollutant point and non-point sources, mine locations). Spatial variations and temporal trends in water quality conditions can be very effectively presented and evaluated using a GIS (Figure 17).

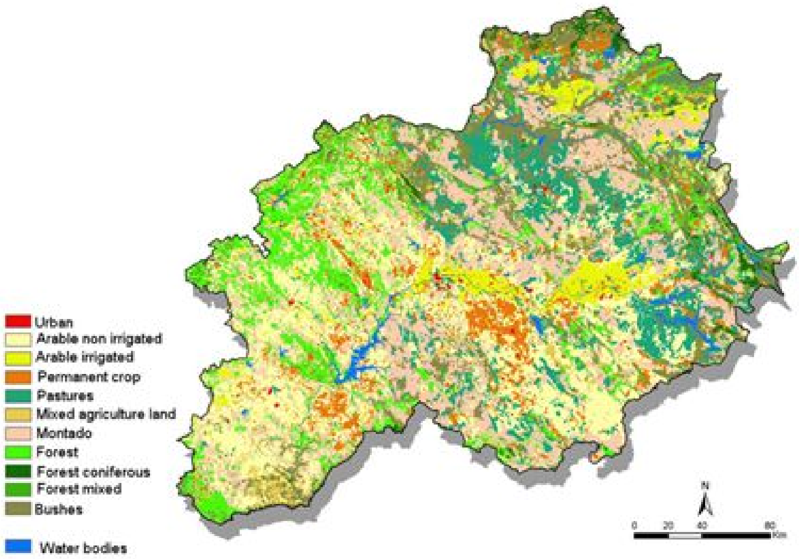


Figure 17 Example of GIS datasets of land use

Other factors that need to be taken into account in characterising the catchment include the soil type, topography and the surface-groundwater hydraulic relationship. This allows assessment of the hydrological response to pollution events, natural attenuation mechanisms, travel time from pollution source to abstraction point and the potential impact of extreme weather events such as storms or droughts.

It is particularly important to understand the potential influence that soil type plays in determining pathways of pollutants into both surface and ground water and thus the risk of contamination reaching the abstraction point. For surface water catchments, movement of water through soil to rivers and streams can be heavily influenced by soil type and also the extent to which drainage systems can bypass soil mechanisms. Groundwater risk assessment needs to take into account the fact that water movement in the unsaturated zone, including the soil horizon, is generally slow and concentrated in the smaller pores where the specific contact surface is larger. Aerobic alkaline chemical conditions are normally favourable to significant potential interception, sorption and elimination of viruses and bacteria. Precipitation, sorption or cation exchange attenuates heavy metals and other inorganic chemicals. Sorption and biodegradation eliminate many organic compounds. Soil can therefore be the first and most important natural defence against groundwater pollution. Flow velocity plays an important role in these reactions, and is roughly determined by moisture content, and in hydraulic surcharge situations, by grain size and selection. All these soil and unsaturated zone properties control the aquifer pollution vulnerability that is essential to define any risk assessment to groundwater.

(21) 4.2.4 Identifying hazards and hazardous activities

In conjunction with relevant catchment stakeholders, potential sources of pollution impacting the abstraction point should be identified and marked on the catchment map, using standard symbols. These may be both point source (e.g. sewage works, factory, other commercial premises) or diffuse source (e.g. intensive farming, roads and railways, urban areas, oil pipelines). More information on detailed methodologies for assessing and managing surface water is given in section 4.3 and groundwater in section 4.4

It is important to recognise that extreme weather events can influence both the quantity and quality of surface and groundwater and this needs to be taken into account as part of the catchment WSP. The hydrological regime in a catchment e.g. extent of evaporation, infiltration, surface runoff, and stream flow, greatly depends on weather parameters such as precipitation, air temperature, and humidity, and how this varies under yearly and monthly variations and ranges. Extreme rain events and water shortage due to drought periods have significant impact on flow of rivers and springs, level of lakes or reservoirs, and water table of groundwaters.

Surface water quality visibly deteriorates after extreme precipitation events, when increased erosion and high turbidity levels usually mean poor quality of drinking raw water that can be critical to the satisfactory functioning of treatment processes. Water shortages imply higher pollutant concentrations due to less dilution capacity of receiving waters. Eutrophication processes in source waters can be greatly stimulated with high air temperatures.

Groundwater normally has better intrinsic protection against climate change. Extreme weather events may nevertheless, cause impact on aquifers. Long drought periods will reduce groundwater recharge, thus probably decreasing contaminant dilution and water availability. Intense precipitation events may not significantly help groundwater recharge, as opposed to more evenly distributed precipitation. Flooding caused by such events may also drive contaminated water into the aquifer through wells.

(22) 4.2.5 Assessing risks, promoting mitigation measures and verifying their effectiveness

The hazards and hazardous activities identified in the catchment should be assessed and prioritised in terms of likely risk at the point of abstraction. In doing so it will be particularly important to take account not just of those potential pollutants which could have a rapid impact on the waterworks (e.g. chemical spillage) but those which could deteriorate over a long time period if mitigation measures are not implemented (e.g. groundwater pollution from nitrate). To support such risk assessment and identify effective mitigation measures, particularly for groundwater, it is best to develop a source/pathway/receptor model. This identifies the source of any potential pollution, the pathways through which it travels and the receptors (e.g. water abstractions) which might be impacted.

Having identified the priority risks to water quality then catchment risk mitigation measures should be promoted in conjunction with the relevant catchment management authorities and potential polluters. More information on common catchment risks, their mitigation and potential control points are given in section 4.5 later in this chapter.

(23) 4.2.6 Implementing risk based raw water monitoring

(24) 4.2.6.1 Introduction

An important part of any catchment management strategy includes implementation of raw water monitoring programmes, targeted at the most likely parameters of concern and based on the catchment characterisation/ risk assessment. Routine raw water quality sampling programmes serve a number of purposes:

- Providing key information on raw water quality and variability to either support routine operation of surface treatment plant or groundwater abstraction or design/upgrade necessary treatment plant
- Supporting catchment management plans as part of the risk assessment process
- Monitoring the effectiveness of catchment risk mitigation measures
- Understanding the background (baseline) natural water condition, thus allowing long term trend assessment for parameters of concern
- Helping to provide warning of raw water quality deterioration, and testing the effectiveness of water quality protection measures.

Such monitoring programmes can be based on continuous monitoring of key parameters and/or discrete sampling with subsequent laboratory analysis. In some situations on site test kits for simple analysis can be of value. The frequency and timing of sampling must take into account the potential variability of raw water pollution load, for example due to weather conditions. In the case of groundwater, a conceptual flow model, defining water velocity and aquifer geometry, is also necessary.

However such programmes can be very expensive to set up and maintain. Thus by basing the sampling design on a catchment risk assessment then the sampling can be cost effectively targeted only at those parameters likely to be of concern and at a time and frequency when they are most likely to occur. For example knowledge of sewerage and sewage treatment facilities (or their lack) as well as livestock farming in the catchment can identify risks from microbiological challenges to water treatment. This particularly needs to take into account the fact that the microbial load can be considerably higher during periods of storm or wet weather.

Similarly knowledge of the scale and type of farming activity in the catchment, particularly when linked to catchment fate and behaviour models, can help to predict the occurrence of agricultural chemical contaminants such nitrate or pesticides. This includes the risks of high peak values lasting a few days which might be missed by occasional monthly spot sampling. Thus additional monitoring during highest risk periods could help to identify the worst case challenges to water treatment. Conversely at other times of the year when such chemicals are not used then the sampling programmes can be scaled back to lower background frequencies.

Groundwater sampling programmes present further challenges. The conceptual flow model of the aquifer has to be understood prior to developing the sampling strategies. Generally slower travel times, when compared to surface water, and natural attenuation characteristics (mainly dilution), make both the sampling frequency and the parameters of interest different to those used for surface resources. More information is given later in Section 4.4.7.

(25) 4.2.6.2 Sampling programme design

The cost effective design of raw water sampling programmes can only be determined by the water supplier based on a good knowledge of the raw water catchment, and taking into account available resources, skills and laboratory capability. The programme should be formally reviewed at least once a year or following an event or incident in the catchment which might impact on raw water quality. Issues to take into account might include:

- Initial sampling programme: Before bringing a new source into supply sampling will need to take place for a period and at a frequency suitable for the type of source. The purpose is to establish any quality risks and the necessary level of treatment. Additionally, for groundwater it is also important to evaluate existing wells/springs in the area to detect water quality problems before the construction of a new well. In the case of natural contamination risks it is necessary to also evaluate the presence of some substance that may leach into the water as a result a change in the redox or pH conditions that is often associated with groundwater development.
- Core routine programme: A basic suite of physicochemical and microbiological analysis will need to be put in place geared to the type of source, its variability and the level of treatment in place. If the catchment characterisation suggests that the raw water quality will be stable (for example deep groundwater) then the monitoring frequency may be quite low. Conversely if the source is a shallow or karstic groundwater subject to surface influence then a higher frequency of sampling will be required. A surface water sampling programme will, of necessity, involve a wider range of parameters and at a higher frequency to reflect the greater range of risks and higher catchment variability.
- Weather or activity related sampling: The core routine sampling programme should be supplemented by additional sampling at times when quality might deteriorate for example during periods of adverse weather (storm or drought) or when additional catchment risks occur (e.g. use of pesticides for crop protection, additional strain on sewerage infrastructure due to tourist influx).
- Monitoring for indicator parameters: In some cases more frequent monitoring for simple indicator parameters may be used as a cost effective complement to other parameters which are more difficult or expensive to carry out. For example ammonia might be used as an early warning of increased levels of sewage or animal wastes. In the case of groundwater, both nitrate and chloride are very common quality aquifer indicators due to their chemical stability and mobility in subsurface environment.
- Long time series sampling for trend analysis: Some catchments might be subject to long term deterioration over a period of years due for example to land use or agricultural change. In such cases it is important that monitoring maintains adequate long time series data for key parameters such as nitrate or salinity. Short term cost savings should not impact the collection of such data.

(26) 4.2.6.3 Sampling for design and operation of treatment plant

Routine risk based monitoring programmes can help to build up a picture of expected raw water quality and the extent of any quality variability. This allows the treatment plant to be designed and operated with sufficient spare capacity to deal adequately with predicted worst raw water quality (See Chapter 4).

(27) 4.2.6.4 Sampling to detect raw water quality deterioration

Even appropriately designed and operated treatment plants can be subject to risks caused by unexpected deterioration in raw water quality. Such deterioration can occur due to accidental pollution, introduction of new industrial activities, changed agricultural practices or extreme climatic events. Knowledge of land use or activities in the catchment which might pose a risk to water quality facilitates the design of monitoring systems that can provide early water of raw water quality deterioration. In groundwater, a potential contamination load evaluation (type of activity and operation) in a radius typically of 2 km can also provide important information to avoid unexpected water deterioration events at a specific abstraction.

Routine spot sampling and analysis usually cannot detect rapid deterioration of raw water quality. However, such quality alteration might be picked up by automatic sampling or intake monitoring systems. Routine sampling is effective to detect adverse raw water changes that take place over a slightly longer time period, such as several days.

The frequency of sampling in groundwater monitoring well networks also has to be defined. However, except in aquifers of extreme or high pollution vulnerability, it will not normally be necessary to monitor aquifer groundwater quality more frequently than for example three-month intervals.

To complement raw water monitoring, early warning systems must be developed with catchment managers and users to allow water suppliers to be notified as soon as possible about pollution events within the catchment in order that emergency procedures can be instituted.

(28) 4.2.6.5 Automatic intake monitoring systems

Reliable and continuous monitoring systems have been increasingly used in routine long-term monitoring, as well as in early warning of accidental or malicious source water contamination. Early water quality monitoring systems were limited to easily measurable physicochemical parameters such as temperature, pH, conductivity and dissolved oxygen. Nowadays, it has evolved to include sophisticated equipment that allows comprehensive monitoring programs with a large number of parameters including organics. Increasingly, novel continuous bio-monitoring techniques can also be used to detect potentially toxic contaminants in source waters. These rely on living organisms such as daphnids, algae, and fish as indicators of a range of potentially toxic substances, although these need to be calibrated to ensure they are reacting to those substances which are of concern to drinking water quality rather than ecological impact.

Automatic intake monitoring systems can be used to provide (near) real-time information on water quality which is important to provide an up-to-date inventory of known contaminants as well as for setting strategies for catchment early warning mechanisms.

(29) 4.2.7 Implementing catchment warning and response procedures

Pollution incidents potentially impacting water supply abstractions will occur from time to time, even where effective arrangements for catchment management and control have been implemented. These may not be detected by intake monitoring systems and even if they do it may not allow sufficient time for appropriate response. Thus effective communication systems between water suppliers and catchment managers/users are important to give early warning of pollution events. Whilst pollution incidents are most likely to impact surface water catchments, particularly those that are large and/or complex, pollution incidents can also impact on groundwater abstractions. Both should therefore be considered for implementation of pollution warning systems.

(30) 4.2.7.1 Organisations typically involved

As well as the water supplier, the organisations that need to be involved in a pollution warning system will depend on local catchment characteristics, legal and institutional arrangements and the catchment risk assessment. Particular complications can arise where catchments cross state or national boundaries. Organisations could though include:

- Water utility staff
- Catchment management agencies
- Municipal authorities including emergency services (fire, police)
- Other upstream abstractors
- Catchment users such as major industrial sites, farmers, fishing organisations

In addition it should be recognised that members of the general public might also report possible pollution incidents or unusual catchment events which need to be rapidly and effectively captured, assessed and communicated.

(31) 4.2.7.2 Early warning procedures

The early warning procedures that need to be put in place will vary depending on the local situation and available communication systems. Whatever procedure is developed will need to be simple, agreed by all parties and clearly documented. Once implemented the procedures should be regularly reviewed to identify areas for improvement. Consideration should also be given to including pollution warning systems in any exercises held to test the effectiveness of incident management procedures (see section 3.6).

(32) 4.2.7.3 Pollution awareness training

Non water supply staff often do not appreciate the range of pollutants that might impact water supply intakes. As well as toxic material, this can include:

- Substances which might impart a taste to water supplies, even at low levels, such as oils, solvents or phenolic material
- Substances which might impact on disinfection effectiveness by exerting increased oxidation demand
- Events such as fire at industrial premises, major transport accident, fuel or chemical spill, natural events such as floods or landslip

For this reason training and awareness programmes should be considered for key external personnel who include:

- The types of pollutant or pollution event that should be notified
- Why these might impact on water supply intakes and treatment
- The importance of speed of notification
- Information which should be captured at time of notification

(33) 4.2.7.4 Effective, timely and accurate communication

Key to effective warning systems is a rapid, foolproof and clearly defined communication mechanism between those capturing the event and the relevant water supplier staff. Such a system could have different levels of warning depending on the severity of pollution risk (e.g. Level 1 - early warning; Level 2- confirmed risk; Level 3 imminent risk). Once a pollution incident has been resolved an “all clear” message should be sent.

The communication method used will depend on local circumstances but to avoid mistakes or misunderstanding the method should preferably be captured on a standard form which is transmitted electronically e.g. via fax or e-mail. The recipient of the warning message within the water supplier should be identified and procedures should ensure that it is picked up and responded to promptly 24/7. Normally this might be at a continuously manned control room or duty officer but other arrangements may also be appropriate.

For groundwater the contaminant plume travel is usually orders of magnitude lower than on the surface water. Therefore it is not normally necessary to have 24/7 response teams, except with karstic and high transmissivity fractured rock aquifers.

(34) 4.2.7.5 Pollution travel time estimation

To improve effective response to pollution warning it is important to be able to assess the potential travel time from the site of the pollution to the water abstraction point. These are defined by the travel distances and intrinsic characteristics of each environment:

- Groundwater: the distance is defined by the thickness of the unsaturated zone, and the location of source and abstraction points, which will roughly determine the travel distance in the saturated zone. Pollutant characteristics must also be taken into account. Fissured aquifers or where natural protective zones are bypassed are particularly vulnerable
- Rivers: the distance involved, the flow rate and pollutant behaviour
- Lakes and reservoirs: the retention and residence time including wind effects and short circuiting

In larger, complex or more vulnerable catchments it may be appropriate to develop practical computer models to forecast time of travel based on the pollutant transport and behaviour as a function of the hydrological properties of the water resource system.

4.3 METHODOLGIES FOR ASSESSING AND MANAGING SURFACE WATER CATCHMENTS

(35) 4.3.1 Introduction

Integrated management of surface catchments must identify all the existing and potential hazards that might pose a risk to surface water abstractions. This in turn can support the implementation of effective source water protection programmes.

A full risk assessment must include the study of ecological and hydrological processes governing catchment systems, as well as the man made polluting activities. The identification and characterisation of pollutant sources are critical to the successful mapping of risks in surface catchments. Table 3 shows major factors affecting source water quality (CCME, 2004).

Natural Factors	Human Factors	
	Pollutant non-point sources	Pollutant point sources
Climate	Agricultural cropland runoff	Industrial discharges
Topography	Livestock/grazing	Wastewater discharges
Geology	Dairies and feedlots	Hazardous waste facilities
Soil cover	Urban development runoff	Mine drainage
Vegetation	Septic tanks	Spills and releases
Fire	Erosion	Urban runoff
Wildlife	Forest management	Combined sewer overflows
Saltwater Intrusion	Mining	Aquaculture
Thermal stratification	Recreational activities	
Erosion	Atmospheric deposition	

Table 3 Factors affecting source water quality

(36) 4.3.2 Use of predictive models

Predictive surface water models provide a very good approach for evaluating alternative catchment management scenarios. When combined with good monitoring datasets, properly calibrated, tested, and verified models can be used to forecast or estimate risks under various scenarios. This allows a good insight into impacts associated with known and anticipated land use activities within the catchment.

Different type of models can be applied simulate and predict surface water quality (USEPA, 2008). These include:

- Rainfall/runoff, for the description of precipitation, infiltration, evaporation, and runoff
- Erosion and sediment transport, for the description of soil detachment, erosion, and sediment movement from a land area
- Pollutant loading, for the description of the wash-off of pollutants from a land area
- Stream transport, for the in-stream behaviour of sediment and pollutants including deposition, resuspension, decay, and transformation

- Management practices that can be land-based (e.g., tillage or fertilizer application), constructed (e.g., storm water ponds), or input/output to a stream (e.g., wastewater treatment).

The decision-making process in catchment planning and management is multidisciplinary in nature and integrates different sources of knowledge (scientific, socioeconomic, and political). Decision support systems use complex, dynamic knowledge from a number of disciplines in a user-friendly graphical user interface, and are tools of valuable interest to organize information, design and assess the impact of alternative long-term catchment management plans. Figure 18 depicts the structure of a web-based decision support system developed for supporting integrated water management of the Portuguese Guadiana river basin (Vieira et al., 2008).

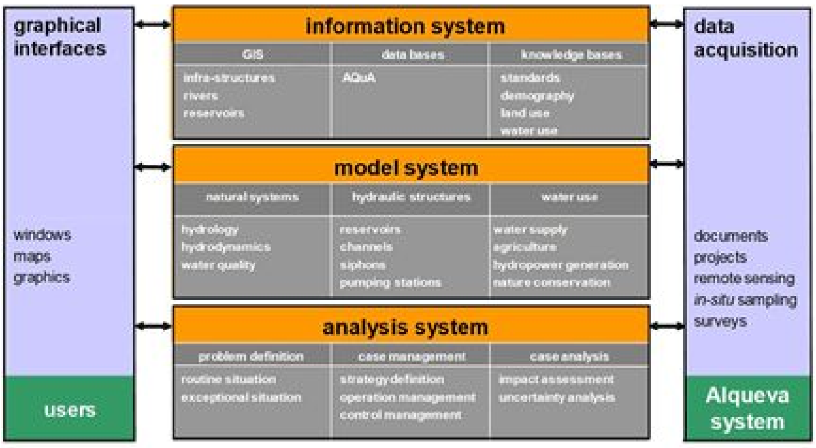


Figure18 Decision support system structure in river Guadiana basin

4.4 METHODOLOGIES FOR ASSESSING AND MANAGING GROUNDWATER CATCHMENTS

(37) 4.4.1 Strategies for control of groundwater pollution

Implementing groundwater pollution prevention measures is a complex task, involving two interrelated but independent strategies which focus on the protection of:

- Groundwater resources (aquifers) as a whole *and/or*
- Groundwater sources - those parts of the aquifers where the resource is exploited for water supply or other purposes

While both approaches are complementary, the emphasis placed on one or other will depend on local hydrogeological conditions, the extent to which groundwater resources have been developed and exploited, and a range of other broader socioeconomic factors.

Once sub surface or groundwater pollution has occurred it is usually very expensive and sometimes impractical to implement remedial action at an economic cost. The exception may be those fast response aquifers where removal of the hazard or hazardous activity can result in reduction of groundwater contamination in a relatively short timescale. The primary aim of groundwater protection should therefore be focussed on prevention of those activities which might result in an unacceptable sub surface contaminating pollution load either across the whole aquifer or within the capture zone for public supply sources.

There are four main catchment protection tools (see later sections for more detail) which can be used to control groundwater pollution risks:

- Mapping overall aquifer pollution vulnerability
- Quantifying the potential sub surface contaminant load
- Implementing Source Protection Areas (SPAs) which define the zone of capture of boreholes, wells and springs
- Placing restrictions on hazards or hazardous activities within defined areas of the catchment

In developing a WSP, ideally the whole aquifer should be considered for protection. However, in some situations it may not be economic or practicable to do so. For example, it may not be cost effective to protect the whole aquifer if only a small amount of it is used as water source. In such situations it would suffice to define the groundwater capture zone of specific water sources, and assess their pollution vulnerability and subsurface contaminant load, usually on a scale of 1:10,000 to 1:50,000. Conversely, in those areas with a large number of significant groundwater abstractions, whole aquifer strategies should be adopted.

The responsibility for implementing each strategy may vary. Aquifer pollution vulnerability assessment is a management tool used as part of land use planning to protect strategic aquifers. Depending on the size of the aquifer, these are therefore usually the responsibility of regional or national authorities. Source pollution hazard assessments, on the other hand, are more useful for local catchment managers and water suppliers.

Whole aquifer strategies are more universally applicable, since they endeavour to achieve a degree of protection for the entire groundwater resource and for all groundwater users. They would commence with aquifer pollution vulnerability mapping of more extensive areas (including one or more important aquifers) working at a scale of 1:100,000 or more if the interest was limited to general information and planning purposes. This would be followed by the identification, localisation and classification of potential contaminant loads. The interaction between these two elements permits the aquifer pollution hazard definition (see figure 19 below)

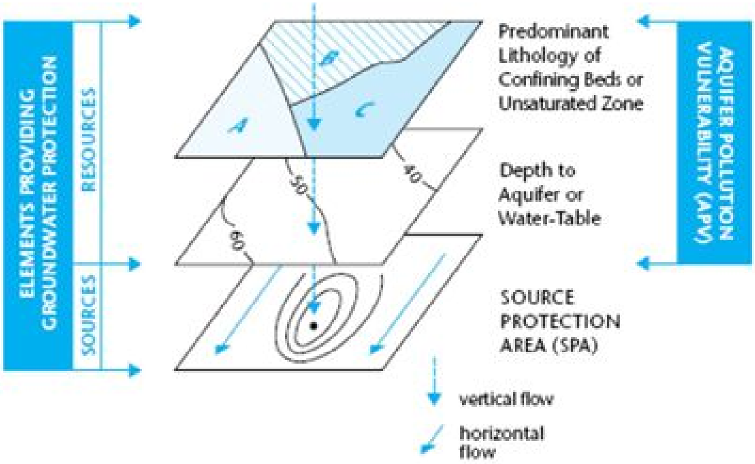


Figure 19 Components of groundwater pollution hazard assessment used for land surface zoning (Foster et al., 2002).

The same approach can be done for source protection, where the pollution hazard is established through superimposition of the outputs from the subsurface contaminant load inventory on the different well capture zones of as set out in figure 20 below.

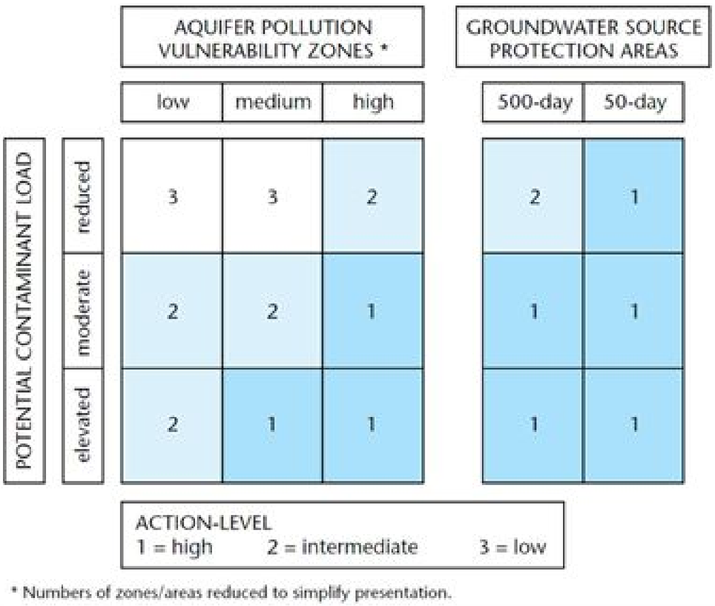


Figure 20 Priority groundwater pollution control action-levels based on aquifer vulnerability, source protection areas, and potential contaminant load (Foster et al 2002)

(38) 4.4.2 Objectives for groundwater pollution prevention

There are three different scenarios to be considered in establishing a groundwater quality protection strategy.

(39) 4.4.2.1 Preventing Future Pollution

Aquifer pollution vulnerability maps are a valuable tool to reduce the risk of creating future groundwater pollution hazards. They identify the areas most vulnerable to groundwater pollution, so that the location of potentially hazardous activities can be avoided or prohibited. Table 3 should help to evaluate potential problems associate to each type of activities.

(40) 4.4.2.2 Dealing with Existing Pollution Sources

In this situation, it is necessary to prioritise groundwater pollution control measures in areas where a range of potentially polluting activities are already exist. First, it will be necessary to establish which among these activities poses the more serious hazard to groundwater quality, using aquifer vulnerability mapping, delineation of water supply protection areas, and inventory of subsurface contaminant load. Table 4 and 5 give examples of the selection of those activities according to different vulnerability classification or delineation of zone of capture.

(41) 4.4.2.3 Selecting New Groundwater Supply Areas

In this situation it is first necessary to define the capture zone of any new public supply well and then to identify all potential contaminant sources existing in the area (Table 5). Where such an assessment identifies anthropogenic activities capable of generating an elevated subsurface contaminant load and/or the aquifer pollution vulnerability is high or extreme over most of the designated groundwater supply capture area, this assessment should be followed by a technical and economic appraisal to establish the possibility of controlling all potential pollution activities. If this is not possible then an alternatively site for the new groundwater supply sources should be investigated.

(42) 4.4.3 Mapping overall groundwater pollution vulnerability

The concept of aquifer vulnerability is related to the intrinsic characteristics of the strata which separate the saturated aquifer from the land surface. These characteristics determine the risk of the aquifer being adversely affected by a surface-applied contaminant load (Foster & Hirata 1988). Vulnerability is determined by:

- An hydraulic assessment of likelihood that the pollutants will reach the saturated aquifer *and*
- An estimate of the extent to which pollutants will be attenuated by physiochemical retention or reaction during passage through the strata overlying the saturated zone.

Aquifer pollution vulnerability maps are designed to provide a general framework within which groundwater protection policy can be developed. They are a simplified, but factual, representation of the best available scientific data on the hydrogeological environment. Generally, the methods provide an overall index for a single integrated vulnerability to all potential pollutants (a map that can encapsulate all type of substances or activities). However, some methods allow aquifer vulnerability to be determined for individual contaminants, group of contaminants or even for activities, and to particular pollution scenarios. However, vulnerability maps for specific contaminants and pollution scenarios are much more costly, complex and difficult to use.

There are many different aquifer pollution vulnerability methods. One of those is known as GOD (Foster and Hirata, 1988) which defines an absolute index, unlike other methods that provide only relative vulnerability indexes. It uses factors for three intrinsic geologic and hydrogeological characteristics:

- Groundwater hydraulic confinement, in the area under consideration.
- Overlying strata, in terms of character and degree of consolidation that determine their contaminant attenuation capacity.
- Depth to groundwater table or to groundwater “strike” in confined aquifers.

There are a number of hydrogeological conditions that create problems for vulnerability assessment and mapping, and this means that expert support and interpretation may be necessary. Also the methods used to generate vulnerability maps do not cover two specific situations: contaminants discharged directly in the subsurface, e.g. from underground storage tanks or septic system and spillages of dense immiscible synthetic organic pollutants (DNAPLs). A high groundwater pollution hazard is present in both situations, regardless of aquifer vulnerability.

(43) 4.4.4 Inventory and classification of subsurface potential contaminant load

A key step in implementing a groundwater protection strategy is to undertake a detailed survey of the aquifer catchment or source protection area to identify those hazards or hazardous activities which have the potential to cause groundwater pollution. In doing so it is important to take into account whether generation of a subsurface contamination load is a direct result of the hazard (e.g. septic tanks) or whether the load might be generated accidentally(e.g. due to spillage) (Foster and others, 1993). It is also important to understand whether any hazardous activities have taken place in the past, since polluting processes or activities which ceased some years before can be still generating a subsurface contaminant load by leaching from contaminated soil.

There are various published methods of assessing the pollution potential of man made activities, although few are directed specifically to rating their potential to generate a subsurface contaminant load (Foster and Hirata, 1988; Johansson and Hirata, 2001). The classification of potentially polluting activities by their spatial distribution provides a direct and visual impression of the type of groundwater contamination threat they pose and the approach to control measures that are likely to be required:

- Point pollution sources normally cause clearly defined and more concentrated plumes, which makes their identification (and in some cases control) easier; however, when point-source pollution activities are small and multiple, in the end they come to represent an essentially diffuse source, as regards identification and control.
- Diffuse pollution sources do not generate clearly defined groundwater pollution plumes, but they normally impact a much larger area (and thus volume) of aquifer.

Using any of these classifications, it is always useful to rank the potential contaminant load in terms of the probability to generate a load that can reach and impact the saturated aquifer. There are some methods that classify the potential load in three levels: elevated, moderate and reduced. The POSH method is one of them (Foster et al. 2002) and it is based on two intrinsic characteristics:

- The likelihood of the presence of contaminants, which are known or expected to be persistent and mobile in the subsurface; and
- The existence of an associated hydraulic load (surcharge) capable of generating transport of contaminants into aquifer system.

(44) 4.4.5 Groundwater source protection areas (SPAs)

The delineation of groundwater source protection areas (SPAs) is an essential element in the protection of drinking water sources from contamination. SPAs have to take into account two different types of contaminants:

1. Those that decay with time, where subsurface residence time is the best measure of protection
2. Non-degradable contaminants, where flowpath-dependent dilution must be provided.

The proximity of a land-use activity to a groundwater source is a key factor influencing the contamination hazard it poses. The pollution threat will depend on whether the activity is located within the capture zone of the water supply source, and the horizontal flow time in the saturated aquifer from the location of the activity to the abstraction point (Figure 21). Source protection areas are therefore normally divided into four zones:

1. Zone A - The operational area immediately adjacent to the wellhead or borehole
2. Zone B - The inner catchment area representing approximately 50 day travel time to the abstraction which is normally considered the minimum necessary for degradation of microbiological pollutants
3. Zone C - the intermediate area representing approximately 4-500 days travel time to the abstraction
4. Zone D- the whole source capture zone

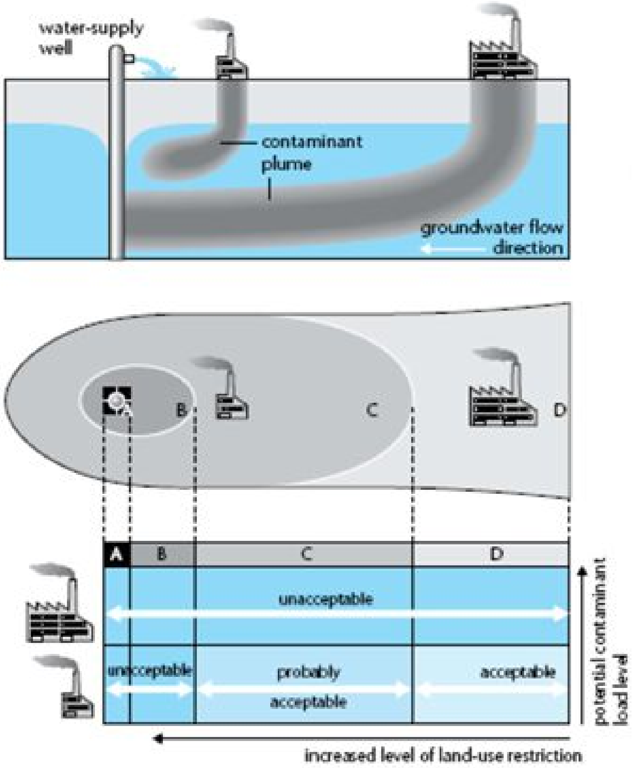


Figure 21 Concept of different levels of source protection areas, with land use restrictions (Foster et al. 2002).

There are five main approaches used for delineating groundwater SPA (USEPA 1994), in increasing order of complexity and cost:

1. Arbitrary fixed/calculated radius around borehole
2. Simplified variable shapes
3. Analytical hydrogeological models
4. Hydrogeological mapping
5. Numerical groundwater flow model with particle tracking

Arbitrary fixed-radius circular zones (1) or simple elliptical shapes (2) have been used. However, because of their questionable reliability they would normally be chosen only in the very first stage of groundwater source protection program. The choice of which of the other methods to use will depend on hydrogeological data availability and available resources. However, the geometry of the protection zone defined will also be influenced by the method used for its delineation. It must also be remembered that the delineation of protection zones is a dynamic process. Groundwater conditions may physically change or new hydrogeological data may come to light that enable the aquifer to be more accurately represented. Given the numerous uncertainties and continuously evolving groundwater conditions it is wise for an “adaptive approach” to SPA implementation strategy. This should be based on the application of analytical method in the first instance, followed by a numerical method when more data are available.

(45) 4.4.6 Placing restrictions on hazards or hazardous activities within defined catchment areas

As previously described the key to effective groundwater protection is to identify the vulnerability of either the whole aquifer or the catchment of a water supply source to sub surface contamination and then control the hazard or hazardous activity which might give rise to such a polluting load.

Table 4 below sets out a typical acceptability matrix for various hazards according to aquifer vulnerability. The terminology used is:

- N = unacceptable in virtually all cases
- PN = probably unacceptable, except in some cases subject to detailed investigation and special design
- PA = probably acceptable subject to specific investigation and design
- A = acceptable subject to standard design

Potentially polluting activity requiring control measures	Aquifer vulnerability		
	high	medium	low
Septic tank, cesspits and latrines			
individual properties, communal properties, public	A	A	A
gasoline station	PA	A	A
Solid Waste Disposal Facilities			
construction/inert	A	A	A
municipal domestic and industrial (class I)	PN	PA	A
industrial (class II and III) and hazardous	N	N	PA
cemetery	PA	A	A
incinerator	N	PN	PA
Mineral and oil Extraction			
construction material (inert)	PA	PA	A
others, including petroleum and gas	N	PA	A
fuel lines	N	PA	A
Industrial Premises			
type I	PA	PA	A
type II and III	PN/N	PA/N	PA/PN
Military Facilities	PN	PA	PA
Infiltration lagoons			
municipal/cooling water	A	A	A
industrial effluent	PN	PA	PA
Soakaway Drainage			
building roof	A	A	A
major road, industrial sites, airport/railway station	PN	PA	A
minor road, parking lots	PA	A	A
Effluent land application			
food industry, sewage effluent and sewage sludge	PA	A	A
all other industries	PN	PA	A
farmyard slurry	A	A	A
Intensive livestock Rearing			
effluent lagoon, farmyard and feedlot drainage	PA	A	A
Agricultural areas			
with pesticide	PN	A	A
with uncontrolled use of fertilizers	PN	A	A
pesticide storage	PN	PA	A

Table 4 Acceptability matrix of common potentially polluting activities and installations according to aquifer vulnerability

Table 5 below sets out a typical acceptability matrix for various hazards using the same criteria within different source protection zones as described in Section 4.4.5.

Potentially polluting activity requiring control measures	Source protection area			
	A	B	C	D
Septic tanks, cesspits and latrines				
individual properties	N	N	A	A
communal properties, public	N	N	PA	A
gasoline station	N	N	PN	PA
Solid Waste Disposal Facilities				
municipal domestic	N	N	N	PN
construction/inert	N	N	PA	PA
industrial hazardous	N	N	N	N
industrial (class I)	N	N	N	PN
industrial (class II and III)	N	N	N	N
cemetery	N	N	PN	A
incinerator	N	N	N	PN
Mineral Extraction				

construction material (inert)	N	N	PN	PA
others, including petroleum and gas	N	N	N	N
fuel lines	N	N	N	PN
Industrial Premises				
type I	N	N	PN	PA
type II and III	N	N	N	N
Military Facilities	N	N	N	N
Infiltration lagoons				
municipal/cooling water	N	N	PA	A
industrial effluent	N	N	N	N
Soakaway Drainage				
building roof	PA	A	A	A
major road	N	N	N	PN
minor road	N	PN	PA	PA
amenity areas	N	PA	PA	A
parking lots	N	N	PN	PA
industrial sites	N	N	N	PN
airport/railway station	N	N	N	PN

Table 5 Acceptability matrix of common potentially polluting activities and installations according to source protection zones

(46) 4.4.7 Groundwater monitoring strategies

Groundwater monitoring strategies include the choice of using existing production wells, or drilling dedicated monitoring wells (Figure 22). The choice of using existing production wells might initially be appealing due to the lower cost and implementation time, but poses serious drawbacks. Production wells usually have large intake intervals, and mix waters from widely different depths, with different residence times and hydrochemical properties. Sampling from a wellhead tap, usually close to high capacity pumping plant, may also impact sample quality by allowing contact with air and causing oxidation and precipitation of Eh-sensitive constituents, volatilization and modification of pH. Purposed-drilled monitoring wells need to be carefully placed, taking account of the conceptual flow model of the aquifer and the objective of the monitoring programme. In a more complex aquifer system where vertical water flow is expected, multi-level monitoring wells have to be considered.

There are three strategies that can be adopted for systematic monitoring for groundwater:

- Proactive monitoring of potential pollution sources, where the objective is to provide early detection of incipient aquifer contamination from known sources of potential pollution. Monitoring is undertaken immediately down the hydraulic gradient and analytical parameters chosen specifically in relation to the pollution source. This approach is expensive and thus has to be highly selective, primarily targeting the more hazardous pollution sources located within groundwater supply capture zones in aquifers of high-moderate pollution vulnerability.
- Defensive monitoring for groundwater supply sources, when the objective is to provide warning of pollution plumes threatening potable well fields or individual water wells and springs. This is achieved through the installation of a monitoring network up the hydraulic gradient, which is capable of detecting approaching polluted groundwater in time for further investigation and remedial action to be taken. A thorough understanding of the local groundwater flow system and contaminant transport pathways is required, especially in relation to selection of the depths of monitoring borehole intakes, to avoid the possibility of by-pass of the defensive monitoring network.
- Evaluation monitoring for sites of known aquifer contamination. A similar approach to that described under proactive monitoring should be adopted This serves two purposes (1) most importantly to confirm the effectiveness of natural contaminant attenuation processes, where these are considered to be the most economic or only feasible way to manage aquifer pollution and (2) to confirm the effectiveness of remedial engineering measures taken to clean up or contain aquifer contamination, where these have been judged technically and economically feasible.

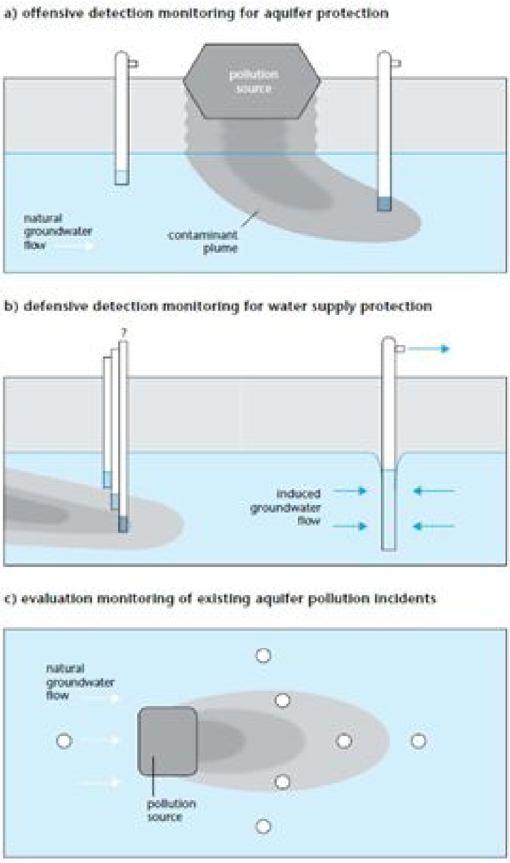


Figure 22 Schematic summary of groundwater quality monitoring strategies (Foster et al 2002)

4.5 COMMON CATCHMENT RISKS AND THEIR MITIGATION

(47) 4.5.1 Introduction

Previous sections of this chapter have described; factors underpinning catchment WSPs; approaches to developing a catchment WSP; and methodologies for managing both surface and groundwater catchments. This section briefly summarises a number of common catchment hazards which might pose a risk to water treatment works, and typical approaches to their mitigation. More information for microbial hazards (WHO 2004) and potential chemical hazards (Thompson et al. 2007) is given in references

Effective pollution control in catchments can be secured through a wide range of policy approaches. These can include legislation, financial or commercial instruments, technical guidance, and voluntary codes of best practice. Many countries use a combination of all these measures with pollution control legislation complemented by other fiscal and voluntary approaches. However, it has to be remembered that legislation and other measures are only effective if coupled with appropriate levels of enforcement and inspection at a local level.

Once mitigation measures have been implemented it is important to verify the extent to which these are effective. These are normally the responsibility of the catchment control authorities, but water suppliers will need to work closely with such organisations to ensure that the pollution control regime adopted is effective in protecting their abstractions.

The control points for different catchment risks will vary considerably but could include:

- Raw water monitoring within the catchment or at the point of abstraction
- Routine monitoring and inspection of point source discharges as well as industrial, commercial or other high risk sites

- Routine inspection of land use to confirm whether or not the required change in practice has occurred (e.g. livestock density, changed land use or cropping)
- Maintenance of records by land users of such things as pesticide and fertiliser usage
- Training and certification requirements for land users.

The particular pollutants that need to be considered will vary widely from catchment to catchment, but could include one or more of the following:

(48) 4.5.2 Naturally occurring surface water pollutants

There are a number of pollutants which can arise naturally in surface waters. However, in many cases these can be made much worse through man's activities. They include:

- Metals such as iron, manganese, and aluminium which if not removed by treatment can give rise to water discolouration.
- Increased turbidity particularly after rainfall which can impact the efficiency of disinfection and other treatment processes
- Natural organic matter (NOM) which can adversely impact on disinfection effectiveness through increased oxidation demand and also lead to increased formation of disinfection byproducts. Depending on the composition it can also provide a nutrient source for microbial regrowth within the distribution network.
- Proliferation of algae due to eutrophication (see section 4.5.13 below).
- In areas with peat soils high levels of humic material can leach into the raw water and thus increase water colouration and also the risk of increased disinfection byproduct formation (see section 4.5.14 below).

Mitigation measures can be difficult. Where natural levels of turbidity are increased due to mining, construction or other industrial activity then this can be controlled though a requirement to manage site runoff by passage through settlement lagoons or equivalent (see later). Loss of soil from agricultural land and forestry can be reduced by improved soil and land management practice. Mitigation of eutrophication and humic materials is dealt with in later sections.

(49) 4.5.3 Natural groundwater hazards

Reactions of rainwater in the soil/rock profile during infiltration and percolation provide groundwater with its essential mineral composition. It takes up carbon dioxide, and the resultant weak acid dissolves soluble minerals. In humid climates with regular recharge, groundwater moves continuously and contact times can be relatively short with only the most readily soluble minerals being dissolved.

Nine major chemical constituents (Na, Ca, Mg, K, HCO3, Cl, SO4, NO3, and Si) make up 99% of the solute content of natural groundwaters. The proportion of each of these constituents, and of the associated trace elements, reflects subsurface groundwater flow path and hydro-geochemical evolution of the groundwater concerned. Aquifer rock-type is also important, since, for example, groundwater movement in crystalline rocks occurs relatively rapidly via joints and fractures, and the rocks themselves are generally not very soluble.

Groundwater in the recharge areas of humid regions is likely to be low in overall mineralisation, compared to that in arid or semi-arid regions where the combination of evaporative concentration and slower groundwater movement can produce much higher concentrations. Elevated concentrations of specific solutes can occur in certain hydrogeological settings, such as high sulphate concentrations associated with the weathering of some basement rocks or dissolution of gypsum in sedimentary sequences, hardness associated with carbonate rocks or from association with some types of geothermal activity.

Although trace elements make up only 1% of naturally-occurring dissolved constituents in groundwater, they can sometimes make it unfit or unacceptable for consumption. At the same time many trace elements are essential for human and/or animal health in small quantities and may be derived from drinking water or solid food. However, the desirable concentration range may be small, and some trace elements are harmful at higher levels (e.g. fluoride). Others are potentially harmful to health, even at very low concentrations (e.g. arsenic and uranium).

Certain elements, particularly As, F, and Se have been identified by WHO as presenting known health risks in groundwater. Other elements, notably Mn, Ni, U and Al, are of increasing concern and may merit further investigation. The concentration of some of these constituents can also be increased through the impact of polluting activities at the land surface. It is thus important for management purposes to differentiate anthropogenic impacts from naturally-occurring problems. This will require investment in detailed groundwater investigation and monitoring. As well those minerals of significance for health, a number will also impact on consumer acceptability, particularly those such as iron and manganese which can lead to water discolouration. Highly mineralised sources can also be unacceptable to consumers due to adverse taste or formation of hardness scale in hot drinks and hot water plumbing systems.

All groundwater sources should be analysed for mineral composition, before being developed for water supply purposes, although the resources for doing this may be less readily available in some developed countries. The level of key minerals should be assessed against national health guidelines and/or advice from WHO. Consumer acceptability issues may also need to be taken into account. Where levels are of potential concern the action to be taken will depend on local circumstances including the scale of any potential problem, the level of financial resources available, and availability of suitable alternative public supply sources. Mitigation measures fall into three main areas. If none of the options are readily available then the action taken will require more detailed evaluation in conjunction with the relevant health and other authorities.

1. *Closure of source*
   In larger utilities where alternative water resources are available, it might be most cost effective to simply close the source and replace it with water from other supplies.
2. *Removal through treatment*
   Depending on the mineral involved and its concentration, suitable treatment may be installed.
3. *Blending with other sources before supply*
   The source may be blended before distribution with water from another source with lower levels of the relevant mineral. In such situations however a full risk assessment should be taken to ensure that levels in supply can be maintained at appropriate levels allowing for natural variation in raw water levels and reliability of the blending infrastructure (e.g. pumping plant).

(50) 4.5.4 Microbiological hazards

All surface waters are likely to have a wide range of microbiological hazards present. They include bacteria, viruses, protozoa and in some situations other organisms such as Helminths. They originate mainly from human sewage disposal and from farm animals and their wastes. In some situations wild animals can also be a significant source of microbial pollution. The microbial load in raw waters can be considerably increased during storm or other adverse weather conditions and this needs to be taken into account as part of the WSP risk assessment. Much more information on the risks associated with specific organisms is available from WHO (WHO 2004).

The unsaturated and saturated zones of aquifers are usually efficient in degrading microbiological hazards. Therefore, for deep well protected aquifers microbiological contamination in groundwater is much less common. However, some aquifers are much more vulnerable to microbial contamination e.g. those which are unconfined and with shallow water level. Additionally inadequate design, construction or maintenance of the well and boreholes headworks can allow direct ingress of microbial pollution from surface water or shallow aquifer layers.

Microbial pollution of raw water can be a major hazard for drinking water supplies. Indeed many of the most serious incidents of waterborne disease, even in wealthy developed countries, have been due to an unrecognised increase in the microbial load in raw water coupled with inadequate disinfection barriers (Hrudey and Hrudey 2004). Typically a major risk can occur when one or more of the following situations arises:

- The microbial load in the raw water increases above the level that can be removed by the existing disinfection barriers
- The type of microbial load changes e.g. increased levels of cryptosporidium which the plant was not designed to cope with
- The effectiveness of the existing disinfection barriers reduces e.g. due to failure or poor maintenance of treatment plant, treatment processes or units being out of commission for maintenance, or an unrecognised increase in the raw water turbidity or oxidation demand which reduces disinfection effectiveness

Because of the importance for protection of public health, the catchment WSP should ensure that there is an ongoing assessment of the risk from microbial contamination of the raw water under all types of weather conditions. Particular attention should be given to Cryptosporidium or other parasites because unlike most bacteria and viruses they are not removed or inactivated by conventional chemical disinfection. In conjunction with the catchment management authorities, new developments which might pose a risk of increased raw water microbial contamination (e.g. new human settlements, increased livestock density, or animal processing plants) should be assessed and wherever possible mitigation actions taken.

Except where there is absolute certainty that raw water microbial contamination cannot occur then robust disinfection treatment processes will be necessary to ensure that the treated water remains safe at all times. If cryptosporidium or other protozoa may be present then treatment will need to ensure that the organisms are physically removed (e.g. through filtration) or inactivated. In larger, particularly surface, catchments, complete mitigation of microbial risks can be difficult and thus disinfection needs to be correspondingly more rigorous. However, in smaller or less developed catchments where treatment plant may have limited disinfection, some mitigation of raw water risk may be possible for example:

- For vulnerable groundwaters/spring sources by fencing to restrict animal access around the immediate source catchment area and by ensuring that well head design and construction is adequate and well maintained (see section 5.xx).
- In upland areas livestock can be kept away from catchment feeder streams by fencing and provision of separate watering facilities
- Where possible temporarily ceasing abstraction or using alternative supply sources if raw water quality deteriorates to a level where disinfection may be compromised

(51) 4.5.5 Sewage and wastewater reuse

As described above human sewage can pose a major microbial risk to water treatment works. However, depending on the level and effectiveness of treatment, sewage disposal and sludge disposal can be a significant source of ammonia, nitrate and natural organic material and also in industrial catchments a wide range of organic and inorganic pollutants. Risks can be mitigated through legally enforceable requirements to treat sewage to defined levels, manage sewer system surcharge in storm conditions, and properly treat and dispose of wastewater sludges.

In groundwater, reuse is being increasingly adopted for managed aquifer recharge (MAR). The main objectives are to store water for future use, implement recharge rates in overexploited areas, use the aquifer as effluent treatment system, and serve as a low-cost option to minimize surface runoff. There are many techniques to infiltrate sewage and wastewater, divided in two main groups: infiltration in the riverbed and outside of the riverbed. Careful evaluation of the wastewater quality is necessary in order to only inject water with contaminants that are degradable in the aquifer. Due to the aquifer contamination risks involved, MAR should only be done in situations where it is really necessary, such as semi-arid and arid regions, and in costal areas to control saline intrusion. More information is available in XXXX.

(52) 4.5.6 Pesticides

Use of pesticides can pose risks to the quality of raw water used to produce drinking water. The treated water standards which apply to pesticides will vary from country to country. In many places standards are based on the toxicity of individual substances (WHO 2004) but in Europe there is an extremely stringent limit for pesticides (0.1 parts per billion) that is at a level which effectively represents a surrogate for zero.

Pesticides are used particularly in arable agriculture, animal husbandry and forestry, but also for amenity purposes, e.g. control of weeds on roads and other impermeable paved surfaces, on railways, and in parks, sports facilities and gardens.

Except where bad practice is used, normally only a small proportion of agrochemicals applied are leached to water, losses rarely reach 5% of total active ingredient applied and more normally are less that 1% (Foster and Hirata, 1988). This results from a complex interaction between:

- Crop and cultivation type
- Soil properties
- Rainfall , drainage and irrigation regime
- Management of soil and agrochemical applications,

However, even with this potentially low leaching loss, pesticides can still pose significant risks to drinking water, particularly in those areas which have very strict standards such as Europe. The risks are typically higher in surface water, particularly from the use of mobile and persistent products in agriculture. Problems can also arise due to use of pesticides on drained hard surfaces such as roads and railways. Pesticides can reach surface water from a number of routes:

- Overspray of streams and ditches
- Poor storage and handling in farmyards
- Overland run-off
- Leaching through soil horizons
- Loss through field drainage where installed

Pesticides tend to be less of a risk to groundwater resources in rural areas, but may be an issue in urban areas due to excessive or incorrect application on unpaved areas, recreational facilities, and other locations. Pesticide contamination of groundwater can also occur due to inadequate pesticide storage and handling, and also use on railways and similar areas where the attenuation effects of soil may be bypassed.

Effective mitigation of pesticide risks first requires a good knowledge of pesticide usage in the catchment, including what is used, for what purpose, when and how. This must be associated with mapping of the agricultural and other land use in the catchment, as well as the soil type and underlying geology. With this information models are now available which enable an estimate of the risk that pesticides might leach to surface or groundwater. There is an increasing amount of best practice information available on how losses from all sources can be reduced but this requires the active cooperation of users and other catchment stakeholders. In many countries there are also rigorous legislative requirements for pesticides which may specify specific authorisation for use and storage of pesticides, as well as conditions of use including rate of application, timing of application, or restrictions for particular purposes. There may also be statutory requirements for training/ certification of users and disposal of used containers.

(53) 4.5.7 Nitrate

The WHO guideline value for nitrate is 50mg/l (as NO3). In many parts of the world this value can be exceeded, or is at risk of being exceeded, in raw drinking water resources, particularly groundwater. The causes can be complex but mainly originate from intensive farming due to excessive use of manures and fertilisers as well as from land management such as ploughing and other activities which releases organically bound N. Nitrate contamination can also arise from poorly controlled treatment and disposal facilities for sewage and sewage sludge.

Extensive areas of monoculture generate the most serious diffuse contamination of groundwater by nitrate. More traditional crop rotations, extensive pasture land, and ecological farming systems normally present less probability of a subsurface contaminant load. Agriculture involving the cultivation of perennial crops also normally has much lower leaching losses than where seasonal cropping is practiced, because there is less disturbance and aeration of the soil and also a more continuous plant demand for nutrients. However, when perennial crops have to be renewed and the soil ploughed, there can be major release and leaching of nutrients. Values of leaching losses obtained from the literature indicate that up to 75% of the total N applied can be oxidized and leached to groundwater (although values of 50% are more common). In some areas other potential sources of groundwater nitrate contamination need to be considered. For example, especially in the more arid climates, agricultural irrigation with wastewater can be an issue. Wastewaters invariably contain nutrients and salts in excess of crop requirements which can lead to significant leaching losses from agricultural soils.

As with pesticides, mitigation of nitrate losses requires a good knowledge of land use in the catchment, as well as mapping the soil type and underlying geology. With this information models are now available which enable an estimate of the risk that nitrate can pose to surface or groundwater. Mitigation measures are normally based on cropping, fertiliser and land use changes to reduce leaching rates, but this often requires legislation to be effective.

In urban areas, nitrate can derive from leakage from existing sewer systems but a particular nitrate problem can arise where sewerage infrastructure is poor or non existent. In such situations local sanitation arrangements (latrines and septic tanks) mainly in high dense populated areas presents a significant aquifer quality hazard, which needs to be managed. This problem is further exacerbated if the local communities also self-supply drinking water from groundwater. In most aquifer types, except the vulnerable shallow sources, there will be sufficient natural groundwater protection to eliminate faecal pathogens in percolating wastewater from properly constructed in situ sanitation. However, elevated concentration of nitrogen compounds (usually nitrate) will also be present in varying degree according to the population density served by latrines and septic systems. Mitigation requires long term investment to install mains sewerage or, in specific areas improved septic tanks can be used.

(54) 4.5.8 Urban development and runoff

As described above, urban development, particularly in less affluent countries can be a significant source of nitrate groundwater pollution. Additionally rainwater runoff from roads in urban areas, particularly when intense storms follow a very dry period, can lead to highly complex polluting discharge containing nitrate, ammonia, heavy metals, pesticides, hydrocarbons, oil and greases, and other inorganic and organic material. Water suppliers will need to assess these risks as part their catchment WSP. Mitigation can be difficult but where the risks are significant could involve interception and treatment of "first flush" storm water.

(55) 4.5.9 Fuel storage and transport

Fuel storage and transport, either though pipelines or by road, represent a common source of raw water contamination in both surface waters and groundwaters used for drinking water production. When oil leaks or is spilled an often complex mixture of hydrocarbons can present a significant toxic hazard to waterworks abstractions. Even at lower concentration, hydrocarbons can often lead to taste complaints in treated water. If the soil and underlying groundwater is severely contaminated with oil residues this can have an impact for decades. The problem is often related to corrosion and thus leakage from storage tanks and pipe work. This can be due to a number of factors including poor design, construction and maintenance.

Accidental oil tanker spills can occur in routine operations of fuel loading, unloading and provisioning. Other diffuse sources, e.g. from highway drainage systems must also be considered (see above).

Mitigation of risks from oil leaks and spills can be secured through a range of either voluntary or statutory best practice measures underpinned by risk based procedures to identify and correct potentially corroded fuel storage and transport infrastructure before it leaks. This can be helped by a risk classification of different plant and equipment linked to regular inspection and maintenance procedures. For example tank corrosion is often associated with its age and there is a strong correlation that tanks more than 20 years old are often seriously corroded and subject to leaks unless they receive regular maintenance. Additional security can be obtained by the design of oil storage facilities so that even if leaks occur the oil can be contained on site without causing pollution. For example tanks installed above ground should have leak proof bunds sufficient to contain at least the volume of oil stored. Level indicators and alarms can warn of potential problems. If tanks must be kept underground then they should be double skinned and again with level indicators and alarms. Drainage from sites with oil storage and or subject to regular vehicle use should have oil traps to protect surface water drainage systems.

(56) 4.5.10 Industry

The range of industrial contaminants that can affect water supply abstractions is potentially very large. As well as potential toxic threats, many industrial substances can also provide a risk to water supplies because of their potential to cause unacceptable tastes and odours at levels well below that which might give rise to a toxic hazard. For example, it has been found that even a few hundred litres of some solvents or hydrocarbons spilled many km upstream of a surface water intake can give rise to tastes in final drinking water. This can also occur with substances such as phenols which can react with chlorine to create unacceptable tastes in the final water distributed to consumers. Some substances such as chlorinated or other solvents can pose a significant risk to groundwater if they enter the sub surface layers.

Because of the range and complexity of industrial installations, particularly in large catchments, risk assessment and mitigation can be difficult and time consuming. However, a typical approach could include the creation by the catchment management authorities of an inventory of all significant industrial installations and activities within the catchment. Those with particular risks to water supply abstractions and/or the environment generally should then be subject to statutory or voluntary controls to reduce the risk that chemical hazards can enter the aquatic or subsurface environment at levels of concern. The control methods used will vary but could include one or more of the following:

- Treatment of process and other harmful wastes with discharge controlled through permits specifying volume and concentration of pollutants
- Permits specifying requirements for biological wastes discharged to sewer for treatment at a sewage works e.g. maximum metal limits
- Requirements covering storage and disposal of hazardous material which might pose a risk to soils or groundwater
- Requirements that surface water drainage from industrial sites be subject to treatment through interceptors to contain any spillage on site
- Measures to minimise the risk of leaks from chemical storage tanks and pipelines though inspection and maintenance, coupled with bunding requirements to contain spills that do occur
- Restriction or banning the use of certain particularly harmful chemicals

(57) 4.5.11 Solid waste disposal

Inadequate disposal of solid waste is responsible for a significant number of cases of groundwater pollution (USEPA, 1980). In some situations leachate from waste sites may also pose a risk to surface water abstractions. This problem is more prevalent in wet regions where substantial volumes of leachate may be generated from these facilities, but it also occurs in more arid climates where leachates will generally be more concentrated. The subsurface contaminant load generated from a waste tip or sanitary landfill is a function of two factors:

- The probability of the existence of contaminants in the solid waste
- The generation of a hydraulic surcharge sufficient to leach such contaminants.

Measures to mitigate this potential source of contamination relate mainly to ensuring that both the base and surface of the solid waste disposal area are impermeable. This should be a requirement for any newly constructed sites but this may not be practical for old pre-existing sites. In such situations, and for all new sites, this will normally require the collection and treatment of leachates. It is also good practice to monitor groundwater in the vicinity of waste sites to monitor any potential risk impacts to aquifers.

(58) 4.5.12 Mining and mineral extraction

To be completed

(59) 4.5.13 Algae and algal toxins

Proliferation of algae due to eutrophication (nutrient enrichment) of surface waters, especially in lakes and reservoirs, can lead to tastes/odours which are unacceptable to consumers. They can also lead to increased oxidation demand and thus impact on disinfection efficiency and disinfection by-product formation. Of particular importance is the fact that the presence of algae has also been recognised as a serious potential human health risk. High concentrations "blooms" of Cyanobacteria (blue-green algae), such as *Microcystis* sp. and *Anabaena* sp. can occur in slow-moving or still surface waters with a moderate to high concentration of nutrients, particularly phosphorus. In perhaps 50% of cases these can produce a range of toxins (Cyanotoxins) which if ingested through drinking water can represent a risk to human health (Chorus and Bartram, 1999).

Mitigation measures for Cyanobacterial bloom formation need to address their growth requirements, by control and reduction of external nutrient loading to the water body, and where possible light availability (e.g. artificial mixing). Since major sources of external nutrient inputs are run-off and erosion from fertilised agricultural areas, erosion resulting from deforestation, and sewage, this may require improvement of agricultural land use practices and by applying advanced wastewater treatment methods for nutrient removal.

Management of raw water abstraction can be also effective in reducing the amount of Cyanobacteria entering the water supply system. This can be achieved by choosing an optimum position (site and depth) for pumped abstractions from surface water bodies, or where practical by abstracting surface water through bank filtration. In addition it has been shown that the use of submerged barley straw can help to mitigate adverse impact of algal blooms if properly installed around surface abstraction points (Ref xxxx)

(60) 4.5.14 Colour in upland catchments

The colour of raw water is usually classified as either "real" colour caused by dissolved matter or "apparent" colour due to the presence of suspended or colloidal material. The most common colours of natural waters are yellow and brown and are caused by the presence of organic matter originates from peat soils, and decayed vegetation. In general brown and yellow natural compounds in unpolluted waters are known as humic substances. Four groups of humic substances can be distinguished based on their solubility in various solvents: fulvic acids (about 90% of total humic substances), hymatomelanic acids, humic acids and humus coal. In some waters the brown colour is enhanced by the presence of iron and manganese.

Raw water colour can be typically be removed by conventional coagulation, clarification and filtration. However when chemical oxidation (e.g., chlorine, ozone) is used then care has to be taken to avoid excessive levels of disinfection byproducts.

In some catchments the level of colour can be significantly exacerbated by the way the catchment is managed due to …. *More to come*

(61) 4.5.15 Radiological

Health effects from radiological contaminants in drinking water depend on the specific contaminant. Risks to surface water abstractions can arise from industrial, medical and military sites using nuclear material. Mitigation of risks is similar to that for other industrial contaminants, although the hazardous nature of the material means that controls over use and emissions are likely to be stringent.

However, due to its percolation through the soil, groundwater sources may poses more vulnerability to the threats from radiological compounds due to its facility to dissolve elements such as uranium and other naturally-occurring radiological elements. The actual risk can only be assessed by evaluation of the naturally occurring elements (see 4.5.3 above).

(62) 4.5.16 Saline intrusion

Excessive abstraction can result in saline and sometimes other pollution of groundwater through induced flow into freshwater aquifer. This situation is common in coastal aquifers (marine intrusion), but also involves problems inland with contaminated aquifer. The main contaminants of concern involve mainly chloride, but can also include persistent human made contaminants, including nitrate, chlorinated solvents among others. The risk of such intrusions can be reduced by use of flow models which allows a calculation of the extraction rate that will not induce contaminated water into the aquifer.

(63) 4.5.17 Recreation

Some raw water storage reservoirs used for drinking water production are in protected catchments where human access is strictly controlled. In other situations raw drinking water reservoirs may be used for recreational purposes, for example boating, sailing or fishing. Depending on the extent of such recreational activity and the level and type of treatment available at the water treatment plant this could in some situations pose a small risk to raw water quality. Any potential risk needs to be assessed and appropriate mitigation measures adopted for example restricting the use of petrol powered boats which could leach fuel boats and strictly controlling disposal of human wastes.

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7.4 Appendix 5: AM739 - DWSP Catchment Survey and Risk Assessment Methodology

*** The rest of this document can be made available on request ***

Purpose

To capture and document the process for carrying out a catchment risk assessment on a defined catchment area

Scope

This methodology applies to anyone carrying out a catchment risk assessment as part of catchment management activities or as part of work on Drinking Water Safety Plans

Audience

- Asset Strategy – all levels of knowledge base
  Water Quality Services
-

Introduction

A land use survey is conducted to ascertain potential sources of point and diffuse pollutants within the catchment area of a borehole, reservoir or river. The risk assessment includes the 'source' characteristics which relate to land use and inferred potential pollutants associated with the land use activity, 'pathway' characteristics, which are the properties of the aquifer or surface water and 'receptor' characteristics, being the borehole or surface water intake.

This methodology has been developed following guidance from 'Drinking water quality management from catchment to customer' Chapter 4: Developing a catchment water safety plan

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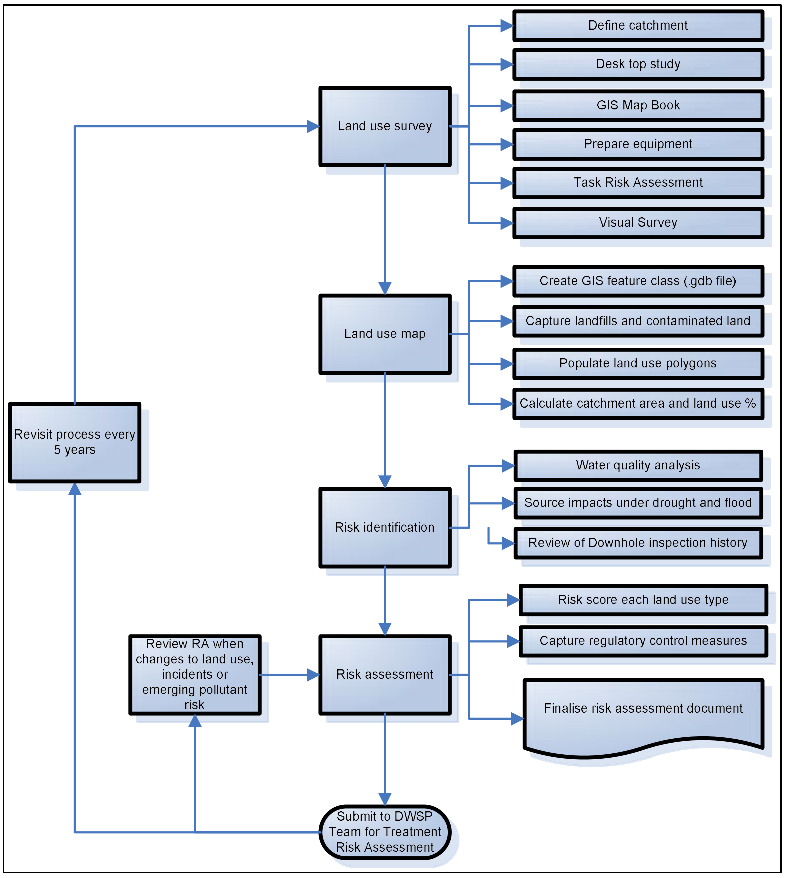
Catchment Risk Assessment Process:



7.5 Appendix 6: Business requirements to support options appraisal (MoSCoW)

7.5.1 Requirements Priority Matrix

Table 4 Requirements Priority Matrix

Designation	Explanation
Must	The solution will not be accepted if a requirement that has a priority of 'Must' has not been delivered
Should	The requirement with a priority of 'Should' would provide business benefit, but the business would accept a solution where this requirement was not delivered e.g. the solution could be delivered by other projects/changes of working practice. If possible the solution should deliver these requirements
Could	The requirement with a priority of 'Could' may provide some business benefit, but not as much as the requirements that have been prioritised as 'should' and 'must'. The business would accept a solution where this requirement was not delivered.
Won’t	Won't do this now but may wish to implement in the future

7.5.2 Functional Requirements

Table 5 Functional Requirements

	Requirement Description	Rationale	Priority
1	Undertake water quality trend analysis over a minimum 5-year period (recommendation of 10 years) for all groundwater sources and surface works	To identify rising trends in contaminant risk to support the risk assessment and identify where further catchment-based investigations are required	Must
2	Carry out a physical land use survey (or desk assessment using remote sensing for medium/low risk sources) for each groundwater source	To identify current land use, and where land use has changed over the previous 5 years to identify potential pollutant risks from certain land use types to support water quality trend analysis and risk assessments	Must
3	Develop a catchment action plan for high risk pollution risks and/or emerging contaminant risks	To proactively identify the source/pathway for the contaminant risk, identify the potential for catchment mitigation measures and support future options appraisal for catchment mitigation schemes	Should
4	Proactively search, review and respond to planning applications that may pose a risk to water quality (e.g. major land use change or development on contaminated land)	Water companies are not statutory consultees within the planning process and our regulators who are statutory consultees (EA) do not always consider public water supply risk in their responses leaving us	Should

		vulnerable if the appropriate conditions are not in place	

7.5.3 Non-Functional Requirements

Table 6 Non-Functional Requirements

	Requirement Description	Rationale	Priority
1	Deliver at least one catchment risk assessment for each groundwater source during AMP7, or where major land use change or pollution incident has occurred, as part of the existing rolling programme	This is a regulatory requirement under Regulations 27 and 28 of Water Supply (Water Quality) Regulations 2000 (Drinking Water Safety Plans) which is subject to audit by the DWI	Must
2	Compliance with relevant Affinity Water standards and policies	Ensure high quality of work	Must
3	Governance documentation completed in line with project lifecycle	Ensure business case is valid and all stakeholders retain buy-in throughout project	Must

Appendix AFW.CE.A1.4

Action ref AFW.CE.A1

Catchment management: Groundwater Pesticides

Catchment management: Groundwater Pesticides

PR19 Business Case

March 2019

Asset Strategy document control sheet

Document amendment history

Version	Status	Date	Amendment to this version
V6	Draft	01/03/2019	Revised BC in new template for re-submission
V7	Draft	06/03/2019	Revision based on initial review with Marie Whaley
V8	Final	22/03/2019	Final version

Document approval

Document title	Catchment management: Groundwater Pesticides PR19 Business Case			
e-Document location				
	Name	**Signature**	**Title**	**Date**
Author/originator	Alister Leggatt		Asset Manager	22/03/2019
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Approver 3 AS Director following EMT review (external use)	Marie Whaley		Director of Asset Strategy, Data and Innovation	22/03/2019

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1 Document Purpose

The purpose of the Project Business Case is to describe the reasons for the project and the justification for undertaking it, based on the estimated costs of the project, the expected business benefits, savings and risks.

The Business case will also present all the options that have been assessed to deliver the project outcome and will indicate the preferred option out of all considered.

During the project a Business Case is a major controlled document that is referenced on a regular basis to ensure and confirm that the project remains viable. It is maintained throughout the lifecycle of the project, being reviewed by key stakeholders at key decision points, i.e. at the end of a phase.

2 Executive Summary

2.1 Introduction

Water supplied from NORM WTW periodically exceeds the drinking water standard for a number of agricultural and amenity pesticides. Water Industry National Environment Programme (WINEP) Investigations carried out by the catchment management team in AMP6 identified the source(s) and pathway(s) for these pesticides alongside delivering a pesticide reduction scheme for metaldehyde, which has since been banned for outdoor use.

The outcomes of these investigations determined that catchment management could be effective in mitigating the risk posed by these pesticides and provide greater long-term resilience to our sources and existing treatment. These investigations also identified additional risk posed to the LANE group of sources due to the interconnectivity of the high-risk catchments considered to be primary sources for these pollutants. This business case sets out the justification for delivering catchment management measures to mitigate the risk of pesticide exceedances for our vulnerable groundwater sources in Hertfordshire. This document also describes the options appraisal undertaken the reasoning behind the selection of the preferred option.

2.2 Drivers

The Groundwater Pesticides Catchment Management scheme drivers include:

- To reduce raw and final water exceedances of the drinking water standard for a range of pesticides at the NORM and LANE group of sources.
- Support achievement of Customer Outcome 3: Supplying high quality water that customers can trust.
- Legal Undertakings for individual and total pesticides agreed with the Drinking Water Inspectorate (DWI) for the NORM group of sources in AMP7.
- Meet our regulatory expectations to deliver catchment management under the 'no deterioration' driver of the Water Framework Directive (WFD) agreed with the Environment Agency (EA) through the Water Industry National Environment Programme (WINEP).
- Work in partnership with neighbouring water companies, regulators, farmers, agronomists and other agencies to incentivise best practice techniques in reducing pesticide losses to water.

- Provide greater resilience to our treatment works and reduce the need for imports, future treatment investment and reduce GAC regeneration frequency by recognising and incentivising farmers (and other pesticide users) as producers of clean water.

- Meet the expectations specified in the Blueprint for Water coalition's 'manifesto on environmental investment for PR19' and the expectations of the Drinking Water Inspectorate (DWI) in Guidance Note: Long term planning for the quality of drinking water supplies.

2.3 Best value option

The best value option is Option 2 - Catchment Management Enhanced at targeted catchment scale.

This option expands the current AMP6 catchment management schemes for metaldehyde to mitigate risk of Individual and Total Pesticide breaches. The foundation of this option is a 'Payment for Ecosystem Services' approach, viewing farmers as producers of clean raw water and develops a series of incentive mechanisms to achieve best practice in crop protection to sustainably improve water quality reducing the need for future treatment investment and providing greater resilience for current treatment and blending options.

A successful, long term reduction in diffuse pesticide pollution affecting raw abstracted water could lead to a reduction in the need for future treatment and a greater resilience for existing treatment and blending options at these abstractions. It also allows water transfer across the company's supply area without regulatory restrictions on deterioration of water quality.

This is the best value option as it:

- Potential to achieve greatest water quality benefit vs cost benefit.

- Builds on the NORM DrWPA catchment management scheme for metaldehyde undertaken in AMP6 and expands the scope and scale of existing pesticide reduction schemes to all "at risk" pesticides to the LANE and NORM groups based on robust evidence gathered from AMP6 schemes and catchment investigations since 2010.

- It utilises the outcomes of the WINEP investigation into at risk pesticides undertaken in AMP6, completed in 2017 and signed off by the EA which supported the options appraisal for this scheme (Appendix 1).

- The approach in this options targets catchment areas where pesticide reduction schemes, infrastructure grants (e.g. pesticide handling areas) and constructed wetlands can achieve the greatest benefit and utilises resources effectively to represent the best value to the customer.

- Meets all regulatory expectations under WFD/WINEP and legal Undertakings agreed with the DWI for AMP7.

- This option has been developed to ensure it meets the requirements of the EA PR19 driver guidance for DrWPA schemes and the DWI long term planning for water quality guidance by recognising our water catchments as critical assets.

- This approach seeks to reduce diffuse agricultural pollution at the source providing greater resilience to existing treatment and blending options.

This option will utilises the findings of an innovative hydrogeological investigation carried out in AMP6 carrying a pesticide risk assessment of Karst geological features (e.g. stream sinks) as pathways for pesticide pollution to our abstractions (Appendix 6). The preferred option initiates measures including pesticide reduction schemes and constructed wetlands to mitigate the risks of these pollutant pathways. This scheme will also develop an innovative Payment for Ecosystem Services (PES) mechanism for incentivizing farmers as producers of clean water in the catchment.

In addition, this project will seek to utilize a range of emerging technologies including satellite imagery, remote sensing, passive samplers and catchment trading platforms and will aim to ascertain the wider ecosystem services benefits of the schemes and undertake Natural Capital assessments to support future business planning.

There is an expectation from Defra, DWI and the EA for water companies to increase their focus on catchment management and incorporate this into the long-term planning for managing water quality in line with the Water Framework Directive (WFD). Article 7 of WFD stipulates a move away from end of pipe treatment solutions to managing risks and issues at the source. This option facilitates the development of catchment action plans to manage pesticide risks in these catchments.

2.4 Cost summary table

Table 1 Costings for the Best Value Option

Preferred Option:	Y1	Y2	Y3	Y4	Y5	Y10	Y20
Costs (capex)	£244,000	£340,000	£490,000	£490,000	£320,000		
Costs (opex)	£10,000	£10,000	£10,000	£10,000	£10,000		
Total costs (capex, risk + opex)	£254,000	£350,000	£500,000	£500,000	£340,000	£0	£0
Total revenue							
Funding requirement (capex + opex – revenue)	£254,000	£350,000	£500,000	£500,000	£340,000	£0	£0
NPV (£k)	-199.5	-294.2	-494.2	-494.2	-262.2	-1,372	-1,012

Please see section 4.3 for commentary around the NPV assessment.

2.5 Customer benefits and resilience benefits

The primary purpose of this investment is to reduced pesticide exceedances at our NORM and sources and LANE group to provide greater resilience to our assets, meet our legal Undertakings for pesticides agreed with the DWI and our regulatory expectations under the Water Framework Directive (WFD) 'no deterioration' driver delivered through the Water Industry National Environment Programme (WINEP). This project can deliver a range of additional benefits including:

- Supports a longer-term strategy of reducing diffuse agricultural pollution at the source in order to prevent further deterioration of water quality and associated treatment needs/costs and delivers on WFD Article 7 requirements.
- Supports achieving our performance commitment 'Water Quality Compliance, Compliance Risk Index (CRI)' target performance.
- Supports achievement of Customer Outcome 3: Supplying high quality water that customers can trust.
- Develops a stronger understanding of our catchments and the risks posed to public water supply.
- Changing our approach to managing pollution risks from reactive to proactive.
- Wider ecosystem services benefits realised through reduction in soil/sediments losses and associated pollutants to surface waters.
- Proactively engages with and develops positive collaboration and enhanced reputation with key stakeholders including: our customers and communities, Defra, EA, Natural England, water companies, landowners, farmers, agronomists and environmental groups.
- Long term objective of reducing capex and opex costs for future treatment investment and ongoing operational costs.

2.6 Methodology

The need for the project was identified based on the current scheme being delivered for metaldehyde in the NORM Drinking Water Protected Area (DrWPA) and WINEP pesticide investigations. Investigations carried out during AMP6 which concluded in March 2017 (Appendix 1) identified a number of "at risk" pesticides contributing to periodic deterioration of water quality at our LANE and NORM group of sources. These investigations identified priority catchments to focus future pesticide reductions schemes and this project has been developed to work collaboratively with farmers, regulators and other key stakeholders in these high-risk catchments to mitigate these pesticide risks. The preferred option expands on existing schemes trialled for metaldehyde in AMP6 and further develops the approach, focusing on key high-risk catchments to address the wider diffuse agricultural pollution risks to public water supply. The methodology will apply a Payment for Ecosystem Services mechanism to drive best practice in sustainable crop protection and where significant risk is identified at the farm/field scale, will incentivize land use change to achieve improvements in raw water quality. Costs for this project have been derived using an inhouse PR19 unit cost model for each source/scheme (Appendix 2 and 3).

3 Defined Need and Dependencies

3.1 Defined need

In 2009, we identified that water supplied from NORM WTW periodically exceeded the drinking water standard for metaldehyde. Following our investigations, we concluded that our pesticide treatment was inadequate to remove this particular pesticide to below the standard. In 2010, we gave Undertakings for metaldehyde to the Drinking Water Inspectorate (DWI). In these Undertakings, we committed to review and investigate our current abstraction regimes and pesticide monitoring strategy as well as review new technology and participate in industry research to achieve compliance and to undertake catchment management investigations to identify the source of metaldehyde and develop catchment-based mitigation measures to reduce the issue at the source. These Undertakings were extended till 2020 as a consequence.

A series of investigations were also agreed with the EA and carried out during AMP6 under the WINEP 'no deterioration' driver. These investigations required us to identify the sources and pathways of diffuse and point source pesticide pollution and identify measures required to mitigate the risk to drinking water supply. The evidence used to support decision-making on where to focus the pesticide reduction schemes was gathered through this programme of detailed catchment investigations completed in March 2017 in order to inform the investment decisions for enhanced catchment management schemes for PR19. Further detail can be found in Appendix 1: National Environment Programme Water Quality Schemes: Groundwater Pesticides Investigation Report. These investigations concluded:

- The complex hydrology and hydrogeology of the Mimmshall Brook and ESSE Brook catchments has a significant influence on groundwater quality for NORM and ESSE respectively. Targeted measures based on geography and topography alone will not be effective in reducing concentrations of the pesticides subject to investigation to levels below the drinking water standard (DWS). A holistic approach to implementing catchment schemes across the whole catchment area is required. Targeted measures may be effective upstream of solution features which are identified as having a significant influence on water quality at the point of abstraction.

- Evidence indicates that the LANE group of sources are affected by water quality issues arising from the Mimmshall Brook caused by the overflow of the Water End swallow holes into the River Colne source during periods of heavy rainfall. There is also potential for localised sources of diffuse pesticide pollution due the complex karst geology in the Upper Colne. We aimed to understand how solution features, such a stream sinks, act as preferential pathways for pollutants in the Upper Colne, as well as the influence Blackbirds sewage treatment works has on water quality.

A further study carried out by the British Geological Survey for Affinity Water in 2017 (Appendix 6) into the pollution risk posed by the complex karst geology identified and risk assessed 29 'stream sinks' acting as pathways for diffuse pollution (including pesticides) from surface water to ground water. A number of these have been identified as high risk and has defined the upstream catchment area where pesticide reduction measures can be focused. Based on the outcome of these investigations and the AMP6 DrWPA catchment scheme for metaldehyde, the EA have included a scheme for "at risk" (Total) pesticides in our WINEP2 list for PR19 schemes to be delivered by Affinity Water in AMP7 under the WFD "no deterioration" of water quality driver for both the NORM and LANE groups. Although metaldehyde has been banned for outdoor use as of March 2020, the experience and approach developed from the metaldehyde scheme delivered in AMP6 can be used to deliver catchment intervention for all ‘at risk’ pesticides.

The Groundwater Pesticides catchment management project is a series of catchment-based schemes with the objective of reducing agricultural pesticide pollution at the source rather than relying solely on water treatment, which is not effective when pesticides go above certain concentrations. It is an enhancement of our current AMP6 schemes for metaldehyde which will end in March 2020 and will expand the scope to mitigate key "at risk" pesticides identified through our AMP6 monitoring and investigations, which pose a risk to failure of the Drinking Water Directive standard for individual and total pesticides. The NORM and LANE groups of groundwater sources abstract from groundwater susceptible to pollution from surface water due to the Karst geology in this region. NORM, ESSE, ROES, NETH, BRIC, TOLP and EAST in particular are risk from agricultural pesticide use in the Autumn/Winter under certain hydrological and hydrogeological conditions. This project will seek to ascertain those conditions and associated influences/pathways building on the investigations carried out in AMP6. The project will develop a programme of catchment intervention measures in the upstream river catchments of the Upper Colne and Mimmshall Brook, building on the work completed to date, to mitigate the risk to public water supply and enhance water quality resilience in order to maintain treatment effectiveness in the long term.

The scope of the schemes to be implemented in these catchments, through this project, will focus on key pesticides used in cereal and oilseed rape crops that are predominantly grown in this region. The key objective of the project is to develop an effective "Payment for Ecosystem Services" (PES) mechanism which aims to empower farmers as producers of clean water in our upstream catchments. The schemes will incentivise farmers to go beyond compliance with their legal obligations, which are not effective for improving water quality, to adopt best practice controls where the need is greatest. The project will support research and provide evidence for the most effective measures and work directly with farmers and other key stakeholders to implement these measures, monitor their effectiveness and replicability in larger catchment areas and prevent further deterioration in water quality. The PES approach will focus on working with farmers to improve crop protection, soil husbandry and water source protection. The measures that will be developed and incentivised have the potential to provide additional ecosystem services benefits including: improved soil retention, greater flood resilience through improved soil organic matter and more sustainable farming. The project work in collaboration with a range of stakeholders including specialist agricultural delivery partners, regulators, Natural England, farmers and agronomists.

Where specific high-risk pollutant pathways have been identified (e.g. stream sinks) further studies will be carried out in the form of tracer testing to confirm their connectivity and influence on our abstractions. Based on the perceived risk, this project will seek to identify solutions such as constructed wetlands upstream of these pathways to reduce the concentrations of pesticides and other pollutants entering groundwater.

This scope of this project will support achieving the target set out in the following performance commitments:

3.2 Assumptions

- Water Framework Directive, Drinking Water Directive and WINEP statutory obligations will remain post-Brexit.
- Legal Undertakings will be agreed with the DWI for individual and total pesticides in AMP7.
- Cost avoidance in NPV assessment assumes one pesticide pollution event per year with a drinking water standard exceedance and reliance on import from Grafham Water
- The Environment Agency will approve the Catchment Measures Specification developed for WINEP based on the preferred option (determination in March 2019).
- Any future restrictions on the use of metaldehyde and other "at risk" pesticides will take a number of years to develop, implement, enforce and water quality improvements realised.

3.3 Constraints

- Current WINEP guidance does not allow for continuation of AMP6 schemes into AMP7 without change of scope or expansion of focus areas.
- DWI long term planning guidance stipulates an expectation of increases in scope and/or scale of AMP6 catchment management activities.
- Tender processes and procurement of services not allowing for professional services contracts outside of approved Frameworks (This project requires specialist services not common within the water industry).
- Current NPV assessment does not include an assessment of Natural Capital and the outputs will not reflect the additional value derived from this scheme.
- NPV assessment does not include cost avoidance measures for reduction in future treatment (capex) and reduction in GAC regeneration (opex) due to high level of uncertainty.
- Uncertainty around Brexit and the development of a UK Common Agricultural Policy leading to limited options to develop outline programme based on future changes to the regulatory landscape. As a consequence, the scope of this project will need to be continually evaluated to ensure it can be effectively delivered.

3.4 Dependencies

- Identifying effective, high quality agricultural specialist advisors to deliver aspects of scheme beyond capability of AW Catchment Team. A number of specialist delivery partners have been trialled on schemes in AMP6. Based on current outputs, suitable delivery partners are available to deliver schemes proposed in the preferred option. In-house expertise through training and development is also underway to ensure effective resourcing for this project at the start of AMP7.
- Farmers willing to participate in the schemes. The lessons learned from the AMP6 schemes including suitable incentive mechanisms to gain the highest level of participation from farmers have been evaluated. Each year in AMP6, post season surveys have been carried out with farmers to determine barriers and incentives to participation. This feedback informs the development of these schemes to ensure that the highest possible number of farmers could be encouraged to participate in future pesticide reduction schemes.

- Landowner permissions and regulatory permits required for constructed wetlands. This has not been undertaken before so options, limitations and other issues will be explored during the concept phase in year 1 of AMP7 with gate review to determine whether this is viable to proceed.
- Success of this programme in helping to maintain resilience where criticality of sources not subject to sustainability reductions has increased. Importance of maintaining availability of sources to meet our supply obligations.

4 Options Appraisal

4.1 Approach

All schemes and investigations within the Environmental Enhancements programme were defined through their respective regulatory driver(s) and aligned to the associated customer outcome(s) and business need. Each scheme/investigation then underwent an options appraisal exploring the mitigation options, costs and resource requirements to address the need and meet the associated regulatory requirements. This appraisal was supported by the business requirements MoSCoW method documented in Appendix 13.

Several options were developed for each scheme/investigation using a bespoke WINEP Unit Cost Model for PR19 developed for the Environmental Enhancements programme by consultants Mott McDonald. The Unit Cost Model compiled all unit costs and staff hours for catchment management projects based on historic proposals and quotes from schemes and investigations delivered during AMP6. The 'Project build' tool incorporated into the model enabled the user to build up an estimate of the total project cost using pre-defined 'tasks' from drop down menus. The number of 'units' against each task was inputted, which produced a cost for each of the option developed per scheme/investigation. An audit trail was prepared for contractor and other (e.g. infrastructure and farmer incentive payment) unit costs. All costs are including company overheads. They are then indexed to 17/18 price base (an uplift of 15%). The detailed cost model for each scheme can be provided on request. All files that provided evidence of the unit costs were subject to an internal audit to check their accuracy.

The Unit Cost spreadsheet for each option in this business case is available in Appendix 1.

4.2 Options

Table 2 Costings for the options considered in the options appraisal

	Option 1	Option 2	Option 3
Year 1	£915,860	**£244,000**	£231,874
Year 2	£915,860	**£340,000**	£231,874
Year 3	£915,860	**£490,000**	£231,874
Year 4	£915,860	**£490,000**	£231,874
Year 5	£915,860	**£320,000**	£231,874

4.2.1 Do nothing

The do nothing option will not proceed with any catchment management activities and rely on monitoring at the point of abstraction and depend on treatment/blending/import options at NORM and LANE to solely manage pesticide raw water quality.

<u>Benefits</u>

- low capex cost.

Risks

- Will not fulfil regulatory obligations under WINEP/WFD.
- Will not meet our legal Undertakings for individual and total pesticides
- Will not facilitate the reduction of metaldehyde and other "at risk" pesticides in the catchment and current work in AMP6 to reduce metaldehyde will be undone and increase concentrations in raw water will lead to greater risk of breaches of the drinking water standard as treatment ineffective.
- Defra, EA, DWI and Ofwat all have stated expectations that water companies will undertake increased catchment management activities as part of long term plans for water quality.
- No benefits in improved water quality and further deterioration resulting in increased treatment costs. The do nothing option will not proceed with the Catchment element of the DWSP process in AMP7 and rely on risk assessments and supporting information from AMP6 to feed into the next stages of Water Safety Plans.

4.2.2 Option 1 - Catchment Management Enhanced at whole catchment scale

Builds on current AMP6 metaldehyde pesticide reduction schemes and expands the approach to incorporate all "at risk" pesticides. This option increases the catchment area for these schemes to cover all high, medium and low risk sub-catchments for NORM and LANE groups of sources covering an estimated catchment area (based on eligible arable crops grown in a given year) of ~15,000 hectares. This option also includes an enhanced Capital Grants scheme for infrastructure improvements to all farmers within these catchments and constructed wetlands upstream of all identified stream sinks.

Benefits

- Significant upscaling of priority catchments and number of potential farmers participating in schemes.
- Will meet all regulatory expectations under WINEP and legal Undertakings for individual and total pesticides.
- Constructed wetlands could help mitigate pesticide and other pollution risks (e.g. urban diffuse pollution) providing greater resilience to existing treatment as well as potential reduction in treatment opex costs and reduction in future treatment capex investment.

Risks

- the non-targeted approach could lead to a decrease in level of participation from farmers due to a reduction in intensive engagement resulting from having to deliver pesticide reduction schemes in much larger areas.
- Focusing on low risk catchment areas does not represent good value for the customer.

- Would require a significant increase in human resource (insourced or outsourced) in order to maintain the level of engagement required to maintain a high level of participation.
- Constructed wetlands not guaranteed to mitigate all pollutant risks (e.g. propyzamide). Would require extensive research prior to proceeding with this aspect of this option.

4.2.3 Option 2 - Catchment Management Enhanced at targeted catchment scale (best value option)

Option 2 Builds on current AMP6 metaldehyde pesticide reduction schemes for the NORM group and expands them to incorporate all "at risk" pesticides in high risk sub-catchments in the Mimmshall Brook, ESSE Brook and Upper Colne covering an estimated catchment area (based on eligible arable crops grown in a given year) of ~6,000-8,000 hectares. This option utilises evidence from catchment monitoring, tracer testing, catchment characterisations and risk assessment and experience from AMP6 Thames DrWPA scheme for metaldehyde to target pesticide reduction schemes at high and medium risk catchment areas for diffuse pesticide pollution for the NORM and LANE groups of sources. This option also includes an enhanced Capital Grants scheme for infrastructure improvements that is focused on farm businesses in high risk catchments where specialist advisors have identified a specific water quality improvement that can be derived and where cost benefit for the investment can be demonstrated. This option also includes constructed wetlands upstream of high risk stream sinks based on outcomes of tracer testing.

Benefits

- Will meet all regulatory expectations under WINEP and legal Undertakings for individual and total pesticides.
- Evidence-based approach enabling targeted interventions to focus where water quality improvements will achieve the greatest benefit.
- Enables targeting of resources where the need is greatest to ensure an intensive level of farmer engagement to ensure the highest level of participation of farmers with high/medium risk land in pesticide reduction schemes.
- Constructed wetlands could help mitigate pesticides, nitrate and other pollution risks (e.g. urban diffuse pollution) providing greater resilience to existing treatment as well as potential reduction in treatment opex costs and reduction in future treatment capex investment.

Risks

- Constructed wetlands and other infrastructure improvements and PES incentives not guaranteed to mitigate all pollutant risks (e.g. metaldehyde). Would require extensive research prior to proceeding with this aspect of this.

4.2.4 Option 3 - Catchment Management Basic with no expansion of scope or scale from AMP6 (This option no longer valid due to metaldehyde ban)

Option 3 maintains the existing metaldehyde pesticide reduction schemes with limited expansion to "at risk" pesticides. This option has been discounted as metaldehyde has been banned for outdoor use from March 2020.

Benefits

- low cost option.
- Will not meet all regulatory expectations under WINEP and Undertakings for individual and total pesticides.

Risks

- Defra, EA, DWI and Ofwat all have stated expectations that water companies will undertake increased catchment management activities as part of long-term plans for water quality.
- Less certainty on reduction in pesticides compared to other options. This approach will not mitigate wider pollution issues affecting these abstractions.
- Greater residual risk at the end of AMP.

4.3 Cost Benefit Analysis

4.3.1 NPV assessment

A high-level assessment of NPV for the preferred option has been carried out. This investment is primarily driven by regulatory requirements under the Water Framework Directive delivered through the National Environment Programme and the Undertakings for NORM in AMP7 to be agreed with the DWI.

The primary method of calculation for this assessment was driven by cost avoidance of pesticide exceedances above the drinking water standard and associated costs of importing water during these events. It is difficult to quantify the profitability of catchment management activities due to the vast number of variables associated with delivering a challenging project of this nature and determining the benefits derived. in the NPV assessment, assumptions have been made with reduced levels of confidence on a reduction of drinking water standard (DWS) failures for pesticides and a reduction on the dependency of Grafham imports resulting from the potential reductions in DWS breaches.

This assessment does not account for reduction in future treatment investment (capex) or long-term reduction in GAC regeneration frequency (opex) resulting from catchment management schemes due to a high level of uncertainty. This assessment also does not take into account the wider ecosystem services benefits of the best value option.

The results based on these factors have determined a payback period of over 20 years as there is currently a lack of evidence to support the quantification of benefits from catchment management activities. To improve this quantification of the benefits of catchment management. the wider ecosystem services benefits of implementing the AMP7 Groundwater Pesticides catchment management scheme will be given further quantification using a Natural Capital approach. This approach is currently being developed using the data collected post AMP6 catchment management schemes as a baseline. This method will allow us to use real data linked to indicators of environmental improvements to calculate financial benefits with increased confidence.

The full NPV assessment can be made available on request. A summary of the outputs is shown in Appendix 4.

4.3.2 Environment Agency WFD Operational Catchment Economic Appraisals for the Colne (February 2018)

The EA updated the Operational Catchment Economic Appraisals for the Colne in February 2018. The bundle of measures identified to meet WFD objectives includes the proposed AMP7 catchment management schemes covered with the Groundwater Pesticides catchment management project. The EA updated their operational catchment economic appraisals in February and March 2018, using costs prepared for our dWRMP and our ongoing AMP6 programme of works.

The Colne Operational Catchment Economic Appraisal used costs prepared for our dWRMP. The Colne catchment includes catchment management schemes for NORM and Sources DrWPA pesticide reduction scheme and LANE Group (Upper Colne) pesticide reduction schemes. This assessed costs of £421 million to deliver the recommended bundle of measures with a Benefit Cost Ratio of 1.76 (EA[1], 2018).

Table 3 Summary of appraisal results for recommended bundle of measure

Operational Catchment	Net Present Value (£m)	Benefit Cost Ratio	Present Value Benefits (£m)	Present Value Costs (£m)
Upper Lee	140.89	1.29	633.51	492.62
Colne	421.88	1.76	977.88	556.00

Source: Environment Agency[1]. 2018. Operational Catchment Economic Appraisal – Final Appraisal Report and Audit Trail: Colne – Version number 3. February 2018

We have also sought the views of our customers and stakeholder for protecting the environment. Our dWRMP consultation concluded that stakeholders are supportive of protecting the environment. Please see Traverse, June 2018, *dWRMP 2020-2080 and PR19 draft Business Plan 2020-2025 Stakeholder Engagement Summary* Report for further information

4.4 Recommendation

The recommended best value option proposed in this business case is Option 2 - Catchment Management Enhanced at targeted catchment scale.

This is the best value option as it fulfils all regulatory obligations under WFD/WINEP. This option has been developed to ensure it meets the requirements of the EA PR19 driver guidance for DrWPA schemes (Appendix 4) and the DWI long term planning for water quality guidance (Appendix 5). This option builds on the catchment management project undertaken in AMP6 and expands the scope and scale of existing pesticide reduction schemes to all "at risk" pesticides to the LANE and NORM groups based on robust evidence gathered from detailed catchment monitoring from 2010, WINEP investigations completed in 2017 (Appendix 1) and the mapping of karst features and identification of preferential pollutant pathways (Appendix 6). The approach in this options targets catchment areas where pesticide reduction schemes and constructed wetlands can achieve the greatest benefit and utilizes resources effectively to represent the best value to the customer. It supports Customer Outcome 3: Supplying high quality water that customers can trust by empowering farmers as producers of clean water through a Payment for Ecosystem Services mechanism that is being trialled during AMP6 and constructing wetlands that can mitigate pollution risks in catchment. This approach seeks to reduce diffuse agricultural pollution at the source providing greater resilience to existing treatment and blending options.

The best value option for project, in addition to the pesticide reduction schemes in high and medium risk catchments and constructed wetlands upstream of high risk stream sinks will incorporate additional measures including:

- A pesticide amnesty for banned and out of date pesticides; Pesticide Applicator training courses for farmers;
- Pesticide applicator calibration and servicing for farmers;
- Access to a Capital Grants scheme for infrastructure investment focused on water quality (e.g. bunded pesticide handling areas) in high risk areas;
- specialist workshops; 1:1 farm visits; support to farmers in developing applications for existing funding streams for water resource protection (e.g. Leader Grants) and incentives based on achieving clean water targets in high risk catchments.

The project will be delivered in partnership with a number of stakeholders including the EA, Natural England, Farming and Wildlife Advisory Group. Where specialist advice and delivery are required, consultancy service agreements will be established with specialist agricultural delivery partners for work beyond the expertise of Affinity Water staff.

5 Risk and Issues

- Changes in legislation around the Common Agricultural Policy arising from Brexit. This risk is being mitigated by developing an approach to this project that can be delivered around a changing regulatory landscape. The scope and delivery plan can be amended based on any changes which are under continual review by our Agricultural Advisor and Catchment Management Programme Manager.
- Changes in legislation on pesticides in focus for this scheme. Regardless of any restrictions (metaldehyde only) on future use, the impact on water quality of other pesticides used in the catchment will remain for much, if not all AMP7. The project scope can be re-evaluated based on the outcomes of future legislative reviews, but will focus on key diffuse pollution risks which will remain/change in future.
- Effects of climate change resulting in greater diffuse pollution challenges. The preferred option has been developed on the assumption that climate change affects will exacerbate current diffuse pollution risks and produce new risks yet to be identified. The Payment for Ecosystem Services approach can be tailored to mitigate the current and future risks brought about by climate change.
- Farmers not willing to participate in our proposed schemes. The lessons learned from the AMP6 schemes including suitable incentive mechanisms to gain the highest level of participation from farmers have been evaluated. Each year in AMP6, post season surveys have been carried out with farmers to determine barriers and incentives to participation. This feedback informs the development of these schemes to ensure that the highest possible number of farmers could be encouraged to participate in future pesticide reduction schemes.
- Appropriate land owner permissions and permits/consents from EA not achieved for constructed wetlands. This has not been undertaken before so options, limitations and other issues will be explored during the concept phase in year 1 of AMP7 with gate review to determine whether this is viable to proceed.
- Constructed wetlands not effective at mitigating key diffuse pollution risks. There is limited data on the benefits of constructed wetlands and therefore academic research will be commissioned during the concept and definition phase and incorporated into the concept gate review before proceeding into definition and implementation.

6 Procurement Strategy

This project will be delivered primarily by in-house expertise through the Catchment Management team. Where specialist agricultural expertise and/or specific local knowledge of high risk catchments is required then the preferred option will seek to appoint specialist agricultural consultants to deliver aspects of the project and provide administration services for the farmer incentive payments.

The best value option will also seek specialist consultancy services for such aspects as remote sensing, machinery calibration and testing, training (e.g. pesticide applicator training) and pesticide amnesties.

As this builds on work undertaken in AMP6, suitable suppliers have been trialled and identified for different aspects of the pesticide reduction schemes. Many of these are already on the Approved Suppliers list and subject to consultancy services agreements. Where required, a framework contract can be implemented based on the size and scale of the aspects of delivery proposed. These are not in place currently, but can be implemented in advance of AMP7 based

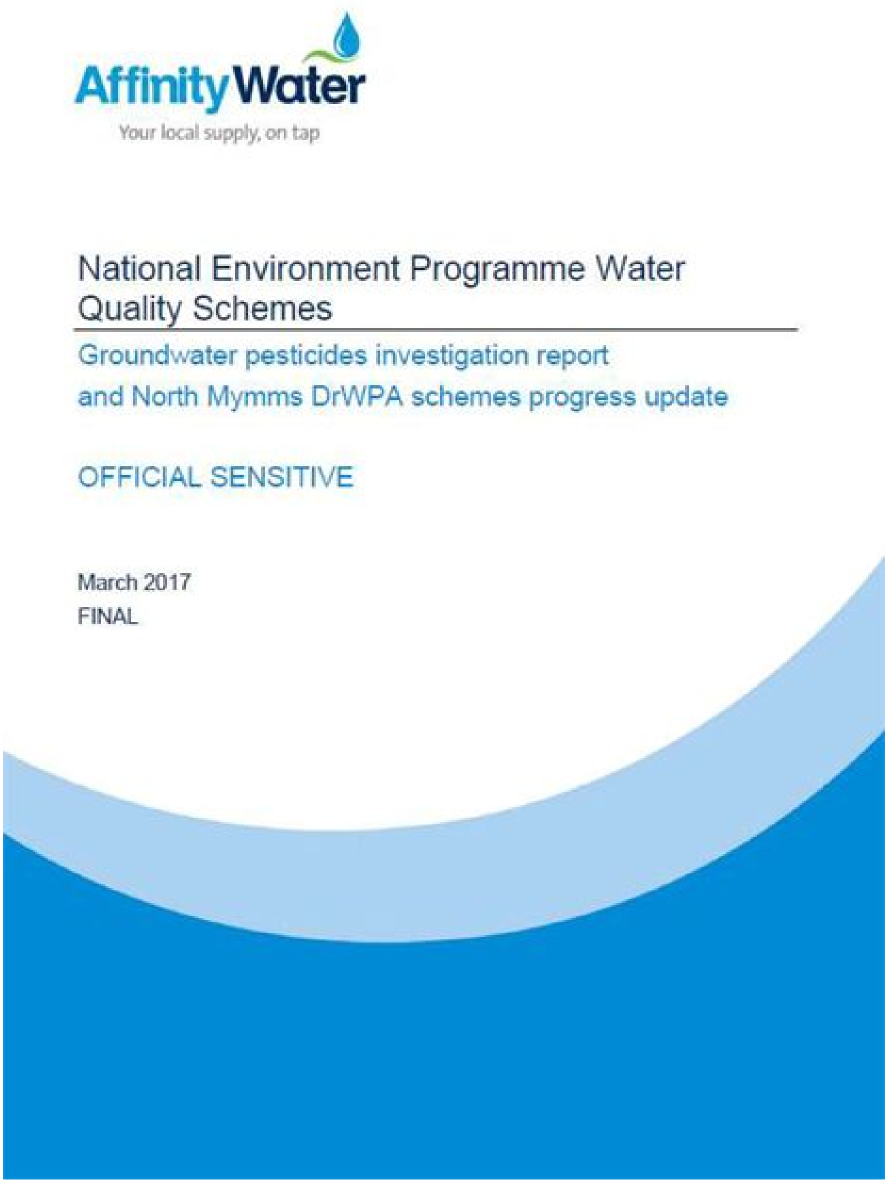
on the best value option being accepted to ensure that no time is lost for delivery at the start of AMP7.

Appendices

7 Appendices

7.1 Appendix 1: National Environment Programme Water Quality Schemes: Groundwater Pesticides Investigation Report 2017

****** The Contents Pages and Executive Summary has been included below. The whole report can be made available on request ******



Affinity Water
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National Environment Programme Water Quality Schemes

Groundwater pesticides investigation report
and North Mymms DrWPA schemes progress update

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March 2017
FINAL

Asset Strategy document control sheet

Document amendment history

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4.0	Final	29/03/2017	Final review and comments from MP

Document approval

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e-Document location				
	Name	Signature	Title	Date
Author/originator	Alister Leggatt Shaun Dowman Danny Coffey Sophie Mortimer Hannah Verman		Asset Manager Agricultural Advisor Catchment Officer Catchment Officer Catchment Officer	15/03/2017
Reviewer	Affie Panayiotou		Head of Water Strategy	17/03/2017
Approver 1 (internal use)	Fiona Waller		Head of Water Quality Services	19/03/2017
Approver 2 (external use)	Mike Pocock		Director of Asset Strategy	29/03/2017

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1 Executive Summary

Our catchment management for water quality programme has been established to investigate and deliver catchment based interventions to improve raw water quality. The programme also supports Affinity Water's obligations under Article 7 of the Water Framework Directive (WFD) delivered through the National Environment Programme for Water Quality (NEP WQ). The investigations and measures undertaken within these schemes for metaldehyde will also deliver the obligations set out in the Undertakings for metaldehyde agreed with the Drinking Water Inspectorate (DWI).

In 2015, we agreed a programme of fourteen NEP WQ investigations (DrW2) with the Environment Agency (EA), primarily focused on pesticides and nitrate. In addition, we had three Drinking Water Protected Area (DrWPA) schemes (DrW1) to deliver catchment interventions for metaldehyde for North Mymms, River Thames (covering our four River Thames abstractions) and Ardleigh (delivered by Anglian Water with co-funding and support from Affinity Water). Phase 5 of the NEP programme (NEP5) was issued by the EA on 29 January 2016 which included two additional sources for DrW2 investigations, Chartridge and Broome, which had been affected by nitrate following the flooding experienced across our regions in early 2014.

This report details the outcomes of NEP WQ investigations into groundwater sources affected by pesticides agreed in NEP5. This includes North Mymms and sources (North Mymms, Essendon, Tyttenhanger and Roestock); our Clay Lane group of sources (Netherwild, Eastbury and Tolpits Lane); Roydon and Sawbridgeworth. The report details our plans for the remainder of AMP6 (2017 – 2020) which provides the foundation for carrying out a feasibility study to support our PR19 options appraisal for developing catchment schemes in AMP7. This report also provides a progress update for the North Mymms DrWPA metaldehyde schemes covering activities undertaken between 1 April 2016 and 31 March 2017.

In summary, our investigations have drawn the following conclusions:

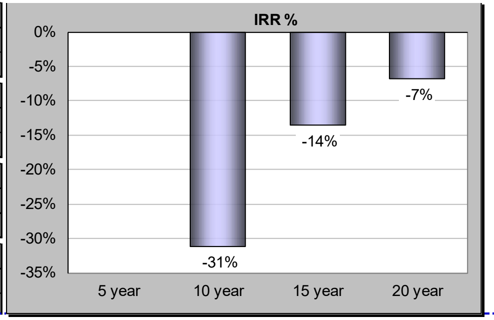
- The complex hydrology and hydrogeology of the Mimmshall Brook and Essendon Brook catchments has a significant influence on groundwater quality for North Mymms and Essendon respectively. Targeted measures based on geography and topography alone will not be effective in reducing concentrations of the pesticides subject to investigation to levels below the DWS. A holistic approach to implementing catchment schemes across the whole catchment area is required. Targeted measures may be effective upstream of solution features which are identified as having a significant influence on water quality at the point of abstraction.
- Our investigation has identified Smallford closed landfill as the likely source of metaldehyde contamination affecting both Tyttenhanger and Roestock sources. In AMP6 we are investing in a treatment solution for metaldehyde at North Mymms. As a consequence, we determine that future catchment management options are limited and do not represent good value to our customers. Roestock is also affected, to a lesser extent, by seasonal agricultural applications of metaldehyde and we will expand our planned catchment measures for North Mymms and Essendon to include the Roestock source protection zone (SPZ) 2.
- Evidence indicates that the Clay Lane group of sources are affected by water quality issues arising from the Mimmshall Brook caused by the overflow of the Water End swallow holes into the River Colne source during periods of heavy rainfall. There is also potential for localised sources of diffuse pesticide pollution due the complex karst

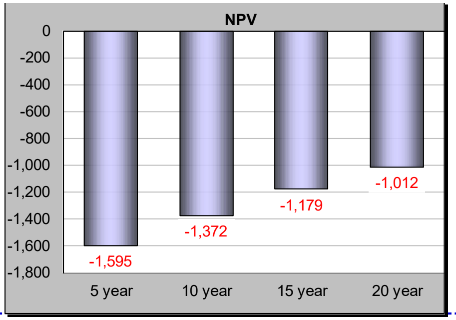
geology in the Upper Colne. We aim to understand how solution features, such a swallow holes, act as preferential pathways for pollutants in the Upper Colne, as well as the influence Blackbirds sewage treatment works has on water quality. Further development of our understanding for these potential sources of pollution is required to support our feasibility study for potential catchment schemes for AMP7.

– Metaldehyde concentrations at Roydon and Sawbridgeworth have remained consistent and stable for the past 5 years. There is no seasonal variability that could be attributed to agricultural metaldehyde use and subsequent leakage from the River Stort into groundwater. Further work is required to determine a potential point source, such as landfill sites within the SPZ 2. We will not be proceeding with developing a catchment scheme for inclusion in the WINEP, but will continue to investigate as part of our Drinking Water Safety Plan (DWSP) for the remainder of AMP6. Thames Water is delivering catchment measures in the River Stort and we will provide support through the Thames Catchment Management Steering Group (TCMSG).

7.2 Appendix 4: NPV assessment summary

5 year		
Financial internal rate of return (IRR)	%	
Financial net present value (NPV)	£'000	-1,595
10 year		
Financial internal rate of return (IRR)	%	-31%
Financial net present value (NPV)	£'000	-1,372
15 year		
Financial internal rate of return (IRR)	%	-14%
Financial net present value (NPV)	£'000	-1,179
20 year		
Financial internal rate of return (IRR)	%	-7%
Financial net present value (NPV)	£'000	-1,012





POSITIVE NPV IN YEAR: 20

3.1 ASSUMPTIONS, DATA AND CONFIDENCE LEVEL OF COST BENEFIT ANALYSIS (CBA)

Total revenue	Confidence (%)	Method of Calculation	How can the benefits be monitored?	When?	Contact Person or Department
- Real cash benefit					
<Insert benefit description>	<Insert %>	<Insert information>	<Insert information>	<Date>	<Insert information>
<Insert benefit description>	<Insert %>	<Insert information>	<Insert information>	<Date>	<Insert information>
<Insert benefit description>	<Insert %>	<Insert information>	<Insert information>	<Date>	<Insert information>
- Cost avoidance		**Method of Calculation**	**How can the cost avoidance be monitored?**	**When?**	**Contact Person or Department**
Avoiding water import from Grafham resulting from pesticide pollution incident	50%	Cost of Grafham import minus avge unit cost of water per ML. North Mymms (9.09ML/d) used as example of WTW outage for 30 days following pesticide failure 226.56 - 41.4 per ML = 185.06. 9.09 ML/d (North Mymms) * 185.06 * 30 (days) = £50,466 example given in each year of the AMP and beyond	Number of outages resulting from WQ failures from pesticides	ongoing	Alister Leggatt
Drinking Water Safety - One off / occasional PCV failure (controlled response)	50%	Reduction in pesticide losses to river and groundwater leading to long term reduction in PCV leading long term reduction in PCV failures. Estimated at 10 per year at £530 per incident = £5,300	Water quality monitoring at the point of abstraction	ongoing	Alister Leggatt / Water Quality Services

7.3 Appendix 5: EA PR19 Driver Guidance: DrWPA Final

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PR19 Driver Guidance
Driver Name: Drinking Water Protected Areas (DrWPA)

Strategic Lead(s): Elinor Smith (surface water) and Helen Bray (groundwater)

Applicable for function (please tick) :
Water Quality ☒ Water Resources ☐ FBG ☐

Catchment Solutions available ☒ To check a box: right click select "properties" and then "checked"

Date: 3 February 2017	**Version: FINAL**

Summary of driver objective

This guidance is for drinking water protected areas, which includes safeguard zones and surface water drinking water protected areas (DrWPAs). Refer to the groundwater guidance for groundwater DrWPA good status requirements.

This driver can be used on its own or in combination with other drivers and partnerships.

Water companies should develop measures to reduce pollution that is reaching their abstractions, these are known as catchment measures and should be developed for safeguard zones.

Water companies may wish to use innovative approaches to catchment management such as:

- Reverse auctions for measures to reduce pollution - where by the lowest bid that achieves the outcome wins
- Payments for the production of clean water and ecosystem services
- Long-term agreements with farmers on farming practices, such as which crops are grown, what pesticides are used etc.
- Emissions trading
- Valuing natural capital

In addition to this document, the Environment Agency (EA) and Drinking Water Inspectorate (DWI) will issue joint Periodic Review 19 (PR19) guidance on metaldehyde, once we have an agreed policy position. Additional guidance for groundwater schemes is available in the groundwater guidance.

Driver code:	Description
DrWPA_ND	Catchment scheme actions and measures recommended by either previous investigations; or, actions for water companies identified in safeguard zone action plans to prevent WQ deterioration to avoid the need for additional treatment (WFD 'must do'): subject to cost effectiveness, sustainability and measurement of effectiveness. Some limited post-scheme appraisal can be included in the catchment management driver. Ongoing surveillance monitoring does not form part of the WINEP and falls into the company's ongoing, business as usual operations, such as catchment monitoring for water safety plans.
DrWPA_IMP	Catchment scheme actions and measures recommended by either previous investigations; or, actions for water companies identified in safeguard zone action plans; or actions identified through other water company work, to improve WQ to reduce the level of existing treatment: subject to cost benefit and sustainability including monitoring of effectiveness of the measures. Some limited post-scheme appraisal can be included in the catchment management driver. Ongoing surveillance monitoring does not form part of the WINEP and falls into the company's ongoing, business as usual operations, such as catchment monitoring for water safety plans.

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DrWPA_INV	Catchment investigations by water companies to fully characterise groundwater and surface water SgZs, undertake an options appraisal and identify and recommend measures for catchment schemes to include in the next AMP period and carry out a cost benefit/cost effectiveness analysis. Monitoring as part of the investigation to understand the issue and identify the action can be included.

Methodology for identifying measures

Who should develop DrWPA schemes for the WINEP?
Groundwater and IEP teams should lead on developing measures for their respective safeguard zones. We encourage them to work together with all area teams and water companies to develop schemes that have wider benefits.

What can be included in the WINEP?
Where a catchment investigation has taken place in PR14, we would not support the inclusion of a further investigation for the same substance in the same area in PR19. The outcomes of the PR14 investigations (and other previous investigations) should be used to inform the catchment improvement schemes proposed for PR19.

Water companies that need to continue catchment measures from previous AMP periods into AMP7 can do so. These will now be funded from their revenue/maintenance budgets and should be included in their business plans accordingly, therefore do not need to be included in the WINEP.

Water companies may suggest a second round of catchment investigation or measures for the same substances if circumstances have changed e.g. where the catchment approach has evolved and new types of measures are now being used, or to meet newly agreed policy objectives. In these instances careful consideration as to whether to support the inclusion of schemes in the WINEP is required.

For both investigations and measures, before any scheme is included in the WINEP a scope detailing the geographic area, substance(s) to be addressed and description of the work that will be carried out must be completed.

Note: Water companies are able to do work outside of the WINEP

Catchment Investigations
Catchment investigations should include investigations to identify what is causing water quality deterioration and an options appraisal, together with an assessment of the costs and benefits to identify the appropriate measures. This will enable water companies to identify cost effective measures to prevent deterioration and cost beneficial measures to reduce treatment. Investigations must not be in the same area for the same substance as in previous AMP cycles.

Catchment measures
The main objectives of the catchment measures for a surface DrWPA and both groundwater and surface water SgZs are to avoid deterioration in water quality and to avoid an increase in the level of water purification treatment (DrWPA_ND). A definition of additional treatment is provided at the end of this section). There is a long term aspiration to improve the environment such that the level of treatment can be reduced over time (DrWPA_IMP). Catchment measures must have clear and measurable outcomes. For groundwater, catchment measures will contribute to meeting good status objectives for the wider groundwater body. There are both good status objectives and protected area objective for groundwater DrWPAs. Groundwater SgZ target measures where they will have most benefit to an abstraction and primarily meet protected area objectives, but will also contribute to good status. Water companies can submit schemes outside of SgZs using the WFD good status driver.

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Where contaminated land (as defined in the Environmental Protection Act 1990 Part 2A) needs to be remediated to protect drinking water supplies, refer to the groundwater guidance.
Catchment measures can include feasibility studies and monitoring to better understand where to target measures, as well as implementing measures to improve water quality. Catchment measures can use the 'payments for ecosystems services' approach or other measures to control the source(s) or pathways of pollution. Catchment measures should also be linked to delivering wider social and environmental benefits and these should be included in any economic analysis.

Water companies should include schemes where an upstream waste water treatment works is causing a deterioration in water quality in a drinking water protected area which may lead to the need for additional purification treatment.

In order to determine which catchment measures are likely to be viable, water companies need to:

- Investigate the source(s) of pollution (this should include all sources such as agriculture, industry, domestic etc.) and understand the mechanisms for pollution to reach the abstraction (DrWPA_INV) i.e. understand the sources, pathways and receptors
- Identify measures and actions to reduce pollution,
- Demonstrate that proposed catchment measures are:
  a) More cost effective than alternatives, where measures are needed to prevent deterioration (DrWPA_ND)
  b) More cost beneficial than alternatives, when seeking to improve water quality to reduce treatment (DrWPA_IMP)
- Not disproportionately costly where they contribute to groundwater DrWPA good status requirements. Refer to the groundwater guidance for more information.

Cost effective catchment measures need to be identified and implemented to prevent deterioration in water bodies and avoid the need for additional treatment. i.e. meet no deterioration objectives. Before proposing an increase in drinking water treatment, all water companies should implement cost effective measures to prevent deterioration. Cost effectiveness is used here as this is considered a 'must do' requirement, so measures must be implemented, but this should be the lowest cost package of measures needed to prevent deterioration and avoid the need for additional treatment.

Cost beneficial measures can be implemented where the water company seeks to improve water quality to reduce treatment.
Where a water company seeks to reduce treatment levels they must consider whether it would be cost-beneficial to develop catchment measures, rather than using treatment. Reducing treatment will provide a longer term more sustainable approach to producing wholesome drinking water. In these cases the EA will consider whether a catchment improvement scheme can be included in the WINEP for improving water quality in DrWPAs that are not 'at risk' and do not have a SgZ. Cost benefit is used here as this is considered a longer term ambition and not a 'must do', so there is a need to demonstrate that the measures are cheaper than using treatment. If the benefits do not outweigh the costs then these measures may not go ahead. Any measures proposed by water companies will also need to be supported by Customer Challenge Groups.

Measures for DrWPA must be supported by an economic analysis that values the wider benefits, such as reduced flood risk, habitat improvement, reduced CO_2 and reduced waste, as well as the direct benefits, such as the reduced capital and operational costs of treatment. These economic analyses and detailed scopes of exactly what works will be done must be shared with the EA before inclusion in the NEP. This is to quantify the total overall investment for drinking water protection, and ensure that there is a mutual understanding of what will be delivered.

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A framework for assessing the benefits of catchment schemes is provided by UKWIR *Quantifying the Benefits of Water Quality Catchment Management Initiatives.* For those schemes that involve contaminated land remediation further guidance is available in the statutory guidance and groundwater PR19 guidance.

Where a proposed scheme is a catchment scheme linked to a DWI legal instrument (Undertaking or Notice) water companies should clearly identify both the DWI Undertaking reference and the EA WINEP unique identifier in any submissions to the EA or DWI. The DWI and EA will share information on proposals submitted by water companies. This will prevent any duplication of schemes in submissions to Ofwat.

Level of confidence required and associated evidence levels

The Environment Agency will use a weight of evidence approach and work with Natural England, local councils and the Drinking Water Inspectorate to share information on proposals as appropriate.

To support inclusion of catchment measures in PR19, the following can be used:

- Evidence of an environmentally significant upward trend at an abstraction point, caused by anthropogenic activities;
- Evidence of a potential or actual water quality standard failure caused by anthropogenic activity;
- Poor DrWPA status for groundwater bodies
- Other evidence of water quality deterioration;
- Land use characteristics in the catchment
- Catchment risk assessment;
- Source-pathway-receptor linkages;
- Source apportionment;
- SgZ action plans;
- Future treatment requirements i.e. what's the risk of future treatment being required, when will treatment be required and to what level;
- Evidence of the wider ecosystem benefits the catchment measure could bring, e.g. recreation and eco-tourism, health benefits;
- Evidence that this is a less expensive way to achieve Article 7 than end of pipe alternatives (i.e. measure cost effectiveness).

Where a contaminated land site is affecting a drinking water supply, we will work with the water company to determine the level of confidence needed for remediation.

All measures need to be location specific, have clear outcomes and delivery timescales, and be supported by a holistic economic analysis (i.e. looking beyond the private sector to include environmental and societal costs and benefits). Area teams in the EA should work with water undertakers to develop SMART measures, including wider partnerships where there are opportunities for co funding.

NB: The DWI requires all proposals for drinking water quality measures to be supported with risk assessments (as required under Regulations 27 and 28 of the Water Supply (Water Quality) Regulations 2000 (amended), and the Welsh equivalent.

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Environmental outcome measure
In order to understand how these schemes protect our drinking waters it is important to understand the outcomes achieved. For drinking waters the schemes should identify: • the geographical area of land where measures are targeted and improvements achieved (km^2) • the length of river improved/no longer deteriorating from point of intervention to abstraction (km) • the area of lake/reservoir improved/no longer deteriorating (km^2) • the volume of water abstracted improved (m^3/d) • the number of people served where there has been an improvement • the number of Water Supply Zones where there has been an improvement • the cost savings achieved through improvements
Costing & Economics
• Cost effectiveness should be used where seeking to prevent deterioration to avoid the need for additional treatment. This is because no deterioration is a must do under WFD. • Cost benefit should be used where seeking to improve water quality to reduce treatment, as there must be a good case to state why it is better to invest in catchment management rather than continue with treatment. • Refer to the groundwater guidance for drinking water protected area good status, no deterioration and contaminated land measures in groundwater.
Links to technical documents/guidance
Legislative overview and technical detail Article 7.3 of the Water Framework Directive requires Member States to ensure the necessary protection for the bodies of water identified as DrWPAs. This is with the aim of preventing deterioration in water quality, to avoid an increase in the level of purification treatment required to produce drinking water, and over time seeking a reduction in the level of purification treatment required. There is a requirement to meet good status for groundwater DrWPAs as well as meet the Article 7 protected area objectives. Safeguard zones have been identified where any of these situations apply: • where there is a risk or actual deterioration of water quality • where the level of purification treatment may need to be increased • where treatment has increased since 2007/8 baseline For safeguard zones, a risk of deterioration means there is is a failure to meet good status or trend objectives (groundwater only), a need to increase treatment, ongoing WQ deterioration, a rising trend in anthropogenic pollution or where risk has already/will materialise 2015. For groundwater where a trend has materialised by 2015 measure must be put in place to reverse the trend. Catchment measures can provide cost effective alternatives to treatment, improve water companies deployable output and may provide wider benefits such as: • reduced energy consumption and treatment costs • reduced waste streams • reduced traffic movements associated with the treatment and waste • reduced carbon dioxide emissions/ increased carbon capture and storage • flood risk mitigation

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- improved ecology
- wider improvements/increases in ecosystem services

We will support catchment measures developed by water companies or as part of local partnerships to meet the requirements of Article 7.3. DrWPA objectives. These may include existing catchment schemes that were initially developed for other purposes, such as flood mitigation or ecological benefits, or new catchment measures. Further guidance on understanding the benefits of catchment measures can be found in UKWIR report 'Quantifying the benefits of water quality catchment management initiatives'.

A collaborative approach between the EA, DWI, water companies and third parties is needed to achieve improvements in water quality in DrWPAs and SgZs. Achievements cannot be made solely by one organisation.

Listed below are the most relevant support documents relating to DrWPAs and SgZs. These contain the current criteria for deciding when there is a significant upward trend at an abstraction; and roles and obligations for Water Companies and internal EA who are developing DrWPA/SgZ Action Plans or working with water companies to identify PR19 measures.

Internal EA guidance on groundwater and surface water DrWPAs and SgZs
Joint DWI/EA PR19 guidance on metaldehyde (not yet written and published)
Directive 2000/60/EC - Article 7
Common Implementation Strategy Document 16: Guidance on Groundwater in Drinking Water Protected Areas
UKTAG guidance - Assessing the achievement of Drinking Water Protected Area objectives
DEFRA - Statement of Obligations
Guidance on Water Company Safety Plans
The Contribution of the Water Supply (Water Quality) Regulations to the implementation of the Water Framework Directive in England & Wales
Joint Guidance on Contribution of Water Supply (Water Quality) Regulations to Water Framework Directive
Groundwater Chemical Status Assessment (Classification) and Trend assessment Method Statements
Existing water company schemes - SCaMP & Managing Water, Managing Land

Other considerations

Link to other Drivers
Prevent deterioration for surface water
Groundwater for achieving good status, preventing deterioration and contaminated land management
Biodiversity: Seeking wider benefits
Flood risk
Climate change

DWI Position
The level of treatment required to supply drinking water from any given source is based on the level of pollution in the source. Water companies are required carry out risk assessments of all their water supply systems, from source to tap, as part of a drinking water safety planning approach to ensure that consumers are supplied with wholesome water. Where a deterioration in raw water quality has been identified that presents a risk to consumers (for example the existing treatment process is not designed to deal with the type or level of contaminant), water companies should investigate the cause of deterioration and actions required to protect consumers. This should include investigations in the catchment and, where feasible, implementing actions to reduce the level of pollution entering the source. In some situations catchment actions alone may be insufficient to reduce the risk to

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consumers to an acceptable (or tolerable) level (i.e. to achieve compliance with a standard or to protect public health) and additional measures (including treatment) may be required to protect consumers. The DWI has statutory powers to put in place legal instruments which establish legally binding commitments on companies to implement all the actions required to protect consumers.

Definition of additional treatment

Additional treatment includes all of the following situations where there is clear evidence that they are a result of deterioration in raw water quality:

- The construction and operation of a new treatment plant;
- The development of a blending scheme (new boreholes or new pipelines);
- The change in blending ratio of an existing scheme;
- Increased use of chemicals in an existing plant;
- Increased workload on an existing plant;
- Additional modular treatment at an existing plant;
- The early replacement of an existing treatment plant;
- An increase in the frequency of carbon regeneration;
- A move from duty/standby to duty/assist status of existing plant; and
- A significant refurbishment and/or up-rating of an existing plant.

Multiple benefits from schemes for other drivers should be considered in any economic analysis. This will help ensure that the most benefit is being achieved with the money being invested. Where multiple benefits are achieved for other drivers, these drivers should be included in the NEP. All drivers where there are benefits should be recorded.

In reference to the government supported salmon 5 point plan, we believe that this driver could in part make a likely contribution to the recovery of salmon stock. More information on the salmon 5 point plan, including GIS shapefiles and maps etc. is available via your FBG NEP lead or from this link

O:\PR19 GENERAL\Strategy\EA\06 FBG Sub Group\Salmon 5PP information for NEP planners

Linked to outstanding policy decision (please tick)

Environment Agency ☐ DEFRA ☒for metaldehyde Ofwat ☐

External Organsiation Consultation:

DEFRA ☒ Ofwat ☐ DWI ☒ NE ☒

Other:

7.4 Appendix 6: EA PR19 Driver Guidance: Groundwater Pressures Final

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PR19 Driver Guidance
Driver Name: Groundwater & Contaminated Land Pressures

Strategic Lead(s): Helen Bray (GWQ) and David Seccombe (GWR)

Applicable for function (please tick) :
Water Quality ☒ Water Resources ☒ FBG ☒

FCRM ☒ Catchment Solutions available ☒

Date: 3 February 2017 | **Version: Final**

Summary of driver objective

Investigations or schemes for groundwater to meet water company obligations in the catchments they influence and operate in. This driver can be used;

- **in isolation to deliver groundwater priorities eg prevent deterioration in a groundwater body; or**
- **in conjunction with other drivers to deliver multiple objectives and added benefits, eg a catchment scheme in combination with a biodiversity, flood risk that provides wider ecosystem service benefits such as improved groundwater levels and quality and flood risk management, as well as preventing groundwater deterioration.**

Groundwater is vulnerable to pollution and in places, over abstraction. Where water company assets are affecting, or being affected by, groundwater quality or quantity issues, the companies should carry out investigations and deliver measures to protect and improve groundwater. Investigations and measures can only be delivered via the WINEP where we agree to their inclusion.

The use of the groundwater driver codes should only be considered if existing statutory obligations and measures are insufficient to protect and improve groundwater. Water companies may need to make improvements outside of the WINEP where they are not meeting statutory obligations, or where they wish to do additional work outside of the WINEP that benefits their business.

The requirements to protect and improve groundwater are:
- prevent deterioration (water quality and quantity)
- reverse upward trends in pollution
- reduce the level of purification treatment required to produce drinking water (see *Drinking water supplies*)
- meet "prevent and limit" objectives of the Environmental Permitting Regulations (2010).
- achieve good status in groundwater bodies

Water companies should recognise the intrinsic value of groundwater, its contribution and interaction with surface water and wider ecosystems. Water companies are expected to deliver integrated environmental improvements based on payment for ecosystems services and natural capital principles.

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Drinking water supplies

Groundwater drinking water protected area (DrWPA) objectives are:

- to meet good status
- avoid deterioration in water quality in order to reduce the level of purification treatment required in the production of drinking water.

The latter is implemented through safeguard zones (SgZ). Further information on groundwater SgZ requirements are described as a separate driver in the DrWPA guidance.

Where a drinking water supply is being affected by an orphaned contaminated land site(s), water companies should enter into agreements with the Environment Agency, land owners/occupiers, local councils to remediate those sites.

General guidance on groundwater driver codes

Due to the complex association between the scale of a groundwater body compared to the linked environmental deterioration/damage, the use of any groundwater driver must be discussed, scoped out and agreed in advance between the Environment Agency and water company. Scopes to support the inclusion of schemes must be provided in advance of agreeing the scheme and be SMART. This will help streamline the aims and objectives of the proposal to ensure consistency and provide a clear line of sight from the evidence to a solution.

If there is a new statutory obligation to meet, investigations and measures can be included in the WINEP. Groundwater investigations and measures should not relate to capital maintenance, or risk assessment and associated monitoring for the Water Supply (Water Quality) regulations, as these are statutory requirements of the water companies, and should go into the maintenance section of the water companies business plans. Neither should they address existing statutory obligations, for example investigating unpermitted discharges to ground via poor sewer integrity, this is to avoid double funding and the WINEP being used to pay for asset maintenance. The WINEP is for new environmental obligations the water companies need to meet.

Investigations must be detailed enough that no further investigation is needed in future, they should include an options appraisal and an assessment of the cost for proposed measures. Investigations must not be for the same substance in the same area as investigated in previous AMP cycles. Monitoring can be included as part of the investigation to gain a more detailed understand the issues and to identify the actions that need to be implemented. Ongoing surveillance monitoring however, does not form part of the WINEP and falls into the company's ongoing, business as usual operations, such as catchment monitoring for water safety plans.

Measures should implement the recommendations of previous AMP investigations or new obligations following a permit review. Some limited post-scheme appraisal monitoring can be included in the measures, however ongoing surveillance monitoring should not form part of the measure.

For groundwater Safeguard Zones, use the DrWPA codes in the DrWPA guidance since these zones are where protected area obligations are implemented. Measures in safeguard

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zones are subject to cost effectiveness analysis. For DrWPA good status measures use WFDGW_INV or WFDGW_IMP, these measures are subject to cost benefit analysis.

Remedial treatment actions and measures on land determined as contaminated land can be included in the WINEP to meet WFD objectives. These objectives include DrWPAs (ie actions in SgZs to prevent deterioration or reduce the level of purification treatment at drinking water sources), no deterioration and good status objectives. Remedial treatment actions and measures can be included in the WINEP following recommendations by previous investigations and cost benefit analysis which were done as part of the Environmental Protection Act Part2A assessments. To include remediation you will need to choose the appropriate driver from this or the DrWPA drivers and record 'contaminated land remediation' on the WINEP spreadsheet.

Driver code	Description
WFDGW_NDINV	Groundwater No deterioration Investigation Investigations by water companies to fully characterise the reasons for deterioration in groundwater bodies, undertake an options appraisal and identify and recommend measures to be included in the next AMP period and carry out a cost effectiveness analysis.
WFDGW_ND	Groundwater No deterioration Measure Actions and measures to prevent deterioration recommended by either previous investigations; or, actions for water companies identified in river basin management plans to prevent WQ or WR deterioration: subject to cost effectiveness, sustainability and measurement of effectiveness
WFDGW_INV	Groundwater Good Status Investigation Investigations by water companies to fully characterise groundwater bodies, undertake an options appraisal and identify and recommend measures to be included in the next AMP period and carry out a cost benefit/cost effectiveness analysis.
WFDGW_IMP	Groundwater Good Status Measure Actions and measures to meet WFD good status recommended by either previous investigations; or, actions for water companies identified in river basin management plans to meet good chemical or quantitative: subject to cost benefit

Methodology for identifying measures

Who should identify schemes for the WINEP?
Area groundwater teams should lead on identifying water company assets that are affected by or affecting groundwater quality and quantity (including orphaned contaminated land sites that are impacting drinking water supplies).
Area groundwater teams should work together with IEP teams to maximise any wider environmental benefits that can be gained from improving groundwater quality/quantity. Groundwater WINEP schemes can be combined with other drivers e.g. biodiversity to deliver multiple benefits.
Area teams, the National River Basin Management Services and E&B should work together with a water company to identify solutions that build resilient catchments. Resilient catchments do not show deteriorating trends in water quality or quantity and support wider

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ecosystems and the economy. The Environment Agency is encouraging a holistic approach to catchment management in PR19.

How to identify schemes for inclusion in the WINEP?
The Catchment Planning System and the 2015 river basin management plans (2015 plans) provide the evidence of the pressure on the groundwater body, the measures to achieve good status and the objectives for the water bodies. Additional evidence may be held by the water company to support the inclusion of measures in the WINEP. Safeguard zone action plans are also relevant for drinking water protected area objectives (see the DrWPA guidance).

In addition, water companies have an obligation to develop and implement groundwater management approaches that reduce pollution and achieve sustainable use of resources. This could, for example, include developing payment for ecosystem services approaches to reduce nitrate leaching from agricultural land in return for cleaner water supplies.

When considering schemes for inclusion, the Environment Agency encourage water companies to develop catchment solutions. When considering the costs and benefits of such solutions, water companies must consider:

- Groundwater rebound and unintended consequences, such as acid mine drainage
- Flood risk, including groundwater flooding
- The need to achieve protected area objectives, particularly DrWPAs and the aim to reduce treatment
- Statutory and non-statutory wetlands
- Balancing changes to deployable output with groundwater quality
- Discharges to ground/groundwater and their inputs of hazardous substances and non-hazardous pollutants
- Land contamination management and its effects on quality/resources
- Climate change and adaptation
- Wider costs and benefits to society and the economy
- Payments for ecosystem services

When schemes are proposed, water companies need to accept that the poor groundwater body status is linked to one of their assets either alone or as part of their wider infrastructure. The scale and ambition of the scheme can be linked to source apportionment where the water companies will work in collaboration with the Environment Agency to achieve a solution across all sectors. The final solution reflects the water company contribution. For protected areas and groundwater safeguard zones see sections DrWPA guidance.

In developing an approach, we would encourage that any proposed measures are trialled using groundwater models for both quality and quantity, especially models developed as part of the Environment Agency's groundwater modelling strategy. Models can provide a robust approach to the strategic management of the groundwater body and to better understand the effectiveness of the proposed measure. Models however, should not be used as a sole decision making tool and do not replace the need for detailed site investigations and field trials. The assumptions on which the models are built should be documented and verified by site specific data.

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Investigations must be completed to a standard whereby no further investigation is needed to identify solutions to the current problem. The outcome of the investigations should be a comprehensive understanding of the issues that are causing WFD or groundwater directive standards not to be met, a comprehensive set of measures that can be implemented and either a cost effectiveness or cost benefit analysis An assessment of the costs and benefits should be done, considering the wider social and economic benefits of the proposal, taking account of the payments for ecosystem services approach. For groundwater safeguard zones, which implement protected area objectives, an assessment of the cost effectiveness of measures must be done. Water companies with discharges to ground ('groundwater activities') must meet the requirements of EPR 2010. If the Environment Agency or water company feel the discharge does not meet the EPR "prevent and limit" requirements or there is a need to investigate the inputs from the discharge, then investigations should be included in the WINEP. Investigation should be comprehensive (as per the paragraph above) and linked to the principles in the chemicals investigation programme. If changes are needed to the permit as a result of the investigation then the permit must be varied accordingly. As part of any variation, water companies will need to implement a risk-based tiered approach to assessing monitoring requirements around the discharge and the "requisite surveillance" requirements of EPR 2010 must be met. At higher risk sites this will include undertaking a modelled assessment of sewage treatment work discharges to ground to assess if the "prevent and limit" requirements of EPR 2010 are being met. Permit conditions to reflect appropriate monitoring requirements may be required. Compliance against EPR 2010 requirements should be reported on an annual basis to the Environment Agency. Compliance with EPR 2010 is a statutory obligation and does not need additional funding through NEP.
Level of confidence required and associated evidence levels
The Environment Agency will use a weight of evidence approach and work with Natural England, local councils and the Drinking Water Inspectorate to share information on proposals as appropriate. The Catchment Planning System and the 2015 plans provide the evidence of classification (status), characterisation (risk) and whether deterioration has occurred against any of the nine groundwater status tests. Where contaminated land remediation is being considered to protect drinking water supplies, the requirements of Part 2A and the statutory guidance must be followed as well as DrWPA objectives. Land must be determined as 'contaminated land' with a pathway to a drinking water supply before any remediation scheme is proposed. The Environment Agency must have confidence in the proposed remedial actions before agreeing to WINEP schemes. Use of the GWCL driver code must be discussed with representatives of the E&B Groundwater and Land Contamination Management teams before use. Measures should only be recommended where investigations have shown confidence in the outcome, for example, through modelling, monitoring, field trials and cost benefit/effectiveness analysis (see table 1)

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Table 1: Type of cost assessment needed for including measures in the WINEP or as part of an investigation output.

Groundwater Objective	Requirement	Type of economic assessment required
Prevent deterioration	Must do	Cost effective
Reverse upward trends in pollution	Must do	Cost effective
Have sustainable abstractions	Must do	Cost effective
Reduce the level of purification treatment required to produce drinking water	Ambition objective	Cost benefit
Meet prevent and limit objectives of EPR	Must do	Cost effective
Achieve good status in groundwater bodies	Ambition objective	Cost benefit

Protected Area considerations

Water companies must consider and identify schemes that will achieve protected area objectives, particularly achievement of drinking water protected area objectives. Benefits to other protected areas. For example bathing waters and protected habitats, should be considered as part of the investigations and taking a holistic approach to catchment management.

FCRM considerations

As part of the investigations that inform measures, water companies must assess the impact of their proposals on flood risk. Water companies must demonstrate their schemes will not cause an unacceptable increase in flood risk, such as from groundwater rebound, sewer integrity failures or sewer flooding and mains leakage.

Measures should be integrated to provide a catchment wide solution that benefits groundwater quality, quantity and flood risk.

Fisheries considerations

None

Environmental outcome measure

Improvements to environmental outcomes should be achieved through an integrated catchment approach. Therefore changes to groundwater activities (including licences and permits) should be part of broad scaled catchment wide solutions. The environmental outcomes will be measured through the integrated schemes. Where this driver is used to affect changes then there are two environmental outcome measures:

- Volume of water improved through active intervention
- Volume of groundwater resources recovered

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Costing & Economics
Schemes to achieve protected area status or to prevent deterioration are not subject to appraisal of costs and benefits because there are no exemptions on economic grounds in the current legislative drivers. However, they should be cost effective (cost effective means the solution that meets the objective with the lowest overall costs (including non-monetised costs) and technically feasible). Schemes to improve the status of ground water bodies should be technically feasible, and cost effective (identified, using the Environment Agency Water Resources Cost Effectiveness Assessment tool (or similar method)). An appraisal of costs and benefits will also be needed to determine if they are likely to be disproportionately costly or not. The Environment Agency's stage 1 valuation methodology, as set out in the Water Appraisal Guidance which includes the Ground Water Appraisal Guidance, should form the basis of the catchment level economic appraisal of these schemes. More guidance about taking a proportionate review and update of current economic appraisals is available here. For investigations, no appraisal of costs and benefits is required to justify the inclusion of investigations and options appraisals on the WINEP. Refer to the DrWPA guidance for additional guidance on DrWPAs.
Links to technical documents
For the application of the WFDGW driver to meet good status, refer to the guidance in the Investigations Toolkit for Objective Setting for second cycle RBMP: • Annex 1 Objective setting process for groundwater quality • Annex 2 Objective setting guidance for groundwater (quantitative) elements; and The overall objectives for the management of groundwater is defined within Groundwater Protection: Policy and Practice
Other considerations
When developing groundwater schemes you must look for wider benefits and catchment partners to deliver measures that consider and benefit the whole catchment and multiple users
Linked to outstanding policy decision (please tick): None
External Organsiation Consultation: DEFRA DWI NE

7.5 Appendix 7: Guidance Note: Long term planning for the quality of drinking water supplies Drinking Water Inspectorate Guidance to water companies

***** The catchment management section of this document has been included below. The rest of the guidance can be made available on request *****

Drinking Water Inspectorate
Guidance to water companies

Guidance Note: Long term planning for the quality of drinking water supplies

GUIDANCE NOTE ON LONG TERM PLANNING FOR THE QUALITY OF DRINKING WATER SUPPLIES

1. Purpose

1.1. The purpose of this Guidance Note is to provide water companies and other stakeholders with guidance on long term planning for the quality of drinking water supplies.

1.2. This long term planning guidance note is not intended to be a comprehensive review of water supply practice. There are no new policy initiatives set out herein, and no new legal obligations. The focus is on delivery of existing obligations, including recent and imminent legislative changes, using current good practice within a long term planning context.

1.3. The guidance note also provides advice on how the Inspectorate might assist companies in the periodic review process for setting of prices, led by Ofwat, including details of arrangements for information submissions to the Inspectorate; the Inspectorate's assessment processes; and a timeline for supporting current expectations of PR19 requirements. It takes account of current draft Ministerial guidance to Ofwat on strategic priorities and objectives from both the Welsh Government and the UK Government.

1.4. We will update this document as necessary to take account of developments in legislation, policy and industry good practice and future periodic reviews. The Inspectorate welcomes comments on the document, including suggestions for areas or matters not currently included.

1.5. The regulatory framework that sets the context for this Guidance Note is summarised in our Guidance on the Regulations: Introduction to the Public Water Supply Regulations in England and Wales.

2. Content summary

3. Principles of approach

3.1 The Inspectorate expects all water companies to take a source to tap approach to manage their water supplies to protect the health of their consumers, and maintain consumer confidence in the supply and services provided. Central to achieving these objectives is the mandatory use of drinking water safety plans. This is current national and international good practice for water supply management.

3.2 The delivery of this approach should be efficient and sustainable, and contribute to a lasting legacy of long term benefit for both the company and its consumers. To have legitimacy, and to gain the support of the Inspectorate, this approach needs to be transparent about short and long term investment requirements, for current consumers and future generations.

3.3 For all aspects of planning, whether for event management, drought management, water resource management, maintenance management or operations management, it is a fundamental requirement that drinking water quality is always central to, and accounted for, in all cost benefit assessments of options considered. It is expected that companies will always plan to meet their statutory obligations for drinking water quality.

3.4 The sustainability and resilience of the quality of supplies are important for services to consumers, and need to be an integral part of all planning and delivery functions of a company. It is expected that companies will plan for their needs from a stewardship perspective across generations of consumers. To do so, companies will need to foster and develop their supply chain to facilitate and retain the knowledge and skills that are the bedrock for building efficient and innovative solutions and service. In respect of routine operational resilience, it is expected that every company will proactively plan for the containment and recovery from potential events that might otherwise impact on consumers, with a view to maintaining levels of drinking water quality protection, confidence, acceptability and service.

3.5 Given the relative stability of the legislative framework for the quality of drinking water supplies, and the consistency of approach over time, the Inspectorate expects that

companies' operations and maintenance arrangements should consistently, proactively and sustainably meet all statutory obligations, while addressing any localised changes to risk profiles as happen from time to time, using established risk assessment reporting processes. We believe that this is at the heart of the relationship between a water company and its consumers, underpinned by the embedded company culture and staff behaviours that support the daily endeavour necessary to maintain a level of quality and service that meets consumers' expectations, and is how problems are dealt with when they arise. By its activities over time, the company demonstrates its trustworthiness, to gain the trust and confidence of its consumers.

3.6 References in this Guidance Note to the Act and the Regulations are to the Water Industry Act 1991 (and updates/amendments), and the Water Supply (Water Quality) Regulations 2016 for England and the Water Supply (Water Quality) Regulations 2010 (as amended) for Wales. Links to these and other relevant key legislation can be found here .

4. Broad considerations in planning for the long term

4.1 Risk assessments

4.1.1 It is mandatory for water companies to carry out risk assessments of all of their water supply systems, from source to tap, adopting a drinking water safety plan approach. The risk assessment reports subsequently submitted to the Inspectorate should identify the hazard (or partially mitigated hazard) and any associated parameters; evidence that the cause of the hazard has been identified and confirmed; and the range of options for mitigation considered including, where appropriate, catchment management measures. There must also be a clear statement of how the benefits delivered by the actions will be measured (to include the scope, frequency and location of monitoring).

4.1.2 Companies are required to keep under review, their risk assessments for all of their water supplies, and to report updates to the Inspectorate. In doing so, they should have regard to any learning from events or near misses that is circulated by the Inspectorate or companies from time to time.

4.1.3 If a regulatory risk assessment identifies clear actual or potentially significant risks, the company must manage and mitigate the risks from the hazard in a timely, effective and efficient manner to the benefit of consumers. The Inspectorate may consider putting in place a legal instrument to ensure that desired outcomes are achieved.

4.2 Catchment management

4.2.1 Catchment management schemes have been widely used by water companies to address both point source and diffuse pollution, such as nitrate and pesticides. There are many benefits to catchment management approaches that address pollution at source: such schemes benefit the wider water environment; reduce the need for, or burden on, water treatment facilities; and provide sustainable, long-term, cost effective solutions. They remain the first consideration of all source to tap risk assessments to reduce risks prior to treatment and ultimately mitigate all significant risks to public health, wholesomeness and acceptability of water supplies

4.2.2 The Inspectorate has actively promoted catchment management approaches for many years, including incorporating their use in legal instruments arising from compliance failures, or identified risks.

4.2.3 The likelihood of success of catchment management measures varies depending on the nature of the parameter, the size and nature of the catchment, the origin of the pollution and other factors. Therefore, individual proposals will be assessed on their merits.

4.2.4 The accumulation of catchment management improvements gained from a multiplicity of proactive integrated solutions (such as stakeholder engagement at both national and local levels; pollution control; raw water management; abstraction control; and raw and/or treated water blending) may negate or delay the need for, new and/or upgraded treatment processes. In addition catchment management offers protection of the quality of water supplies.

4.2.5 For such solutions to be effective and sustainable, they require the commitment of significant resources and multiple interactions over a prolonged period by companies, and often require the co-ordination of outputs to be delivered by various third parties. Although control of the hazard at source is always the primary objective, where catchment management solutions are specified, we recognise that the full delivery of outcomes via catchment management measures may be uncertain, or may prolong the period before benefits accrue to consumers. To ensure that a legal instrument is fit for purpose, the Inspectorate will need to understand these constraints, and the other actions that the company may need to take, or to make provision for, to supplement its catchment management activities, including the relative contribution of catchment management activities to outcome delivery; the potential impact on priorities; the timescale for completion; and the arrangements for programme recovery, if needed.

4.2.6 The Inspectorate will continue to pursue this policy, and will encourage companies to routinely incorporate catchment management solutions as a fundamental part of their source to tap management of their water supplies. This approach is consistent with wider environmental considerations, including delivery of the provisions of the Water Framework Directive (WFD), Article 7. We will support companies, working with the stakeholders and Regulators involved, to find and implement the most cost effective, efficient and sustainable solutions to deliver the required outcomes. We will continue to work with other Regulators to facilitate the scope and specification of catchment solutions where there are synergies with environmental drivers, and we expect companies to liaise with their local environmental Regulator representatives on the development of their catchment management solutions.

4.2.7 Whilst the most significant catchment management schemes, from a drinking water quality perspective, will continue to be incorporated within legal instruments, we expect companies to routinely engage in proactive catchment management activity as a matter of good practice for all of their water supplies.

4.3 Resource and supply management

4.3.1 The Inspectorate expects water companies to meet their statutory obligations under section 68 of the Act, including, their duty to supply wholesome water.

7.6 Appendix 8: Mapping of karst features and identification of preferential pollutant pathways

****** The Contents Pages and Introduction to this report have been included below. The whole report can be made available on request ******

CR/17/071

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Mapping of karst features and identification of preferential pollutant pathways

Geology and Regional Geophysics Programme
Commissioned Report CR/17/071

CR/17/071

BRITISH GEOLOGICAL SURVEY

GEOLOGY AND REGIONAL GEOPHYSICS PROGRAMME
COMMISSIONED REPORT CR/17/071

Mapping of karst features and identification of preferential pollutant pathways

A R Farrant, L Maurice, M E Stuart and A M Patton

Keywords

Karst, Chalk, groundwater Hertfordshire, stream sink, pollutant pathways

Front cover

Stream sink on the Essendon Brook (Essendon Brook Lower sink). Photo. A Farrant

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CR/17/071

BRITISH GEOLOGICAL SURVEY

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The British Geological Survey is a component body of the Natural Environment Research Council.

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1 Introduction

This report provides an assessment of the potential for karst features and rapid groundwater flow in selected Affinity Water abstraction catchments. Affinity Water has identified 20 catchments in the Chilterns and the North Downs which are under investigation through the National Environment Programme for Water Quality (NEP WQ). The catchments are based on the Environment Agency Source Protection Zone 2 (SPZ 2) areas provided by Affinity Water, and have a combined area of 275 km^2 (Table 1.1). The aim of this study is to identify where there is the potential for karst stream sinks to feed into preferential pollutant pathways connecting surface water inputs and groundwater outlets. These are then evaluated to determine whether they may be affecting drinking water abstractions, and to provide suggestions for mitigation. Essendon, Water End and the Upper Colne abstractions have well developed karst features, including stream sinks. In other catchments where karst stream sinks are apparently absent, the aim is to assess whether there is any other evidence for rapid karstic flow along preferential pollutant pathways.

Source Name	Catchment size (km^2) based on SPZ 2	Pollutant of concern	Combined catchment
North Mymms	60	Pesticides	
Essendon	16	Pesticides	
Netherwild	36 (total for Upper Colne)	Pesticides	Upper Colne
Bricket Wood	36 (total for Upper Colne)	Pesticides	Upper Colne
Wall Hall	36 (total for Upper Colne)	Pesticides	Upper Colne
Berry Grove	36 (total for Upper Colne)	Pesticides	Upper Colne
Bushey Hall	36 (total for Upper Colne)	Pesticides	Upper Colne
Bushey	36 (total for Upper Colne)	Pesticides	Upper Colne
Sawbridgeworth	28.8	Pesticides	
Roydon	28.4	Pesticides	
Offley Bottom	10	Nitrate	
Chartridge	1.38	Nitrate	
Broome (Kent)	3.8	Nitrate	
Kingsdown (Kent)	7.2	Nitrate	
Stansted	15	Nitrate	
Newport	7.5	Nitrate	
Kings Walden	3.8	Nitrate	
Chipping	11.1	Nitrate	
Slip End	11	Nitrate	
Oughtonhead	10	Nitrate	

Table 1.1 Catchments assessed for the potential for karst features and rapid groundwater flow.

2 Definitions

In this report, we define the term 'stream sink' as a discrete point or area where streams or other surface runoff sinks underground into karstic cavities. A stream sink may encompass multiple individual sink points within a large closed depression or small geographical area, or a place in a stream bed where water sinks underground. It does not include other dissolution phenomena such as caves, sinkholes or dissolution pipes that do not accept discrete water inflow. A sinkhole is a closed depression which may or may not take water, also sometimes known as a 'doline'. The term sinkhole is sometimes also used in the context of surface collapses that are caused by underground mine workings which are not related to karst, and can cause confusion. However, in this report, the term sinkhole is solely used to refer to karstic features, and not anthropogenic collapses. The term 'swallow hole' has been used to mean a stream sink or a doline, which has also led to confusion, so is not used in this report.

3 Methods

3.1 OVERVIEW

To assess the likelihood that karst may affect drinking water sources, and to provide evidence to determine future catchment mitigation measures, an assessment of the surface karst features in each abstraction catchment area identified by Affinity Water (defined as area covered by the SPZ 2) was undertaken.

The initial phase of work was a comprehensive desk study evaluation to identify and characterise stream sinks and other karst features, using a variety of data sources outlined below. This included a review of the available literature, coupled with GIS analysis of geological and other spatial data in each catchment. Datasets examined included data from public sources (journal papers and reports, maps, caving club journals), datasets held by BGS (geological field slips, karst databases) and data held by Affinity Water. This literature review was augmented by data from a short field survey of the Water End, Essendon and Upper Colne catchments. Where discrete stream sinks were identified, their surface catchments were determined from topographic maps. DTM and Lidar data was also evaluated but woodland areas proved problematic. These data were then used to assess the hydrological significance of each stream sink (or group of sinks), in terms of how much flow they contribute to the aquifer.

An appraisal of risk, based on available evidence was undertaken using land use and other relevant data provided by the client to characterise potential contamination sources within the topographical catchment of the stream sinks. The potential for contamination was combined with the hydrological appraisal of each stream sink to create an overall risk assessment for the stream sink catchment.

In the two pesticide impacted catchments and nine nitrate impacted catchments where stream sinks were not identified, the approach was to evaluate any other evidence for karst and rapid groundwater flow in the catchment.

The methodology can be summarised thus:

Stage 1.	Desk study assessment (BGS fieldslips & data, databases, Affinity Water data)
Stage 2	Field survey of karst features (Essendon, North Mymms and Upper Colne area)
Stage 3	Delineation of stream sink catchment areas
Stage 4	Hydrological appraisal of stream sinks (stream sink characteristics and flow)
Stage 5	Appraisal of contamination risk from land use analysis
Stage 6	Combined hazard score from contamination risk and hydrological assessment
Stage 7	Assessment of risk in catchments with no stream sinks

3.2 SOURCES OF INFORMATION

A number of sources of information were consulted to identify surface karst features, notably stream sinks and sinkholes in the abstraction catchments.

7.7 Appendix 9: Business requirements to support options appraisal

7.7.1 Requirements Priority Matrix

Table 4 Requirement Priority Matrix

Designation	Explanation
Must	The solution will not be accepted if a requirement that has a priority of 'Must' has not been delivered.
Should	The requirement with a priority of 'Should' would provide business benefit, but the business would accept a solution where this requirement was not delivered e.g. the solution could be delivered by other projects/changes of working practice. If possible, the solution should deliver these requirements.
Could	The requirement with a priority of 'Could' may provide some business benefit, but not as much as the requirements that have been prioritised as 'should' and 'must'. The business would accept a solution where this requirement was not delivered.
Won't	Won't do this now but may wish to implement in the future.

7.7.2 Functional Requirements

Table 5 Functional Requirements

	Requirement Description	Rationale	Priority
1	Implement an enhanced combined programme of catchment pesticide monitoring of the River Colne and Mimmshall Brook for "at risk" pesticides for implementation in Aug 2020. This will build on the existing combined programme of monitoring for metaldehyde currently implemented in AMP6	This combined programme of monitoring enables us to identify priority areas to focus catchment management resources and targeted pesticide reduction schemes where the greatest water quality benefit can be derived	Must
2	Implement pesticide reduction schemes for "at risk" pesticides using PES methodology in high risk sub-catchments identified through catchment monitoring by Sept 2021	To incentivise farmers in high risk areas to implement best practice measures to reduce pesticides affecting raw water quality at the source to reduce the risk of breaches of the drinking water standard at the River Thames abstractions	Must
3	Develop a Payment for Ecosystem Services methodology and incentive mechanism with appropriate menu of measures identified (e.g. Reverse auctions) through AMP6 investigations by Sept 2020	This methodology and mechanism can be applied to pesticide reduction schemes and utilised to ensure a high level of farmer participation in identified schemes	Must
4	Undertake tracer testing of key karst geological features (stream sinks) and	To classify the stream sinks in terms of risk in order to prioritise intervention	Must

	classify each feature in terms of contribution to raw water quality	measures (pesticide reduction schemes, changes in land use and constructed wetlands)	
5	Develop a Capital Grants scheme available to farmers in high risk areas for funding towards farm infrastructure improvements (e.g. pesticide handling areas) that will ultimately improve raw water quality or mitigate the risk of pollution events	To further enhance pesticide reduction schemes and provide a greater assurance of risk mitigation for pesticide losses to raw water in high risk areas	Could
6	Undertake an annual Pesticide Amnesty in all high risk catchments available to farmers to safely remove all banned, out of date and unwanted pesticides	Building on the pesticide amnesties trialled in AMP6 with the benefit of a) removing the risk of pesticides ending up in raw water and b) Providing a cost effective route for engagement farmers to encourage higher level of participation in pesticide reduction schemes	Could

7.7.3 Non-Functional Requirements

Table 6 Non-Functional Requirements

	Requirement Description	Rationale	Priority
1	Identify and procure specialist agricultural delivery partners through either consultancy services agreements of a framework to support delivery of the pesticide reduction schemes and associated catchment characterization activities by Sept 2020	To provide specialist expertise on implementing pesticide reduction schemes where we are unable to source this expertise in-house. Experience from AMP6 has identified suitable delivery partners and the value of identifying partners with experience with local farmer groups	Must
2	Agree catchment management approach to DrWPA schemes with the EA and ensure sign off of WINEP Catchment Measures Specification for agreed PR19 approach by Mar 2020	To agree the scope of activities to be delivered through the NORM and Upper Colne DrWPA schemes under WINEP. Ensure this is aligned with agreed options funded under PR19 business plan	Must
3	Annual progress reporting in accordance with agreed reporting requirements with the EA (WINEP driver) and DWI (Undertakings)	To ensure we meet the regulatory requirements of EA and DWI and provide ongoing progress reporting with benefits realization on effectiveness of the implemented programme of work	Must
4	Improvement in raw water quality	Potentially lower treatment costs through extending life of GAC between regeneration / changes	Should

Appendix AFW.CE.A1.5

Action ref AFW.CE.A1

Catchment management: Nitrate affected sources

Catchment management: Nitrate affected sources

PR19 Business Case

March 2019

Asset Strategy document control sheet

Document amendment history

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Document approval

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1 Document Purpose

The purpose of the Project Business Case is to describe the reasons for the project and the justification for undertaking it, based on the estimated costs of the project, the expected business benefits, savings and risks.

The Business case will also present all the options that have been assessed to deliver the project outcome and will indicate the preferred option out of all considered.

During the project a Business Case is a major controlled document that is referenced on a regular basis to ensure and confirm that the project remains viable. It is maintained throughout the lifecycle of the project, being reviewed by key stakeholders at key decision points, i.e. at the end of a phase.

2 Executive Summary

2.1 Introduction

A recent report from the government Environmental Audit Committee (November 2018) highlighted that historic overuse of fertilisers poses risk to around a third of UK drinking water. A ‘nitrate time bomb’, caused by a historic overuse of farming fertilisers, is working its way through much of the UK’s groundwater sources. The delay caused through percolation means nitrate pollution might not peak for another 60 years.

A number of Affinity Water groundwater sources in the Lee and Dour communities are affected by long-term increasing trends in nitrate concentrations, with several of these sources already exceeding the drinking water standard of 50mg/l as NO^3 either on a continual basis, or resulting from seasonal peak in nitrate concentrations linked to the agricultural season.

Investigations carried out by our catchment management team in AMP6 for BROM, CHAR, CHIP, KINW, KIND, OFFS, OUGH and SLIP has modelled the long-term trend in nitrate over the next 70 years and assessed the viability of catchment-based measures in AMP7 and beyond as part of a long-term programme of reducing nitrate leaching into groundwater in these catchments.

This business case documents the need for investment in catchment measures for these sources. This document also describes the options appraisal undertaken the reasoning behind the selection of the preferred option.

2.2 Drivers

The Nitrate Affected Sources Catchment Management scheme drivers include:

- Mitigate rising trends in nitrate concentrations affecting eight groundwater sources by working with farmers and other polluters (e.g. waste water) through catchment measures.
- Increasing resilience of our assets by focusing effort in reducing nitrate leaching in the catchment. This will reduce the frequency of nitrate exceedances above the drinking water standard (seasonal peaks influenced by rising and falling groundwater levels) in the short to medium term (2 to 5 years) and support reduction in future treatment investment (capex) and ongoing opex costs for nitrate removal plants in the longer term (5 to 50 years).
- Regulatory expectations to deliver catchment management under the 'no deterioration' driver of the Water Framework Directive (WFD) agreed with the Environment Agency (EA) through the Water Industry National Environment Programme (WINEP).

- Meet the expectations stipulated by the Blueprint for Water coalition's manifesto on environmental investment for PR19 and the requirements of the DWI Guidance Note: Long term planning for the quality of drinking water supplies issued September 2017.

2.3 Best value option

Option 1 - Catchment Management Enhanced with nitrate reduction schemes for eight groundwater sources.

This is the best value option as it fulfils all regulatory obligations under WFD and is most likely to be effective in curtailing requirements for additional treatment. This option has been developed to ensure it meets the requirements of the EA PR19 driver guidance for groundwater pressures (Appendix 9) and the DWI long term planning for water quality guidance (Appendix 10). This option develops a programme of measures to reduce nitrate leaching to groundwater based on robust evidence gathered from the WINEP investigations completed in 2017 (Appendix 1) and the mapping of karst features and identification of preferential pollutant pathways (Appendix 12) and nitrate modelling for each source (Appendix 13). It supports Customer Outcome 3: Supplying high quality water that customers can trust by empowering farmers as producers of clean water through a Payment for Ecosystem Services mechanism that is being trialled during AMP6 for pesticides and through a series of cover cropping trials being carried out in AMP6 to measure the reduction in nitrate leaching from particular crops. The evidence gathered from both these trials will inform the development of a nitrate reduction scheme through the preferred option. This approach seeks to reduce diffuse agricultural pollution at the source providing greater resilience to existing treatment and blending options.

The key objective of the project is to develop an effective "Payment for Ecosystem Services" (PES) mechanism which aims to empower farmers as producers of clean water in our catchments. The schemes will incentivise farmers to go beyond compliance with their legal obligations, which are not effective for improving water quality, to adopt best practice controls where the need is greatest. The project will support research and provide evidence for the most effective measures and work directly with farmers and other key stakeholders to implement these measures, monitor their effectiveness and replicability in larger catchment areas and prevent further deterioration in water quality. The PES approach will focus on working with farmers to improve crop protection, soil husbandry and water source protection. The measures that will be developed and incentivised have the potential to provide additional ecosystem services benefits including: improved soil retention, greater flood resilience through improved soil organic matter and more sustainable farming. The project work in collaboration with a range of stakeholders including specialist agricultural delivery partners, regulators, Natural England, farmers and agronomists.

There are limited examples of catchment-based schemes for nitrate reduction in the UK and the proposed Payment for Ecosystem Services approach, using an innovative catchment trading platform, will develop catchment-specific solutions to reduce nitrate leaching to groundwater. The project will identify and drive best practice in soil husbandry and associated incentive mechanisms to encourage greater uptake of measures with farmers in our affected catchments and work with academia to progress the science in this field.

In addition, this project will seek to utilise a range of emerging technologies including satellite imagery, remote sensing, passive samplers, drone technology and will aim to ascertain the wider ecosystem services benefits of the schemes and undertake Natural Capital assessments to support future business planning.

The scope of activities included in the best value option include (but are not limited to):

- 1:1 specialist farm visits.
- Workshops, training and fertiliser spreader servicing and calibration.
- Nitrate reduction catchment measures e.g. subsidised adoption of nitrogen fixing cover crops.
- Incentives for farmers to change practices, take land out production and change fertiliser type
- Access to a funded Capital Grants scheme for infrastructure designed to reduce nitrate leaching.
- Drilling of observation boreholes to monitor nitrate leaching in the soil, unsaturated zone and aquifer.

The project will be delivered in partnership with a number of stakeholders including the EA, Natural England, Farming and Wildlife Advisory Group. Where specialist advice and delivery is required, consultancy service agreements will be established with specialist agricultural delivery partners for work beyond the expertise of Affinity Water staff.

2.4 Cost summary table

Table 1 Costings for the Best Value Option

Preferred Option:	Y1	Y2	Y3	Y4	Y5	Y10	Y20
Costs (capex)	£237,000	£290,000	£440,000	£450,000	£390,000		
Costs (opex)	£10,000	£10,000	£10,000	£10,000	£10,000		
Total costs (capex + opex)	£247,000	£300,000	£450,000	£460,000	£400,000	£0	£0
Total revenue							
Funding requirement (capex + opex – revenue)	£247,000	£300,000	£450,000	£460,000	£400,000	£0	£0
NPV (£k)	-275	-334	-500	-500	-421	4,728	5,020

Please see section 4.3 for commentary around the NPV assessment.

2.5 Customer benefits and resilience benefits

The primary purpose of this investment is to mitigate rising trends and exceedances in nitrate at a number of groundwater sources in the Lee and Dour communities, through a programme of catchment-based measures to reduce leaching of nitrate into the aquifers to provide greater resilience to our assets. This project also meets our regulatory expectations under the Water Framework Directive 'no deterioration' driver delivered through the Water Industry National Environment Programme (WINEP). A successful, long term reduction in diffuse nitrate pollution affecting raw abstracted water from our vulnerable groundwater sources will lead to a reduction in the need for future treatment investment and provide resilience that existing treatment and blending options at these sources. This project can deliver a range of additional benefits including:

- Supports a longer-term strategy of reducing diffuse agricultural pollution at the source in order to prevent further deterioration of water quality and associated treatment needs/costs and WFD Article 7 requirements of no further 'end of pipe' treatment solutions and providing greater resilience to existing treatment and blending options.
- Meets the regulatory expectations stipulated in the Environment Agency (EA) PR19 driver guidance for groundwater pressures and the Drinking Water Inspectorate (DWI) long term planning for water quality guidance.
- Programme of measures to reduce nitrate leaching to groundwater based on robust evidence gathered from the WINEP investigations completed in 2017 (see Appendix 1) and nitrate modelling for each source (see Appendix 12).
- It supports Customer Outcome 3: Supplying high quality water that customers can trust by empowering farmers as producers of clean water.
- Supports achieving our performance commitment 'Water Quality Compliance, Compliance Risk Index (CRI)' target performance.
- Changing our approach to managing pollution risks from reactive to proactive.
- Wider ecosystem services benefits realised through reduction in soil/sediments losses and associated pollutants to surface waters.
- Measures to reduce nitrate leaching (e.g. cover crops) have significant potential in increasing infiltration and natural recharge of groundwater on a catchment-scale to support protection of water resources.
- Proactively engages with and develops positive collaboration and enhanced reputation with key stakeholders inc: our customers and communities, Defra, EA, Natural England, water companies, landowners, farmers, agronomists and environmental groups.
- Long term objective of reducing capex and opex costs for future treatment investment and ongoing operational costs.

2.6 Methodology

The need for the project was identified based on Investigations carried out during AMP6 under the WFD 'no deterioration' driver through the Water Industry National Environment Programme (WINEP) which concluded in March 2017 (Appendix 1). This investigation identified eight groundwater sources (BROM, KIND, CHAR, SLIP, OFFS, OUGH, CHIP and KINW) with long term increasing trends in nitrate concentrations that either have, or will exceed the current drinking water standard (DWS) consistently over the next few decades. These investigations identified priority catchments to focus future nitrate reduction schemes and this project has been developed to work collaboratively with farmers, regulators and other key stakeholders in these high-risk catchments to mitigate these pesticide risks. The preferred option utilizes the outcomes from a number of reports (Appendix 1, 11 and 12) with learning taken from current pesticide reduction schemes and nitrate reduction pilot projects in AMP6 to develop Payment for Ecosystem Services incentive mechanisms to reduce long term nitrate leaching to groundwater. Costs for this project have been derived using an in-house PR19 unit cost model for each source/scheme (Appendix 2 to 8).

3 Defined Need and Dependencies

3.1 Defined need

A number of our groundwater sources in Hertfordshire, Essex and Kent are affected by long term increasing trends in nitrate concentrations. A number of these sources currently observe concentrations that exceed the drinking water standard (DWS) of 50mg/l as NO^3, with others predicted to frequently exceed the standard over the next few decades, based on detailed modelling (Appendix 12).

A programme of investigations into eight groundwater sources were agreed with the EA and carried out during AMP6 under the WFD 'no deterioration' driver delivered through WINEP. These investigations required us to identify the sources and pathways of diffuse and point source nitrate pollution and identify whether catchment management could effectively reduce nitrate concentrations in groundwater and estimate the timescale for realisation of these reductions. Due to the slow movement of groundwater much of the nitrate currently observed can be decades old, although some sources show seasonal peaks attributed to rising and falling groundwater levels. Based on the outcomes of the investigation for each source, recommendations were made on the potential for catchment management and the type of measures required to mitigate the risk to customers drinking water supply. The evidence gathered through the AMP6 programme of detailed catchment investigations completed in March 2017 has been used to inform the investment decisions for catchment management nitrate reduction schemes proposed for PR19. Further detail can be found in Appendix 1: National Environment Programme Water Quality Schemes: Nitrate Affected Sources Investigation Report. These investigations concluded:

- Our modelling study carried out by Amec Foster Wheeler (Appendix 13) predicts that KIND, BROM, KINW, CHIP, SLIP, OFFS and OUGH will observe peak nitrate concentrations between 2020 and 2040 with peak concentrations exceeding the DWS consistently.
- CHAR is predicted to observe peak nitrate concentration in the late 2030s but is not predicted to exceed the DWS during the forecast period up to 2070. However, peaks above the DWS are likely during periods of exceptionally high groundwater levels similar to the 2001 and 2014 groundwater emergence events.
- Nitrate concentrations at KIND, BROM and CHIP have greater seasonal variability associated with fluctuating groundwater levels. In addition, utilising catchment management to reduce nitrate leaching for CHAR could provide greater resilience during periods of exceptionally high groundwater. Potential future schemes will be prioritised for these sources as there is greater potential to achieve a shorter-term benefit in nitrate reductions during the peak periods. Catchment measures will be developed for the other sources, but benefits are likely to be realised over a longer period.
- It is unlikely that catchment measures for nitrate at any of these sources will be effective at preventing deterioration in the short-term due to the time-scales in which nitrate leaching from the surface reaches our groundwater abstractions. Future catchment schemes we commit to undertake will need to be implemented over a longer time period (multiple AMPs) to achieve the desired water quality benefits.

A further study carried out by the British Geological Survey for Affinity Water in 2017 (Appendix 11) into the pollution risk posed by karst and other localised geology risk assessed potential sources and pathways for diffuse nitrate pollution. This study identified areas within the catchments for these abstractions where nitrate reduction measures could be focused.

Based on the outcome of these investigations the EA have included a catchment scheme (referred to as catchment measures in WINEP) for each of these sources in our WINEP3 list for PR19 schemes to be delivered by Affinity Water in AMP7 under the WFD "no deterioration" of water quality driver.

The nitrate affected sources catchment management project is a series of catchment-based schemes with the objective of reducing nitrate leaching into groundwater from agriculture and other sources (e.g. waste water, septic tanks) at the source rather than relying solely on water treatment/blending. Nitrate treatment (Ion Exchange) is expensive, energy intensive and complex and this project seeks to reduce the long term need for additional treatment investment and/or improve resilience for existing treatment/blending where seasonal peaks in concentrations are observed. The project will build on the investigations and pilot trials carried out in AMP6 and develop measures in the catchments for these eight sources. Further investigations into rising nitrate trends are also proposed in a separate business case for North Mymms, Whitehall, Newport and Stansted under a separate PR19 catchment management project (CM WINEP Water Quality Investigations). This project will need to work in partnership with landowners, regulators and other stakeholders to identify and implement ways of reducing the current inputs of nitrate leaching into groundwater.

The objective is to stem the current trends in nitrate concentrations and develop a sustainable long-term solution to reduce nitrate leaching to negate the need for future treatment investment and where treatment is already in place, to reduce the period in which the treatment is required. Where suitable intervention opportunities for the other sources are identified they will be replicated for these sources where resource and funding allows. Modelling undertaken in AMP6 assessed the long-term benefits in nitrate concentrations based on nitrate reduction schemes that could reduce leaching of nitrate into groundwater by 50%. This showed on average that benefits would not be realised until 2040 onwards. This project and the best value option will seek to reduce nitrate leaching by 70% with the objective of realising the benefits from reduced need for treatment investment and imports from Grafham by 2030 onwards.

3.2 Assumptions

- Nitrate trends will continue to increase as determined in the modelling carried out in 2016 and the long term historic trend in water quality.
- Based on modelling outputs a 50% reduction in nitrate leaching into groundwater through catchment management could realise benefits from 2040 onwards.
- Water Framework Directive, Drinking Water Directive and WINEP statutory obligations will remain post-Brexit.
- Current (or future amendments) to Nitrate Vulnerable Zone regulations will continue to be ineffective solely in mitigating nitrate losses to groundwater.
- DWI long term planning guidance stipulates an expectation of increases in scope and/or scale of AMP6 catchment management activities.

3.3 Constraints

- Current WINEP guidance does not allow for continuation of AMP6 schemes into AMP7 without change of scope or expansion of focus areas.
- Tender processes and procurement of services not allowing for professional services contracts outside of approved Frameworks (This project requires specialist services not common within the water industry).
- Current NPV assessment does not include an assessment of Natural Capital and the outputs will not reflect the additional value derived from this scheme.
- Uncertainty around Brexit and the development of a UK Common Agricultural Policy leading to limited options to develop outline programme based on future changes to the regulatory landscape. As a consequence, the scope of this project will need to be continually evaluated to ensure it can be effectively delivered.

3.4 Dependencies

- Identifying effective, high quality agricultural specialist advisors to deliver aspects of scheme beyond capability of AW Catchment Team. A number of specialist delivery partners have been trialled on schemes in AMP6. Based on current outputs, suitable delivery partners are available to deliver schemes proposed in the preferred option. In-house expertise through training and development is also underway to ensure effective resourcing for this project at the start of AMP7.
- Co-operation required from waste water providers within these catchments to ascertain the risk posed from leaking sewer systems. The AW Catchment Team have a close working relationship with Thames Water and Anglian Water catchment teams and work in partnership on a number of initiatives. This should facilitate better access to relevant information.

4 Options Appraisal

4.1 Approach

All schemes and investigations within the Environmental Enhancements programme were defined through their respective regulatory driver(s) and aligned to the associated customer outcome(s) and business need. Each scheme/investigation then underwent an options appraisal exploring the mitigation options, costs and resource requirements to address the need and meet the associated regulatory requirements. This appraisal was supported by the business requirements MoSCoW method documented in Appendix 14.

Several options were developed for each scheme/investigation using a bespoke WINEP Unit Cost Model for PR19 developed for the Environmental Enhancements programme by consultants Mott McDonald. The Unit Cost Model compiled all unit costs and staff hours for catchment management projects based on historic proposals and quotes from schemes and investigations delivered during AMP6. The 'Project build' tool incorporated into the model enabled the user to build up an estimate of the total project cost using pre-defined 'tasks' from drop down menus. The number of 'units' against each task was inputted, which produced a cost for each of the option developed per scheme/investigation. An audit trail was prepared for contractor and other (e.g. infrastructure and farmer incentive payment) unit costs. All costs are including company overheads. They are then indexed to 17/18 price base (an uplift of 15%). The detailed cost model for each scheme can be provided on request. All files that provided evidence of the unit costs were subject to an internal audit to check their accuracy.

The Unit Cost spreadsheet for each option in this business case is available in Appendix 2 to 8.

4.2 Options

Table 2 Costings for the selected options in the options appraisal

	Option 1	Option 2
Year 1	**£237,000**	£200,000
Year 2	**£290,000**	£254,000
Year 3	**£440,000**	£355,000
Year 4	**£450,000**	£355,000
Year 5	**£390,000**	£275,000

4.2.1 Do nothing

The do-nothing option will not proceed with any catchment management activities and rely on monitoring at the point of abstraction and depend on treatment/blending/import options at the nitrate affected sources to solely manage nitrate raw water quality.

Benefits

- low capex cost.

Risks

- Will not fulfil our regulatory expectations under WINEP/WFD.
- Will not facilitate the reduction of nitrate leaching to groundwater in the catchment and will lead to greater risk of breaches of the drinking water standard in the future based on modelling predictions for these sources.
- Would disregard regulatory expectation set out by Defra, EA, DWI and Ofwat that water companies should undertake increased catchment management activities as part of long term plans for water quality.
- No benefits in improved water quality and further deterioration resulting in increased treatment costs. The do nothing option will not proceed with the Catchment element of the DWSP process in AMP7 and rely on risk assessments and supporting information from AMP6 to feed into the next stages of Drinking Water Safety Plans.

4.2.2 Option 1 - Catchment Management Enhanced at whole catchment scale for eight nitrate affected groundwater sources (best value option)

Includes the development of an incentivized nitrate reduction scheme (e.g. cover cropping) applying a Payment for Ecosystems Services methodology for the groundwater catchment area for the eight groundwater sources subject to WINEP catchment schemes. This option would include catchment schemes covering an estimated catchment area of ~80km2 starting in year one of AMP7. This option also includes a capital grants scheme for infrastructure improvements to farms within these catchments where high risks for nitrate leaching have been identified (e.g. high-risk slurry storage). Includes development and roll out of an innovative catchment nutrient trading platform offset nitrate losses to groundwater with the aim of incentivize farmers to propose measures (e.g. cover crops) that reduce nutrient leaching to groundwater through a reverse auction process.

Benefits

- Comprehensive approach building on, and developing measures based on findings from AMP6 investigations.
- Potential to realise medium term benefits for sources with seasonal nitrate peaks. Greatest chance of success in realising longer term reductions in nitrate concentrations.
- Will meet all regulatory expectations under WINEP and the guidance in the DWI long term plan for water quality.
- Will provide greater resilience for water quality during flood and drought periods (high and low groundwater levels).
- Supports a more holistic approach to catchment management with benefits for surface water quality and more sustainable farming systems.
- Innovation through use of IT solutions for land managers catchment trading portal.

Risks

- More expensive capex catchment management option (although likely to reduce long term treatment/blending opex costs) and prevent increased number of treatment plants being built (long term capex costs).
- Nitrate catchment management schemes will take a long time to realise benefits (in some cases decades) due to slow movement of groundwater through the aquifer.

4.2.3 Option 2 - Catchment Management nitrate mitigation pilot schemes at targeted catchment scale

Includes development of a small-scale pilot nitrate reduction scheme applying a Payment for Ecosystems Services methodology for the high-risk areas identified through catchment characterisation for two nitrate affected source groundwater sources (one in the Lee and one in the Dour communities) subject to WINEP catchment schemes to test the potential for future full-scale nitrate reduction schemes. This option would include pilot schemes covering an estimated catchment area of ~20km^2 in years 1 to 3 of AMP7 with a full-scale roll out of catchment measures in years 4 and 5 (~80km^2) informing AMP8 future schemes.

Benefits

- Will meet all regulatory obligations under WINEP.
- Undertaking a trial grants scheme will enable evidence to support development of a full-scale scheme for AMP8.
- Cheaper capex option for AMP7.

Risks

- Nitrate catchment management schemes will take a long time to realise benefits (in some cases decades) due to slow movement of groundwater through the aquifer.
- This option will defer some of the wider scale delivery to AMP8 leading to delays in realising longer term benefits in all nitrate affected sources.

4.3 Cost Benefit Analysis

4.3.1 NPV assessment

A high-level assessment of NPV for the preferred option has been carried out. This investment is primarily driven by regulatory requirements under the Water Framework Directive delivered through WINEP.

The primary method of calculation for NPV in this assessment was driven by identifying cost avoidance options through long term reduction of nitrate leaching into groundwater (50%

reduction between 2020 and 2030). It has been assumed that in the long term this would avoid the need for treatment investment in 3 out of the 8 nitrate affected sources and a reduction in both drinking water standard (DWS) exceedances and avoiding imports of water from Grafham resulting from losses deployable output from the nitrate affected sources. This has been represented by the positive NPV in year 12 onwards by avoiding the need for additional treatment from AMP9 onwards.

It is difficult to quantify the profitability of catchment management activities due to the vast number of variables associated with delivering a challenging project of this nature and determining the benefits derived. In the NPV assessment, assumptions have been made with reduced levels of confidence on a reduction of DWS failures for nitrate and a reduction on the dependency of Grafham imports resulting from the potential reductions in DWS breaches.

The monetary benefits of implementing the AMP7 nitrate affected sources catchment management scheme will be given further quantification using a Natural Capital approach. This approach is currently being developed using the data collected post AMP6 catchment management schemes as a baseline. This method will allow us to use real data linked to indicators of environmental improvements to calculate financial benefits with increased confidence.

The full NPV assessment can be made available on request. A summary of the outputs is shown in Appendix 9.

4.3.2 Environment Agency Operational Catchment Economic Appraisals for the Upper Lee in February 2018

The EA updated the Operational Catchment Economic Appraisals for the Upper Lee in February 2018. The bundle of measures identified to meet WFD objectives includes the proposed AMP7 catchment management nitrate reduction schemes. The EA updated their operational catchment economic appraisals in February and March 2018, using costs prepared for our dWRMP costs for delivering our ongoing AMP6 programme of works.

The Upper Lee Operational Catchment Economic Appraisal included a cost of £140 million with a Benefit Cost Ratio of 1.29 for the recommended bundle of measures (EA[2], 2018). The Upper Lee operational catchment includes catchment management schemes for CHIP, SLIP, OFFS, OUGH and KINW.

Table 3 Summary of appraisal results for recommended bundle of measure

Operational Catchment	Net Present Value (£m)	Benefit Cost Ratio	Present Value Benefits (£m)	Present Value Costs (£m)
Upper Lee	140.89	1.29	633.51	492.62

Source: Environment Agency[2]. 2018. Operational Catchment Economic Appraisal – Final Appraisal Report and Audit Trail: Upper Lee – Version number 3. February 2018

We have also sought the views of our customers and stakeholder for protecting the environment. Our dWRMP consultation concluded that stakeholders are supportive of protecting the environment. Please see Traverse, June 2018, *dWRMP 2020-2080 and PR19 draft Business Plan 2020-2025 Stakeholder Engagement Summary* Report for further information.

4.4 Recommendation

The recommended option proposed in this business case is Option 1 - Catchment Management Enhanced at whole catchment scale for eight nitrate affected groundwater sources.

This is the preferred option as it fulfils all regulatory expectations under WFD/WINEP and has the greatest potential to be effective in curtailing requirements for additional treatment and provide greater resilience in the longer term (10 to 50 years) to our groundwater sources by recognising our water catchments as critical assets. This option has been developed to ensure it meets the expectations of the EA PR19 driver guidance for groundwater pressures (Appendix 9) and the DWI long term planning for water quality guidance (Appendix 10). This option develops a programme of measures to reduce nitrate leaching to groundwater based on robust evidence gathered from the WINEP investigations completed in 2017 (Appendix 1) and the mapping of karst features and identification of preferential pollutant pathways (Appendix 11) and nitrate modelling for each source (Appendix 12). It supports Customer Outcome 2: Supplying high quality water that customers can trust by empowering farmers as producers of clean water through a Payment for Ecosystem Services mechanism through an innovative catchment trading platform that is being piloted during AMP6 and through a series of cover cropping trials being carried out in AMP6 to measure the reduction in nitrate leaching from particular crops. The evidence gathered from both these pilots will inform the development of a nitrate reduction scheme through the preferred option. This approach seeks to reduce diffuse agricultural pollution at the source providing greater resilience to existing treatment and blending options.

5 Risks and Issues

- Changes in legislation around the Common Agricultural Policy arising from Brexit. This risk is being mitigated by developing an approach to this project that can be delivered around a changing regulatory landscape. The scope and delivery plan can be amended based on any changes which are under continual review by our Agricultural Advisor and Catchment Management Programme Manager.
- Effects of climate change resulting in greater diffuse pollution challenges. The preferred option has been developed on the assumption that climate change affects will exacerbate current diffuse pollution risks and produce new risks yet to be identified. The Payment for Ecosystem Services approach can be tailored to mitigate the current and future risks brought about by climate change.
- Farmers not willing to participate in our proposed schemes. The lessons learned from the AMP6 schemes including suitable incentive mechanisms to gain the highest level of participation from farmers have been evaluated. Each year in AMP6, post season surveys have been carried out with farmers to determine barriers and incentives to participation. This feedback informs the development of these schemes to ensure that the highest possible number of farmers could be encouraged to participate in future pesticide reduction schemes.
- Due to the long-term return period for water quality benefits anticipated from nitrate reduction schemes, it is difficult to measure the effectiveness of the schemes in the short term. Trials will be undertaken in a similar way to the AMP6 cover cropping trials through installation of monitoring in the unsaturated zone (e.g. porous pots) to measure reductions in nitrate leaching. We will also have worked closely with academic institutions e.g. Rothamsted to ensure options are scientifically evaluated to ensure their effectiveness.

6 Procurement Strategy

This project will be delivered primarily by in-house expertise through the Catchment Management team. Where specialist agricultural expertise and/or specific local knowledge of target catchments is required then the preferred option will seek to appoint specialist agricultural consultants to deliver aspects of the project and provide administration services for the farmer incentive payments.

The preferred option will also seek specialist consultancy services for such aspects as remote sensing, machinery calibration and testing, training (e.g. fertilizer applicator training) and Capital Grants development.

As this builds on catchment management schemes undertaken in AMP6, suitable suppliers have been trialled and identified for different aspects of the project (e.g. catchment characterisation and specialist 1:1 farmer visits. Many of these are already on the Approved Suppliers list and subject to consultancy services agreements. Where required, a framework contract can be implemented based on the size and scale of the aspects of delivery proposed. These are not in place currently, but can be implemented in advance of AMP7 based on the preferred option being accepted to ensure that no time is lost for delivery at the start of AMP7.

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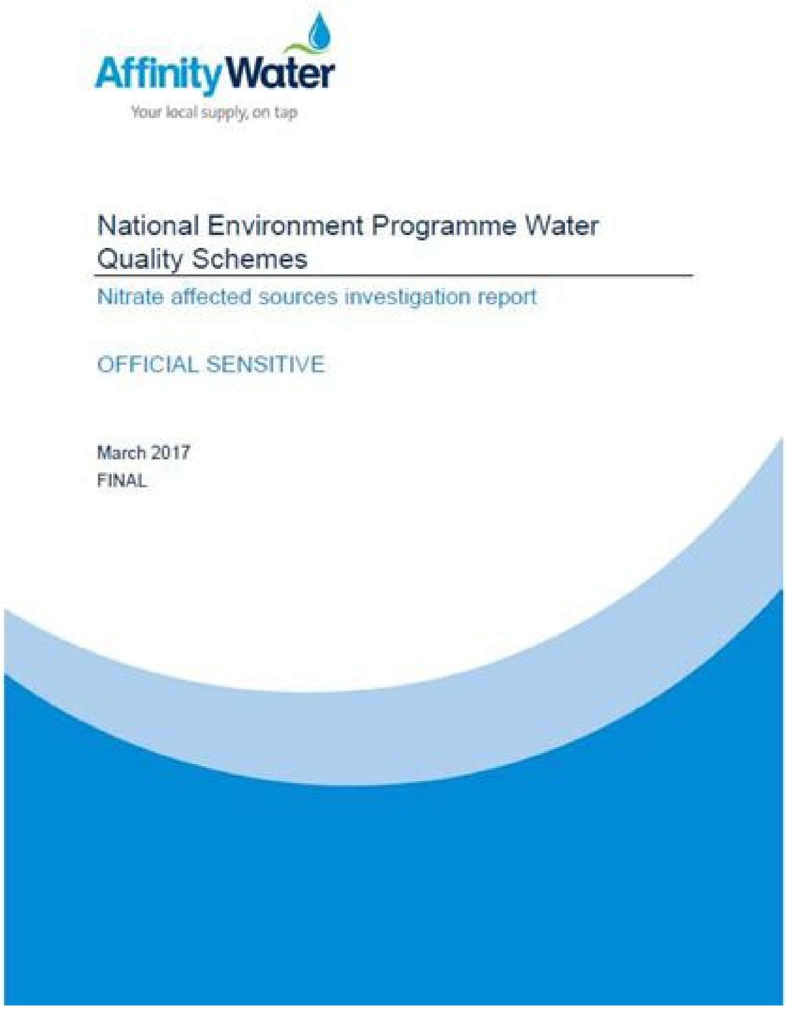
Appendices

7 Appendices

7.1 Appendix 1: National Environment Programme Water Quality Schemes: Nitrate Affected Sources Investigation Report 2017

***** The Contents Pages and Executive Summary have been included within these appendices. The whole report can be provided on request ******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National Environment Programme Water Quality Schemes

Nitrate affected sources investigation report

OFFICIAL SENSITIVE

March 2017
FINAL

Asset Strategy document control sheet

Document amendment history

Version	Status	Date	Amendment to this version
1.0	Draft	15/03/2017	First draft for review
2.0	Draft	18/03/2017	Amendments based on comments from AP
3.0	Draft	20/03/2017	Amendments based on FW review
4.0	Final	28/03/2017	Final review and comments from MP

Document approval

Document title	National Environment Programme Water Quality Schemes: Nitrate affected sources investigation report 2017			
e-Document location				
	Name	Signature	Title	Date
Author/originator	Alister Leggatt Sophie Mortimer		Asset Manager Catchment Officer	15/03/2017
Reviewer	Affie Panayiotou		Head of Water Strategy	17/03/2017
Approver 1 (internal use)	Fiona Waller		Head of Water Quality Services	19/03/2017
Approver 2 (external use)	Mike Pocock		Director of Asset Strategy	28/03/2017

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1 Executive Summary

Our catchment management for water quality programme has been established to investigate and deliver catchment based interventions to improve raw water quality. The programme also supports Affinity Water's obligations under Article 7 of the Water Framework Directive (WFD) delivered through the National Environment Programme for Water Quality (NEP WQ). The investigations and measures undertaken within these schemes for metaldehyde will also deliver the obligations set out in the Undertakings for metaldehyde agreed with the Drinking Water Inspectorate (DWI).

In 2015, we agreed a programme of fourteen NEP WQ investigations (DrW2) with the Environment Agency (EA), primarily focused on pesticides and nitrate. In addition, we had three Drinking Water Protected Area (DrWPA) schemes (DrW1) to deliver catchment interventions for metaldehyde for North Mymms, the River Thames (covering our four River Thames abstractions) and Ardleigh (delivered by Anglian Water with co-funding and support from Affinity Water). Phase 5 of the NEP programme (NEP5) was issued by the EA on 29 January 2016 which included two additional sources for DrW2 investigations, Chartridge and Broome, which had been affected by nitrate following the flooding experienced across our regions in early 2014.

This report details the outcomes of the eight NEP WQ investigations related to nitrate agreed in NEP5 and details our plans for the remainder of AMP6 (2017 – 2020). This review forms the foundation for developing our feasibility study to support our PR19 options appraisal for developing catchment schemes in AMP7.

In summary, our investigations have drawn the following conclusions:

- Effective investigation of sources affected by nitrate within the two period allowed for NEP investigations has been unrealistic and further work will be required to continue to develop our understanding of the sources; pathways; predicted future trends for nitrate; viability of catchment schemes and the likely return period for water quality benefits as part of our Drinking Water Safety Plans (DWSP).
- Our modelling study predicts that Kingsdown, Broome, Kings Walden, Chipping, Slip End, Offley Bottom and Oughton Head will observe peak nitrate concentrations between 2020 and 2040 with peak concentrations exceeding the Drinking Water Standard (DWS) consistently.
- Kings Walden and Chipping currently have nitrate removal treatment installed. Slip End and Offley Bottom have existing blending schemes. Treatment and blending schemes will be explored as part of our PR19 options appraisal for AMP7 schemes.
- Chartridge is predicted to observe peak nitrate in the late 2030s but is not predicted to exceed the drinking water standard (DWS) during the forecast period up to 2070. However, peaks above the DWS are likely during periods of exceptionally high groundwater levels similar to the 2001 and 2014 groundwater emergence events.
- Catchment measures will be explored as part of a feasibility study to support our PR19 options appraisal for AMP7 catchment schemes.
  - Nitrate concentrations at Kingsdown, Broome and Chipping have greater seasonal variability associated with fluctuating groundwater levels.
  - In addition, utilising catchment management to reduce nitrate leaching for Chartridge could provide greater resilience during periods of exceptionally high groundwater. Potential future schemes will be prioritised for these sources as there is greater

potential to achieve a shorter term benefit in nitrate reductions during the peak periods.

- Catchment measures will be explored for the other sources, but benefits are likely to be realised over a longer period.

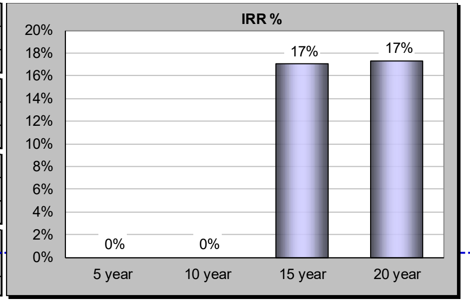
– It is unlikely that catchment measures for nitrate at any of these sources will be effective at preventing deterioration within WFD timescales (by 2027). We consider that any future catchment measure we commit to undertake will need to implemented over a longer time period to achieve the desired water quality benefits

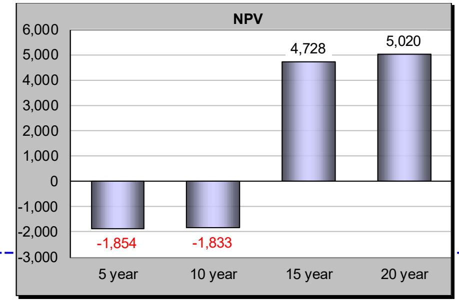
– We are currently running a series of cover crop demonstration trials to provide evidence to support the effectiveness of cover crops at reducing nitrate leaching. This will inform the viability of cover crops as a potential catchment measure supporting our feasibility study for PR19

7.2 Appendix 9: Summary of NPV assessment

***** Detailed NPV assessment spreadsheet can be made available on request *****

5 year		
Financial internal rate of return (IRR)	%	n/a
Financial net present value (NPV)	£'000	-1,854
10 year		
Financial internal rate of return (IRR)	%	n/a
Financial net present value (NPV)	£'000	-1,833
15 year		
Financial internal rate of return (IRR)	%	17%
Financial net present value (NPV)	£'000	4,728
20 year		
Financial internal rate of return (IRR)	%	17%
Financial net present value (NPV)	£'000	5,020





POSITIVE NPV IN YEAR: 12

3.1 ASSUMPTIONS, DATA AND CONFIDENCE LEVEL OF COST BENEFIT ANALYSIS (CBA)

Total revenue	**Confidence (%)**	**Method of Calculation**	**How can the benefits be monitored?**	**When?**	**Contact Person or Department**
- Real cash benefit					
<Insert benefit description>	<Insert %>	<Insert information>	<Insert information>	<Date>	<Insert information>
<Insert benefit description>	<Insert %>	<Insert information>	<Insert information>	<Date>	<Insert information>
<Insert benefit description>	<Insert %>	<Insert information>	<Insert information>	<Date>	<Insert information>
- Cost avoidance		**Method of Calculation**	**How can the cost avoidance be monitored?**	**When?**	**Contact Person or Department**
Cost of avoiding Ion Exchange Treatment	50%	Modelling predicts that these sites will regularly exceed the drinking water standard from 2030 onwards with increased exceedances from 2020. Assuming the cost of Ion Exchange treatment estimate of £3m (capex figure based on estimated costs for AMP7 nitrate treatment projects) avoiding treatment at 3 of the 8 sources included in this scheme from 2030 = £9m	Long term WQ monitoring for nitrates. Number of outages arising from WQ failures. AMP8 and beyond treatment investment options appraisals	01/03/30	Alister Leggatt / Asset Strategy
Avoiding water import from Grafham resulting fr	50%	Cost of Grafham import minus avge unit cost of water per ML. Oughton Head; Chartridge; Offley Bottom and Slip End combined daily abstraction (16.56ML/d) used as example of WTW outage for 30 days per year following nitrate exceedances 226.56 - 41.4 per ML = 185.06. 16.56 ML/d (Nitrate affected sources - Central region) * 185.06 * 30 (days) = £91,937.80 example given in each year of the AMP and beyond. The starting year for when cost avoidance based on reductions in nitrate leaching through this scheme has been estimated at 2030 based on outputs of nitrate modelling work	Number of outages resulting from WQ failures from nitrates	01/01/30	Alister Leggatt
Drinking Water Safety - One off / occasional PC	50%	Reduction in nitrate leaching leading to long term reduction in PCV leading long term reduction in PCV failures. Estimated at 10 per year at £530 per incident = £5,300	Water quality monitoring at the point of abstraction	ongoing	Alister Leggatt / Water Quality Services

7.3 Appendix 10: EA PR19 Driver Guidance: Groundwater Pressures Final

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PR19 Driver Guidance
Driver Name: Groundwater & Contaminated Land Pressures
Strategic Lead(s): Helen Bray (GWQ) and David Seccombe (GWR)
Applicable for function (please tick) : Water Quality ☒ Water Resources ☒ FBG ☒ FCRM ☒ Catchment Solutions available ☒
Date: 3 February 2017 | **Version: Final**
Summary of driver objective

Investigations or schemes for groundwater to meet water company obligations in the catchments they influence and operate in. This driver can be used;

- **in isolation to deliver groundwater priorities eg prevent deterioration in a groundwater body; or**
- **in conjunction with other drivers to deliver multiple objectives and added benefits, eg a catchment scheme in combination with a biodiversity, flood risk that provides wider ecosystem service benefits such as improved groundwater levels and quality and flood risk management, as well as preventing groundwater deterioration.**

Groundwater is vulnerable to pollution and in places, over abstraction. Where water company assets are affecting, or being affected by, groundwater quality or quantity issues, the companies should carry out investigations and deliver measures to protect and improve groundwater. Investigations and measures can only be delivered via the WINEP where we agree to their inclusion.

The use of the groundwater driver codes should only be considered if existing statutory obligations and measures are insufficient to protect and improve groundwater. Water companies may need to make improvements outside of the WINEP where they are not meeting statutory obligations, or where they wish to do additional work outside of the WINEP that benefits their business.

The requirements to protect and improve groundwater are:

- prevent deterioration (water quality and quantity)
- reverse upward trends in pollution
- reduce the level of purification treatment required to produce drinking water (see *Drinking water supplies*)
- meet “prevent and limit” objectives of the Environmental Permitting Regulations (2010).
- achieve good status in groundwater bodies

Water companies should recognise the intrinsic value of groundwater, its contribution and interaction with surface water and wider ecosystems. Water companies are expected to deliver integrated environmental improvements based on payment for ecosystems services and natural capital principles.

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Drinking water supplies

Groundwater drinking water protected area (DrWPA) objectives are:

- to meet good status
- avoid deterioration in water quality in order to reduce the level of purification treatment required in the production of drinking water.

The latter is implemented through safeguard zones (SgZ). Further information on groundwater SgZ requirements are described as a separate driver in the DrWPA guidance.

Where a drinking water supply is being affected by an orphaned contaminated land site(s), water companies should enter into agreements with the Environment Agency, land owners/occupiers, local councils to remediate those sites.

General guidance on groundwater driver codes

Due to the complex association between the scale of a groundwater body compared to the linked environmental deterioration/damage, the use of any groundwater driver must be discussed, scoped out and agreed in advance between the Environment Agency and water company. Scopes to support the inclusion of schemes must be provided in advance of agreeing the scheme and be SMART. This will help streamline the aims and objectives of the proposal to ensure consistency and provide a clear line of sight from the evidence to a solution.

If there is a new statutory obligation to meet, investigations and measures can be included in the WINEP. Groundwater investigations and measures should not relate to capital maintenance, or risk assessment and associated monitoring for the Water Supply (Water Quality) regulations, as these are statutory requirements of the water companies, and should go into the maintenance section of the water companies business plans. Neither should they address existing statutory obligations, for example investigating unpermitted discharges to ground via poor sewer integrity, this is to avoid double funding and the WINEP being used to pay for asset maintenance. The WINEP is for new environmental obligations the water companies need to meet.

Investigations must be detailed enough that no further investigation is needed in future, they should include an options appraisal and an assessment of the cost for proposed measures. Investigations must not be for the same substance in the same area as investigated in previous AMP cycles. Monitoring can be included as part of the investigation to gain a more detailed understand the issues and to identify the actions that need to be implemented. Ongoing surveillance monitoring however, does not form part of the WINEP and falls into the company's ongoing, business as usual operations, such as catchment monitoring for water safety plans.

Measures should implement the recommendations of previous AMP investigations or new obligations following a permit review. Some limited post-scheme appraisal monitoring can be included in the measures, however ongoing surveillance monitoring should not form part of the measure.

For groundwater Safeguard Zones, use the DrWPA codes in the DrWPA guidance since these zones are where protected area obligations are implemented. Measures in safeguard

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zones are subject to cost effectiveness analysis. For DrWPA good status measures use WFDGW_INV or WFDGW_IMP, these measures are subject to cost benefit analysis.

Remedial treatment actions and measures on land determined as contaminated land can be included in the WINEP to meet WFD objectives. These objectives include DrWPAs (ie actions in SgZs to prevent deterioration or reduce the level of purification treatment at drinking water sources), no deterioration and good status objectives. Remedial treatment actions and measures can be included in the WINEP following recommendations by previous investigations and cost benefit analysis which were done as part of the Environmental Protection Act Part2A assessments. To include remediation you will need to choose the appropriate driver from this or the DrWPA drivers and record 'contaminated land remediation' on the WINEP spreadsheet.

Driver code	Description
WFDGW_NDINV	Groundwater No deterioration Investigation Investigations by water companies to fully characterise the reasons for deterioration in groundwater bodies, undertake an options appraisal and identify and recommend measures to be included in the next AMP period and carry out a cost effectiveness analysis.
WFDGW_ND	Groundwater No deterioration Measure Actions and measures to prevent deterioration recommended by either previous investigations; or, actions for water companies identified in river basin management plans to prevent WQ or WR deterioration: subject to cost effectiveness, sustainability and measurement of effectiveness
WFDGW_INV	Groundwater Good Status Investigation Investigations by water companies to fully characterise groundwater bodies, undertake an options appraisal and identify and recommend measures to be included in the next AMP period and carry out a cost benefit/cost effectiveness analysis.
WFDGW_IMP	Groundwater Good Status Measure Actions and measures to meet WFD good status recommended by either previous investigations; or, actions for water companies identified in river basin management plans to meet good chemical or quantitative: subject to cost benefit

Methodology for identifying measures

Who should identify schemes for the WINEP?
Area groundwater teams should lead on identifying water company assets that are affected by or affecting groundwater quality and quantity (including orphaned contaminated land sites that are impacting drinking water supplies).
Area groundwater teams should work together with IEP teams to maximise any wider environmental benefits that can be gained from improving groundwater quality/quantity. Groundwater WINEP schemes can be combined with other drivers e.g. biodiversity to deliver multiple benefits.
Area teams, the National River Basin Management Services and E&B should work together with a water company to identify solutions that build resilient catchments. Resilient catchments do not show deteriorating trends in water quality or quantity and support wider

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ecosystems and the economy. The Environment Agency is encouraging a holistic approach to catchment management in PR19.

How to identify schemes for inclusion in the WINEP?
The Catchment Planning System and the 2015 river basin management plans (2015 plans) provide the evidence of the pressure on the groundwater body, the measures to achieve good status and the objectives for the water bodies. Additional evidence may be held by the water company to support the inclusion of measures in the WINEP. Safeguard zone action plans are also relevant for drinking water protected area objectives (see the DrWPA guidance).

In addition, water companies have an obligation to develop and implement groundwater management approaches that reduce pollution and achieve sustainable use of resources. This could, for example, include developing payment for ecosystem services approaches to reduce nitrate leaching from agricultural land in return for cleaner water supplies.

When considering schemes for inclusion, the Environment Agency encourage water companies to develop catchment solutions. When considering the costs and benefits of such solutions, water companies must consider:

- Groundwater rebound and unintended consequences, such as acid mine drainage
- Flood risk, including groundwater flooding
- The need to achieve protected area objectives, particularly DrWPAs and the aim to reduce treatment
- Statutory and non-statutory wetlands
- Balancing changes to deployable output with groundwater quality
- Discharges to ground/groundwater and their inputs of hazardous substances and non-hazardous pollutants
- Land contamination management and its effects on quality/resources
- Climate change and adaptation
- Wider costs and benefits to society and the economy
- Payments for ecosystem services

When schemes are proposed, water companies need to accept that the poor groundwater body status is linked to one of their assets either alone or as part of their wider infrastructure. The scale and ambition of the scheme can be linked to source apportionment where the water companies will work in collaboration with the Environment Agency to achieve a solution across all sectors. The final solution reflects the water company contribution. For protected areas and groundwater safeguard zones see sections DrWPA guidance.

In developing an approach, we would encourage that any proposed measures are trialled using groundwater models for both quality and quantity, especially models developed as part of the Environment Agency's groundwater modelling strategy. Models can provide a robust approach to the strategic management of the groundwater body and to better understand the effectiveness of the proposed measure. Models however, should not be used as a sole decision making tool and do not replace the need for detailed site investigations and field trials. The assumptions on which the models are built should be documented and verified by site specific data.

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Investigations must be completed to a standard whereby no further investigation is needed to identify solutions to the current problem. The outcome of the investigations should be a comprehensive understanding of the issues that are causing WFD or groundwater directive standards not to be met, a comprehensive set of measures that can be implemented and either a cost effectiveness or cost benefit analysis An assessment of the costs and benefits should be done, considering the wider social and economic benefits of the proposal, taking account of the payments for ecosystem services approach. For groundwater safeguard zones, which implement protected area objectives, an assessment of the cost effectiveness of measures must be done. Water companies with discharges to ground ('groundwater activities') must meet the requirements of EPR 2010. If the Environment Agency or water company feel the discharge does not meet the EPR "prevent and limit" requirements or there is a need to investigate the inputs from the discharge, then investigations should be included in the WINEP. Investigation should be comprehensive (as per the paragraph above) and linked to the principles in the chemicals investigation programme. If changes are needed to the permit as a result of the investigation then the permit must be varied accordingly. As part of any variation, water companies will need to implement a risk-based tiered approach to assessing monitoring requirements around the discharge and the "requisite surveillance" requirements of EPR 2010 must be met. At higher risk sites this will include undertaking a modelled assessment of sewage treatment work discharges to ground to assess if the "prevent and limit" requirements of EPR 2010 are being met. Permit conditions to reflect appropriate monitoring requirements may be required. Compliance against EPR 2010 requirements should be reported on an annual basis to the Environment Agency. Compliance with EPR 2010 is a statutory obligation and does not need additional funding through NEP.
Level of confidence required and associated evidence levels
The Environment Agency will use a weight of evidence approach and work with Natural England, local councils and the Drinking Water Inspectorate to share information on proposals as appropriate. The Catchment Planning System and the 2015 plans provide the evidence of classification (status), characterisation (risk) and whether deterioration has occurred against any of the nine groundwater status tests. Where contaminated land remediation is being considered to protect drinking water supplies, the requirements of Part 2A and the statutory guidance must be followed as well as DrWPA objectives. Land must be determined as 'contaminated land' with a pathway to a drinking water supply before any remediation scheme is proposed. The Environment Agency must have confidence in the proposed remedial actions before agreeing to WINEP schemes. Use of the GWCL driver code must be discussed with representatives of the E&B Groundwater and Land Contamination Management teams before use. Measures should only be recommended where investigations have shown confidence in the outcome, for example, through modelling, monitoring, field trials and cost benefit/effectiveness analysis (see table 1)

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Table 1: Type of cost assessment needed for including measures in the WINEP or as part of an investigation output.

Groundwater Objective	Requirement	Type of economic assessment required
Prevent deterioration	Must do	Cost effective
Reverse upward trends in pollution	Must do	Cost effective
Have sustainable abstractions	Must do	Cost effective
Reduce the level of purification treatment required to produce drinking water	Ambition objective	Cost benefit
Meet prevent and limit objectives of EPR	Must do	Cost effective
Achieve good status in groundwater bodies	Ambition objective	Cost benefit

Protected Area considerations

Water companies must consider and identify schemes that will achieve protected area objectives, particularly achievement of drinking water protected area objectives. Benefits to other protected areas. For example bathing waters and protected habitats, should be considered as part of the investigations and taking a holistic approach to catchment management.

FCRM considerations

As part of the investigations that inform measures, water companies must assess the impact of their proposals on flood risk. Water companies must demonstrate their schemes will not cause an unacceptable increase in flood risk, such as from groundwater rebound, sewer integrity failures or sewer flooding and mains leakage.

Measures should be integrated to provide a catchment wide solution that benefits groundwater quality, quantity and flood risk.

Fisheries considerations

None

Environmental outcome measure

Improvements to environmental outcomes should be achieved through an integrated catchment approach. Therefore changes to groundwater activities (including licences and permits) should be part of broad scaled catchment wide solutions. The environmental outcomes will be measured through the integrated schemes. Where this driver is used to affect changes then there are two environmental outcome measures:

- Volume of water improved through active intervention
- Volume of groundwater resources recovered

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Costing & Economics
Schemes to achieve protected area status or to prevent deterioration are not subject to appraisal of costs and benefits because there are no exemptions on economic grounds in the current legislative drivers. However, they should be cost effective (cost effective means the solution that meets the objective with the lowest overall costs (including non-monetised costs) and technically feasible). Schemes to improve the status of ground water bodies should be technically feasible, and cost effective (identified, using the Environment Agency Water Resources Cost Effectiveness Assessment tool (or similar method)). An appraisal of costs and benefits will also be needed to determine if they are likely to be disproportionately costly or not. The Environment Agency's stage 1 valuation methodology, as set out in the Water Appraisal Guidance which includes the Ground Water Appraisal Guidance, should form the basis of the catchment level economic appraisal of these schemes. More guidance about taking a proportionate review and update of current economic appraisals is available here. For investigations, no appraisal of costs and benefits is required to justify the inclusion of investigations and options appraisals on the WINEP. Refer to the DrWPA guidance for additional guidance on DrWPAs.
Links to technical documents
For the application of the WFDGW driver to meet good status, refer to the guidance in the Investigations Toolkit for Objective Setting for second cycle RBMP: • Annex 1 Objective setting process for groundwater quality • Annex 2 Objective setting guidance for groundwater (quantitative) elements; and The overall objectives for the management of groundwater is defined within Groundwater Protection: Policy and Practice
Other considerations
When developing groundwater schemes you must look for wider benefits and catchment partners to deliver measures that consider and benefit the whole catchment and multiple users
Linked to outstanding policy decision (please tick): None
External Organsiation Consultation: DEFRA DWI NE

7.4 Appendix 11: Guidance Note: Long term planning for the quality of drinking water supplies Drinking Water Inspectorate Guidance to water companies

***** The catchment management section of this document has been included below. The rest of the guidance can be made available on request *****

Drinking Water Inspectorate
Guidance to water companies

dwi

Guidance Note: Long term planning for the quality of drinking water supplies

UNCONTROLLED IF PRINTED
LTP VERSION 01

Issue date: September 2017
Page 1 of 23

GUIDANCE NOTE ON LONG TERM PLANNING FOR THE QUALITY OF DRINKING WATER SUPPLIES

1. Purpose

1.1. The purpose of this Guidance Note is to provide water companies and other stakeholders with guidance on long term planning for the quality of drinking water supplies.

1.2. This long term planning guidance note is not intended to be a comprehensive review of water supply practice. There are no new policy initiatives set out herein, and no new legal obligations. The focus is on delivery of existing obligations, including recent and imminent legislative changes, using current good practice within a long term planning context.

1.3. The guidance note also provides advice on how the Inspectorate might assist companies in the periodic review process for setting of prices, led by Ofwat, including details of arrangements for information submissions to the Inspectorate; the Inspectorate's assessment processes; and a timeline for supporting current expectations of PR19 requirements. It takes account of current draft Ministerial guidance to Ofwat on strategic priorities and objectives from both the Welsh Government and the UK Government.

1.4. We will update this document as necessary to take account of developments in legislation, policy and industry good practice and future periodic reviews. The Inspectorate welcomes comments on the document, including suggestions for areas or matters not currently included.

1.5. The regulatory framework that sets the context for this Guidance Note is summarised in our Guidance on the Regulations: Introduction to the Public Water Supply Regulations in England and Wales.

2. Content summary

3. Principles of approach

3.1 The Inspectorate expects all water companies to take a source to tap approach to manage their water supplies to protect the health of their consumers, and maintain consumer confidence in the supply and services provided. Central to achieving these objectives is the mandatory use of drinking water safety plans. This is current national and international good practice for water supply management.

3.2 The delivery of this approach should be efficient and sustainable, and contribute to a lasting legacy of long term benefit for both the company and its consumers. To have legitimacy, and to gain the support of the Inspectorate, this approach needs to be transparent about short and long term investment requirements, for current consumers and future generations.

3.3 For all aspects of planning, whether for event management, drought management, water resource management, maintenance management or operations management, it is a fundamental requirement that drinking water quality is always central to, and accounted for, in all cost benefit assessments of options considered. It is expected that companies will always plan to meet their statutory obligations for drinking water quality.

3.4 The sustainability and resilience of the quality of supplies are important for services to consumers, and need to be an integral part of all planning and delivery functions of a company. It is expected that companies will plan for their needs from a stewardship perspective across generations of consumers. To do so, companies will need to foster and develop their supply chain to facilitate and retain the knowledge and skills that are the bedrock for building efficient and innovative solutions and service. In respect of routine operational resilience, it is expected that every company will proactively plan for the containment and recovery from potential events that might otherwise impact on consumers, with a view to maintaining levels of drinking water quality protection, confidence, acceptability and service.

3.5 Given the relative stability of the legislative framework for the quality of drinking water supplies, and the consistency of approach over time, the Inspectorate expects that

companies' operations and maintenance arrangements should consistently, proactively and sustainably meet all statutory obligations, while addressing any localised changes to risk profiles as happen from time to time, using established risk assessment reporting processes. We believe that this is at the heart of the relationship between a water company and its consumers, underpinned by the embedded company culture and staff behaviours that support the daily endeavour necessary to maintain a level of quality and service that meets consumers' expectations, and is how problems are dealt with when they arise. By its activities over time, the company demonstrates its trustworthiness, to gain the trust and confidence of its consumers.

3.6 References in this Guidance Note to the Act and the Regulations are to the Water Industry Act 1991 (and updates/amendments), and the Water Supply (Water Quality) Regulations 2016 for England and the Water Supply (Water Quality) Regulations 2010 (as amended) for Wales. Links to these and other relevant key legislation can be found here .

4. Broad considerations in planning for the long term

4.1 Risk assessments

4.1.1 It is mandatory for water companies to carry out risk assessments of all of their water supply systems, from source to tap, adopting a drinking water safety plan approach. The risk assessment reports subsequently submitted to the Inspectorate should identify the hazard (or partially mitigated hazard) and any associated parameters; evidence that the cause of the hazard has been identified and confirmed; and the range of options for mitigation considered including, where appropriate, catchment management measures. There must also be a clear statement of how the benefits delivered by the actions will be measured (to include the scope, frequency and location of monitoring).

4.1.2 Companies are required to keep under review, their risk assessments for all of their water supplies, and to report updates to the Inspectorate. In doing so, they should have regard to any learning from events or near misses that is circulated by the Inspectorate or companies from time to time.

4.1.3 If a regulatory risk assessment identifies clear actual or potentially significant risks, the company must manage and mitigate the risks from the hazard in a timely, effective and efficient manner to the benefit of consumers. The Inspectorate may consider putting in place a legal instrument to ensure that desired outcomes are achieved.

4.2 Catchment management

4.2.1 Catchment management schemes have been widely used by water companies to address both point source and diffuse pollution, such as nitrate and pesticides. There are many benefits to catchment management approaches that address pollution at source: such schemes benefit the wider water environment; reduce the need for, or burden on, water treatment facilities; and provide sustainable, long-term, cost effective solutions. They remain the first consideration of all source to tap risk assessments to reduce risks prior to treatment and ultimately mitigate all significant risks to public health, wholesomeness and acceptability of water supplies

4.2.2 The Inspectorate has actively promoted catchment management approaches for many years, including incorporating their use in legal instruments arising from compliance failures, or identified risks.

4.2.3 The likelihood of success of catchment management measures varies depending on the nature of the parameter, the size and nature of the catchment, the origin of the pollution and other factors. Therefore, individual proposals will be assessed on their merits.

4.2.4 The accumulation of catchment management improvements gained from a multiplicity of proactive integrated solutions (such as stakeholder engagement at both national and local levels; pollution control; raw water management; abstraction control; and raw and/or treated water blending) may negate or delay the need for, new and/or upgraded treatment processes. In addition catchment management offers protection of the quality of water supplies.

4.2.5 For such solutions to be effective and sustainable, they require the commitment of significant resources and multiple interactions over a prolonged period by companies, and often require the co-ordination of outputs to be delivered by various third parties. Although control of the hazard at source is always the primary objective, where catchment management solutions are specified, we recognise that the full delivery of outcomes via catchment management measures may be uncertain, or may prolong the period before benefits accrue to consumers. To ensure that a legal instrument is fit for purpose, the Inspectorate will need to understand these constraints, and the other actions that the company may need to take, or to make provision for, to supplement its catchment management activities, including the relative contribution of catchment management activities to outcome delivery; the potential impact on priorities; the timescale for completion; and the arrangements for programme recovery, if needed.

4.2.6 The Inspectorate will continue to pursue this policy, and will encourage companies to routinely incorporate catchment management solutions as a fundamental part of their source to tap management of their water supplies. This approach is consistent with wider environmental considerations, including delivery of the provisions of the Water Framework Directive (WFD), Article 7. We will support companies, working with the stakeholders and Regulators involved, to find and implement the most cost effective, efficient and sustainable solutions to deliver the required outcomes. We will continue to work with other Regulators to facilitate the scope and specification of catchment solutions where there are synergies with environmental drivers, and we expect companies to liaise with their local environmental Regulator representatives on the development of their catchment management solutions.

4.2.7 Whilst the most significant catchment management schemes, from a drinking water quality perspective, will continue to be incorporated within legal instruments, we expect companies to routinely engage in proactive catchment management activity as a matter of good practice for all of their water supplies.

4.3 Resource and supply management

4.3.1 The Inspectorate expects water companies to meet their statutory obligations under section 68 of the Act, including, their duty to supply wholesome water.

7.5 Appendix 12: Mapping of karst features and identification of preferential pollutant pathways

****** The Contents Pages and Introduction to this report have been included below. The whole report can be made available on request ******

CR/17/071

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Mapping of karst features and identification of preferential pollutant pathways

Geology and Regional Geophysics Programme
Commissioned Report CR/17/071

CR/17/071

BRITISH GEOLOGICAL SURVEY

GEOLOGY AND REGIONAL GEOPHYSICS PROGRAMME

COMMISSIONED REPORT CR/17/071

Mapping of karst features and identification of preferential pollutant pathways

A R Farrant, L Maurice, M E Stuart and A M Patton

Keywords

Karst, Chalk, groundwater Hertfordshire, stream sink, pollutant pathways

Front cover

Stream sink on the Essendon Brook (Essendon Brook Lower sink). Photo. A Farrant

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Keyworth, Nottingham British Geological Survey 2017

CR/17/071

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1 Introduction

This report provides an assessment of the potential for karst features and rapid groundwater flow in selected Affinity Water abstraction catchments. Affinity Water has identified 20 catchments in the Chilterns and the North Downs which are under investigation through the National Environment Programme for Water Quality (NEP WQ). The catchments are based on the Environment Agency Source Protection Zone 2 (SPZ 2) areas provided by Affinity Water, and have a combined area of 275 km^2 (Table 1.1). The aim of this study is to identify where there is the potential for karst stream sinks to feed into preferential pollutant pathways connecting surface water inputs and groundwater outlets. These are then evaluated to determine whether they may be affecting drinking water abstractions, and to provide suggestions for mitigation. Essendon, Water End and the Upper Colne abstractions have well developed karst features, including stream sinks. In other catchments where karst stream sinks are apparently absent, the aim is to assess whether there is any other evidence for rapid karstic flow along preferential pollutant pathways.

Source Name	Catchment size (km^2) based on SPZ 2	Pollutant of concern	Combined catchment
North Mymms	60	Pesticides	
Essendon	16	Pesticides	
Netherwild	36 (total for Upper Colne)	Pesticides	Upper Colne
Bricket Wood	36 (total for Upper Colne)	Pesticides	Upper Colne
Wall Hall	36 (total for Upper Colne)	Pesticides	Upper Colne
Berry Grove	36 (total for Upper Colne)	Pesticides	Upper Colne
Bushey Hall	36 (total for Upper Colne)	Pesticides	Upper Colne
Bushey	36 (total for Upper Colne)	Pesticides	Upper Colne
Sawbridgeworth	28.8	Pesticides	
Roydon	28.4	Pesticides	
Offley Bottom	10	Nitrate	
Chartridge	1.38	Nitrate	
Broome (Kent)	3.8	Nitrate	
Kingsdown (Kent)	7.2	Nitrate	
Stansted	15	Nitrate	
Newport	7.5	Nitrate	
Kings Walden	3.8	Nitrate	
Chipping	11.1	Nitrate	
Slip End	11	Nitrate	
Oughtonhead	10	Nitrate	

Table 1.1 Catchments assessed for the potential for karst features and rapid groundwater flow.

2 Definitions

In this report, we define the term 'stream sink' as a discrete point or area where streams or other surface runoff sinks underground into karstic cavities. A stream sink may encompass multiple individual sink points within a large closed depression or small geographical area, or a place in a stream bed where water sinks underground. It does not include other dissolution

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phenomena such as caves, sinkholes or dissolution pipes that do not accept discrete water inflow. A sinkhole is a closed depression which may or may not take water, also sometimes known as a 'doline'. The term sinkhole is sometimes also used in the context of surface collapses that are caused by underground mine workings which are not related to karst, and can cause confusion. However, in this report, the term sinkhole is solely used to refer to karstic features, and not anthropogenic collapses. The term 'swallow hole' has been used to mean a stream sink or a doline, which has also led to confusion, so is not used in this report.

3 Methods

3.1 OVERVIEW

To assess the likelihood that karst may affect drinking water sources, and to provide evidence to determine future catchment mitigation measures, an assessment of the surface karst features in each abstraction catchment area identified by Affinity Water (defined as area covered by the SPZ 2) was undertaken.

The initial phase of work was a comprehensive desk study evaluation to identify and characterise stream sinks and other karst features, using a variety of data sources outlined below. This included a review of the available literature, coupled with GIS analysis of geological and other spatial data in each catchment. Datasets examined included data from public sources (journal papers and reports, maps, caving club journals), datasets held by BGS (geological field slips, karst databases) and data held by Affinity Water. This literature review was augmented by data from a short field survey of the Water End, Essendon and Upper Colne catchments. Where discrete stream sinks were identified, their surface catchments were determined from topographic maps. DTM and Lidar data was also evaluated but woodland areas proved problematic. These data were then used to assess the hydrological significance of each stream sink (or group of sinks), in terms of how much flow they contribute to the aquifer.

An appraisal of risk, based on available evidence was undertaken using land use and other relevant data provided by the client to characterise potential contamination sources within the topographical catchment of the stream sinks. The potential for contamination was combined with the hydrological appraisal of each stream sink to create an overall risk assessment for the stream sink catchment.

In the two pesticide impacted catchments and nine nitrate impacted catchments where stream sinks were not identified, the approach was to evaluate any other evidence for karst and rapid groundwater flow in the catchment.

The methodology can be summarised thus:

Stage 1.	Desk study assessment (BGS fieldslips & data, databases, Affinity Water data)
Stage 2	Field survey of karst features (Essendon, North Mymms and Upper Colne area)
Stage 3	Delineation of stream sink catchment areas
Stage 4	Hydrological appraisal of stream sinks (stream sink characteristics and flow)
Stage 5	Appraisal of contamination risk from land use analysis
Stage 6	Combined hazard score from contamination risk and hydrological assessment
Stage 7	Assessment of risk in catchments with no stream sinks

3.2 SOURCES OF INFORMATION

A number of sources of information were consulted to identify surface karst features, notably stream sinks and sinkholes in the abstraction catchments.

7.6 Appendix 13: Amec Foster Wheeler: Affinity Water Nitrate and Pesticide Modelling Synthesis Report

****** The Contents Pages and Introduction to this report have been included below. The whole report can be made available on request ******

Affinity Water

Nitrate and Pesticide Modelling

Synthesis Report

October 2016

Amec Foster Wheeler Environment
& Infrastructure UK Limited

Report for

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Document revisions

No.	Details	Date
1	Draft Report	July 2016
2	Final Report	Oct 2016

Contents

July 2016
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1. Introduction

As part of their AMP6 NEP Affinity Water have agreed to investigate rising nitrate and pesticide concentrations at 17 groundwater abstractions from the Hertfordshire and Kent Chalk. This report describes the outcomes of a desk based investigation aimed at improving the conceptual understanding of the sources and pathways by which nitrate or pesticides reach the abstractions. This will feed into long term (25 year) management plans either for catchment management, where feasible, and/or investment in treatment or blending.

1.1 Purpose of this report

The purpose of this synthesis report is to describe the overarching data review, nitrate modelling methods and catchment scale pesticide risk-mapping, interpretation of the results and suggested catchment actions from the desk-based. The individual reports for each of the catchments investigated are included in Appendix B of this report. The desk-based study included the following tasks:

- Characterisation of sources of nitrate and pesticides in each catchment, including point and diffuse sources and their relative significance;
- Determination of likely pathways of pollutant transfer in each catchment;
- Review of historic nitrate and pesticide concentrations in groundwater to understand patterns and potential controls;
- Development of a conceptual model of each catchment, describing the principal sources and pathways of pollution of groundwater, identifying particular conditions (e.g. intense rainfall) that transfer pollutants to groundwater, and bearing in mind the frequency of sampling data;
- Modelling of historic trends in nitrate concentrations in pumped groundwater, and future trends over the next 25 year period (prediction is made for a 75 year period) and identification of the potential magnitude and timing of peak concentrations, and timescales for reversal of rising trends;
- Identification of potential mitigation methods to reduce future inputs of nitrate or pesticides; and
- Identification of the timescale and magnitude of reduction in nitrate concentration that could be achieved through mitigation methods.

1.2 Source locations

Conceptualisation and modelling has been carried out at the 17 Public Water Supply (PWS) abstractions operated by Affinity Water (Table 1.1 and Figure 1.1).

The sources are predominantly in Hertfordshire, Buckinghamshire, Bedfordshire and Essex, with two sources (Broome and Kingsdown) in Kent (Figure 1.1). The pesticides of concern include metaldehyde, carbetamide, isoproturon (field use banned since 2009), carbendazim and propyzamide.

Table 1.1 Affinity Water sources included in this investigation

Source	Catchment Size (km^2) (SPZ2)	Pollutant(s)	Catchment / adjacent river at pesticide impacted sources
Kings Walden	3.8	Nitrate	
Chipping	11.1	Nitrate	
Slip End	11	Nitrate	
Oughton Head	10	Nitrate	
Offley Bottom	10	Nitrate	
Chartridge	1.38	Nitrate	
Broome	3.8	Nitrate	
Kingsdown	7.2	Nitrate	
Newport	23.0	Nitrate	
Stansted	8.1	Nitrate	
Netherwild	27.5	Metaldehyde and carbetamide	Colne
Bricket Wood	16.5	Metaldehyde and carbetamide	Colne
Tolpits Lane	15.1	Metaldehyde and carbetamide	Colne
Eastbury	10.5	Metaldehyde and carbetamide	Colne
Roydon	28.4	Metaldehyde and isoproturon	Lea & Stort
Sawbridgeworth	28.8	Metaldehyde	Lea & Stort
Essendon	6.6	Carbetamide, propyzamide, carbendazim, and metaldehyde	Lea

1.3 Layout of this report

The structure of this report includes:

- This introduction (Section 1);
- An overarching description of source locations and the catchments used for the purposes of this report (Section 2);
- A description of the method used for nitrate source apportionment (Section 3);
- A description of the method used for nitrate trend prediction and the outcomes of this modelling (Section 4);
- A description of the approach used to investigate sources and pathways of pesticides in the catchments to affected boreholes (Section 5);
- Identified mitigation methods that could be applied for each source (Section 6); and
- Summary Conclusions (Section 7).

7.7 Appendix 14: Business requirements to support options appraisal

7.7.1 Requirements Priority Matrix

Table 5 Requirements Priority Matrix

Designation	Explanation
Must	The solution will not be accepted if a requirement that has a priority of 'Must' has not been delivered.
Should	The requirement with a priority of 'Should' would provide business benefit, but the business would accept a solution where this requirement was not delivered e.g. the solution could be delivered by other projects/changes of working practice. If possible the solution should deliver these requirements.
Could	The requirement with a priority of 'Could' may provide some business benefit, but not as much as the requirements that have been prioritised as 'should' and 'must'. The business would accept a solution where this requirement was not delivered.
Won't	Won't do this now but may wish to implement in the future.

7.7.2 Functional Requirements

Table 6 Functional Requirements

	Requirement Description	Rationale	Priority
1	Implement an enhanced programme of nitrate monitoring of the groundwater for the nitrate affected sources Aug 2020. This will include the drilling of observation boreholes where necessary	This programme of monitoring enables us to identify priority areas to focus catchment management resources and targeted nitrate reduction schemes where the greatest water quality benefit can be derived	Must
2	Carry out catchment walkovers of each catchment including utilising remote sensing technology where necessary and create pollution risk map for focused engagement requirement by March 2021	To fully characterise and understand the pollution risks in each catchment to enable prioritisation of measures required	Must
3	Undertake a programme of engagement (1:1 visits, workshops, training events, newsletters) with farm businesses with the SPZ/SgZ for the eight nitrate affected sources by Mar 2021 raising awareness of the issues faced and identifying potential sources of pollution	This methodology and mechanism can be applied to pesticide reduction schemes and utilised to ensure a high level of farmer participation in identified schemes	Must

4	Develop and implement nitrate reduction schemes for "at risk" pesticides using PES methodology (including IT requirements) and associated incentive mechanisms in eight nitrate affected sources catchments by Sept 2021	To incentivise farmers in high risk areas to implement best practice measures to reduce nitrate leaching to groundwater affecting raw water quality at the source to reduce the concentrations of nitrate mobilising to groundwater	Must
5	Develop a Capital Grants and/or nitrate trading platform scheme available to farmers in high risk areas for funding towards farm infrastructure improvements (e.g. minimum tillage and cover crop establishment) that will ultimately improve raw water quality or mitigate the risk of pollution events	To further enhance nitrate reduction schemes and provide a greater assurance of risk mitigation for nitrate losses to groundwater water in high risk areas	Should
6	Pay farmers to take land out of production or change land use where the nitrate leaching to groundwater risk is consider very high	Where a specific risk (e.g. karst solution feature) is identified that poses a significant risk to water quality, paying farmer to change land use to mitigate this risk is likely to be more cost beneficial than treatment	Should

7.7.3 Non-Functional Requirements

Table 7 Non-Functional Requirements

	Requirement Description	Rationale	Priority
1	Identify and procure specialist agricultural delivery partners through either consultancy services agreements of a framework to support delivery of the nitrate reduction schemes and associated catchment characterization activities by Sept 2020	To provide specialist expertise on implementing pesticide reduction schemes where we are unable to source this expertise in-house. Experience from AMP6 has identified suitable delivery partners and the value of identifying partners with experience with local farmer groups	Must
2	Agree catchment management approach to SgZ schemes with the EA and ensure sign off of WINEP Catchment Measures Specification for agreed PR19 approach by Mar 2020	To agree the scope of activities to be delivered through the Nitrate Affected Sources scheme detailed in WINEP3. Ensure this is aligned with agreed options funded under PR19 business plan	Must
3	Annual progress reporting in accordance with agreed reporting requirements with the EA (WINEP driver)	To ensure we meet the regulatory requirements of EA and provide ongoing progress reporting with benefits realisation on effectiveness of the implemented programme of work	Must
4	Improvement in raw water quality	Potentially lower treatment costs through reduction in need for blending, Ion exchange or imports	Should

Appendix AFW.CE.A1.6

Action ref AFW.CE.A1

Catchment management: River Thames Pesticides

Affinity Water

Your local supply, on tap

Catchment Management: River Thames Pesticides

PR19 Business Case

March 2019

Asset Strategy document control sheet

Document amendment history

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V7	Draft	01/03/2019	Revised BC in new template for re-submission
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Document approval

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	Name	**Signature**	**Title**	**Date**
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Approver 3 AS Director following EMT review (external use)	Marie Whaley		Director of Asset Strategy, Data and Innovation	22/03/2019

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1 Document Purpose

The purpose of the Project Business Case is to describe the reasons for the project and the justification for undertaking it, based on the estimated costs of the project, the expected business benefits, savings and risks.

The Business case will also present all the options that have been assessed to deliver the project outcome and will indicate the preferred option out of all considered.

During the project a Business Case is a major controlled document that is referenced on a regular basis to ensure and confirm that the project remains viable. It is maintained throughout the lifecycle of the project, being reviewed by key stakeholders at key decision points, i.e. at the end of a phase.

2 Executive Summary

2.1 Introduction

Water supplied from EGHS, HWFS, CHERS and WALS water treatment works (WTW) periodically exceeds the drinking water standard for a number of agricultural and amenity pesticides. Water Industry National Environment Programme (WINEP) Investigations carried out by the catchment management team in AMP6 identified the source(s) and pathway(s) for these pesticides alongside delivering a pesticide reduction scheme for metaldehyde, which has since been banned for outdoor use.

The outcomes of these investigations determined that catchment management could be effective in mitigating the risk posed by these pesticides and provide greater long-term resilience to our sources and existing treatment. This business case sets out the justification for delivering catchment management measures to mitigate the risk of exceedances for a range of pesticides in detected in the River Thames. This business case is complimented by parallel submissions in PR19 from Thames Water and South East Water as catchment measures in the River Thames basin are delivered in partnership between the three water companies. This document also describes the options appraisal undertaken the reasoning behind the selection of the preferred option.

2.2 Drivers

The River Thames pesticide reduction scheme drivers include:

- To reduce raw and final water exceedances of the drinking water standard for a range of pesticides at the River Thames surface works and reduce need to import.
- Legal Undertakings for individual and total pesticides agreed with the Drinking Water Inspectorate (DWI) for the NORM group of sources in AMP7.
- Support achievement of Customer Outcome 3: Supplying high quality water that customers can trust.
- Meet the company's regulatory expectations to deliver catchment management under the 'no deterioration' driver of the Water Framework Directive (WFD) agreed with the Environment Agency (EA) through the Water Industry National Environment Programme (WINEP).

- Work in partnership with neighbouring water companies, regulators, farmers, agronomists and other agencies to incentivise best practice techniques in reducing pesticide losses to water to provide greater resilience to our treatment works and reduce the need for future treatment investment.

- Align with schemes being developed by Thames Water and South East Water covering the entire Thames Basin to avoid duplication of effort and ensure clear and consistent messages and provided to pesticide users to ensure the greatest water quality improvement benefit.

- Meet the expectations stipulated by the Blueprint for Water coalition's manifesto on environmental investment for PR19 and the expectations set out by the DWI in their 'DWI Guidance Note: Long term planning for the quality of drinking water supplies'

2.3 Best value option

Option 2 - Catchment Management Enhanced at targeted catchment scale.

This option expands the current AMP6 catchment schemes for metaldehyde to mitigate risk of Total Pesticide breaches at the River Thames abstractions. It builds on the 'Payment for Ecosystem Services' (PES) approach developed in AMP6 which recognises farmers as potential producers of clean raw water in our catchments. This option seeks to empower farmers through a suite of incentive mechanisms to support achieving best practice in crop protection to sustainably improve water quality reducing the cost of future treatment and providing greater resilience for current treatment and blending options. This is the best value option as it:

- Provides the greatest cost benefit for the potential water quality improvements (based on evidence of successful AMP6 metaldehyde scheme).

- Meets all regulatory expectations under WFD/WINEP and legal Undertakings agreed with the DWI for AMP7.

- Supports Customer Outcome 3: Supplying high quality water that customers can trust by empowering farmers as producers of clean water through a Payment for Ecosystem Services mechanism that is being developed and trialled during AMP6.

- Builds on the knowledge and experience gained from the AMP6 metaldehyde reduction scheme which successfully implemented a range of pesticide reduction schemes that were successful in preventing metaldehyde exceedances in the River Thames in 2017 and 2018. Although metaldehyde is due to be banned, the experience and positive engagement made through these schemes will be applied to a wider suite of pesticide risk.

- This options targets catchment areas where pesticide reduction schemes can achieve the greatest benefit (both in terms of cost and water quality improvement) based on an extensive catchment monitoring programme implemented in 2010.

- This approach seeks to reduce diffuse agricultural pollution at the source providing greater resilience to existing treatment and blending options.

- Builds on the catchment management project undertaken in AMP6 and expands the scope and scale of existing pesticide reduction schemes to all "at risk" pesticides to the River Thames abstraction based on robust evidence gathered from detailed catchment monitoring since 2010.

- Utilises resources effectively to represent the best value to the customer

- Developed to ensure it meets the requirements of the EA PR19 driver guidance for DrWPA schemes and the DWI long term planning for water quality guidance.

A successful, long term reduction in diffuse pesticide pollution affecting raw abstracted water could lead to a reduction in the need for future treatment and a greater resilience for existing treatment and blending options at these abstractions. It also allows water transfer across the company's supply area without regulatory restrictions on deterioration of water quality.

There is an expectation from Defra, DWI and the EA for water companies to increase their focus on catchment management and incorporate this into the long-term planning for managing water quality in line with the Water Framework Directive (WFD). Article 7 of WFD stipulates a move away from end of pipe treatment solutions to managing risks and issues at the source. This option facilitates the development of catchment action plans to manage pesticide risks in the River Thames basin aligning Affinity Water's catchment management programme alongside Thames Water and South East Water to ensure most effective coverage of catchment-based measures.

The partnership approach adopted by AW, Thames Water and South East Water established in 2010 with combined schemes incorporating ~11,000km^2 upstream Thames River Basin with catchment intervention measures is unique in the UK, viewed positively by our regulators and enables sharing of ideas, collaborative research, sharing costs, pooling resources and cross-border cooperation.

In addition, this project will seek to utilize a range of emerging technologies including satellite imagery, remote sensing, passive samplers, catchment trading platforms and will aim to ascertain the wider ecosystem services benefits of the schemes and undertake Natural Capital assessments to support future business planning.

2.4 Cost summary table

Table 1 Costings for the Preferred Option

Preferred Option:	Y1	Y2	Y3	Y4	Y5	Y10	Y20
Costs (capex)	£414,000	£490,000	£490,000	£490,000	£390,000		
Costs (opex)	£10,000	£10,000	£10,000	£10,000	£10,000		
Total costs (capex, risk + opex)	£424,000	£500,000	£500,000	£500,000	£400,000	£0	
Total revenue	£0	£0	£0	£0	£0		
Funding requirement (capex + opex – revenue)	£424,000	£500,000	£500,000	£500,000	£400,000	£0	
NPV (£k)	-500	-562.7	-550.9	-589.7	-535.7	-2,306	-2,021

Please see section 4.3 for commentary around the NPV assessment.

2.5 Customer benefits and resilience benefits

The primary purpose of this investment is to reduced pesticide exceedances at our River Thames abstractions to provide greater resilience to our assets, meet our legal Undertakings for pesticides agreed with the DWI and our regulatory expectations under the Water Framework Directive (WFD) 'no deterioration' driver delivered through the Water Industry National Environment Programme (WINEP). This project can deliver a range of additional benefits including:

- Supports a longer-term strategy of reducing diffuse agricultural pollution at the source in order to prevent further deterioration of water quality and associated treatment needs/costs and delivers on WFD Article 7 requirements.
- Supports Customer Outcome 3: Supplying high quality water that customers can trust.
- Supports achieving our performance commitment 'Water Quality Compliance, Compliance Risk Index (CRI)' target performance.
- Develops a stronger understanding of our catchments and the risks posed to public water supply.
- Changing our approach to managing pollution risks from reactive to proactive.

- Wider ecosystem services benefits realised through reduction in soil/sediments losses and associated pollutants to surface waters.

- Proactively engages with and develops positive collaboration and enhanced reputation with key stakeholders inc: our customers and communities, Defra, EA, Natural England, water companies, landowners, farmers, agronomists and environmental groups.

- Long term objective of reducing capex and opex costs for future treatment investment and ongoing operational costs.

2.6 Methodology

The need for the project was identified based on evidence gathered through the catchment and abstraction monitoring programme carried out in AMP6, to support the current WFD Drinking Water Protected Area (DrWPA) scheme for pesticides being delivered through the WINEP agreed with the EA. WINEP investigations that were completed in March 2017 (documented in Appendix 1) identified a number of "at risk" and “of concern” pesticides contributing to deteriorating water quality at our River Thames abstractions. These investigations, also carried out by Thames Water and South East Water in the wider River Thames Basin, undertook a risk assessment of all catchments of the River Thames and identified priority sub-catchments to focus future pesticide reductions schemes. This project has been developed to work collaboratively with farmers, regulators and other key stakeholders in these high-risk catchments to mitigate pesticide losses to water. The preferred option utilizes the evidence gathered from the successful approaches trialled for metaldehyde in AMP6 and further develops these schemes to address the wider diffuse agricultural pollution risks to public water supply. The methodology will apply a Payment for Ecosystem Services mechanism to drive best practice in sustainable crop protection. Costs for this project have been derived using an inhouse PR19 unit cost model for each source/scheme (Appendix 2 and 3).

3 Defined Need and Dependencies

3.1 Defined need

In 2009, we identified that water supplied from Iver, EGHS, WALS and CHERS Water Treatment Works (WTW) periodically exceeded the drinking water standard for metaldehyde. Following our investigations, we concluded that our pesticide treatment was inadequate to remove this particular pesticide to below the standard at all times. In 2010, we gave Undertakings for metaldehyde to the Drinking Water Inspectorate (DWI) for the sites listed above. In these Undertakings, we committed to review and investigate our current abstraction regimes and pesticide monitoring strategy as well as review new technology and participate in industry research to achieve compliance and to undertake catchment management investigations to identify the source of metaldehyde and develop catchment-based mitigation measures to reduce the issue at the source. The catchment management schemes for metaldehyde that were implemented in AMP6 were largely successful with no exceedances of the drinking water standard observed at any of the four River Thames abstractions in 2017 and 2018 once upscaling of measures to the catchment-scale were achieved. Metaldehyde has since been banned for outdoor use as of March 2020, but supporting investigations under WINEP completed in 2017 also identified a range of other pesticides posing a risk to drinking water quality that require catchment measures to be implemented in AMP7 (see Appendix 1).

The Thames River Basin District (RBD) covers over 11,000km^2 across south east and west England upstream of our HFWS, EGHS, CHERS and WALS water treatment works (WTWs). All four WTWs abstract directly from the River Thames in West London and are susceptible to upstream diffuse and point source pollution risks. Eighteen major river catchments flow into the River Thames with thirty-eight major tributaries which includes drainage and waste water from sixteen cities and key towns. Three water companies abstract water from the River Thames: Thames Water, Affinity Water and South East Water. In September 2010, we set up the Thames Catchment Management Steering Group (TCMSG), to work in partnership to investigate and identify interventions to reduce the impact of diffuse metaldehyde pollution. In AMP6 the remit has been extended to also include other pesticides and water quality issues as part of WINEP. The purpose of the partnership is to share data, evidence and information, coordinate work, avoid duplication, standardise target setting, share experiences and knowledge from engagement with farmers and agronomists, and support the EA with Water Framework Directive (WFD) delivery.

The River Thames Pesticides catchment management project is a series of catchment-based pesticide reduction schemes with the objective of reducing agricultural pesticide pollution at the source rather than relying solely on water treatment. It is a continuation of current AMP6 schemes for metaldehyde and the proposed increase in scope of this project will extend to mitigate the impacts of key "at risk" pesticides (inc. carbetamide, propyzamide and quinmerac) which pose a risk of breaching the drinking water standard for individual and total pesticides. The TCMSG produces aligned plans developed collaboratively through the WINEP and shares the targeting of catchment schemes in high risk catchments identified in AMP5 and AMP6 to ensure that the greatest proportion of high risk areas with the Thames River Basin are covered by catchment intervention measures. Affinity Water leads on catchment schemes in the Loddon, Lower Wey and Colne catchments and provides monitoring and technical support to Thames Water in the Lea catchment and to South East Water in the Lower Thames catchment. Thames Water and South East Water are currently developing parallel schemes through PR19 focusing on other high risk catchments identified by the TCMSG and are requesting funding for similar schemes through their PR19 process.

The evidence used to support decision-making on where to focus the pesticide reduction schemes was gathered through a programme of detailed catchment investigations agreed with the EA in the Thames DrWPA completed in March 2017 to inform the investment decisions for enhanced catchment management schemes in AMP7. Further detail can be found in Appendix 1: National Environment Programme Water Quality Schemes: River Thames DrWPA Investigation Report. Based on the outcome of these investigations and the ongoing DrWPA catchment scheme for metaldehyde, the EA have included a scheme for "at risk" and “of concern” (Total) pesticides in our WINEP3 list for PR19 schemes to be delivered by Affinity Water in AMP7 under the WFD "no deterioration" of water quality driver.

The scope of the schemes to be implemented in these catchments, through this project, are required through WINEP to focus on key pesticides used in cereal and oilseed rape crops that are predominantly grown in this region.

3.2 Assumptions

- Legal Undertakings will be agreed with the DWI for individual and total pesticides in AMP7.
- Cost avoidance in NPV assessment assumes one pesticide pollution event per year with a drinking water standard exceedance and reliance on import from Grafham Water
- Water Framework Directive, Drinking Water Directive and WINEP statutory obligations will remain post-Brexit.
- The Environment Agency will approve the Catchment Measures Specification developed for WINEP based on the preferred option (determination in March 2019).
- Any future restrictions on the use of metaldehyde and other "at risk" pesticides will take a number of years to develop, implement, enforce and water quality improvements realised.
- Thames Water and South East Water PR19 catchment management plans for River Thames pesticide schemes will align with preferred option for this project.

3.3 Constraints

- NPV assessment does not include cost avoidance measures for reduction in future treatment (capex) and reduction in GAC regeneration (opex) due to high level of uncertainty.
- Current NPV assessment does not include an assessment of Natural Capital and the outputs will not reflect the additional value derived from this scheme.
- Current WINEP guidance does not allow for continuation of AMP6 schemes into AMP7 without change of scope or expansion of focus areas.
- DWI long term planning guidance stipulates an expectation of increases in scope and/or scale of AMP6 catchment management activities.

- Tender processes and procurement of services not allowing for professional services contracts outside of approved Frameworks (This project requires specialist services not common within the water industry).

- Uncertainty around Brexit and the development of a UK Common Agricultural Policy leading to limited options to develop outline programme based on future changes to the regulatory landscape. As a consequence, the scope of this project will need to be continually evaluated to ensure it can be effectively delivered.

3.4 Dependencies

- Thames Water and South East Water deliver effective parallel schemes in wider Thames River Basin. This is being managed through the TCMSG partnership which has agreed the high and medium risk catchments each water company will lead in and develop investment plans to avoid duplication of cost and resource. The TCMSG meets bi-monthly and shares the outputs of the AMP6 pesticide reduction schemes and lessons learned are used to inform the preferred option captured in this business case.

- Identifying effective, high quality internal Catchment Officers and agricultural specialist consultants to deliver aspects of scheme beyond capability of AW Catchment Team. A number of specialist delivery partners have been trialled on schemes in AMP6. Based on current outputs, suitable delivery partners are available to deliver schemes proposed in the preferred option. In-house expertise through training and development is also underway to ensure effective resourcing for this project at the start of AMP7.

- Farmers willing to participate in the schemes. The lessons learned from the AMP6 schemes including suitable incentive mechanisms to gain the highest level of participation from farmers have been evaluated. Each year in AMP6, post season surveys have been carried out with farmers to determine barriers and incentives to participation. This feedback informs the development of these schemes to ensure that the highest possible number of farmers could be encouraged to participate in future pesticide reduction schemes.

4 Options Appraisal

4.1 Approach

All schemes and investigations within the Environmental Enhancements programme were defined through their respective regulatory driver(s) and aligned to the associated customer outcome(s) and business need. Each scheme/investigation then underwent an options appraisal exploring the mitigation options, costs and resource requirements to address the need and meet the associated regulatory requirements. This appraisal was supported by the business requirements MoSCoW method documented in Appendix 13.

Several options were developed for each scheme/investigation using a bespoke WINEP Unit Cost Model for PR19 developed for the Environmental Enhancements programme by consultants Mott McDonald. The Unit Cost Model compiled all unit costs and staff hours for catchment management projects based on historic proposals and quotes from schemes and investigations delivered during AMP6. The 'Project build' tool incorporated into the model enabled the user to build up an estimate of the total project cost using pre-defined 'tasks' from drop down menus. The number of 'units' against each task was inputted, which produced a cost for each of the option developed per scheme/investigation. An audit trail was prepared for contractor and other (e.g. infrastructure and farmer incentive payment) unit costs. All costs are including company overheads. They are then indexed to 17/18 price base (an uplift of 15%). The detailed cost model for each scheme can be provided on request. All files that provided evidence of the unit costs were subject to an internal audit to check their accuracy.

The Unit Cost spreadsheet for each option in this business case is available in Appendix 1.

4.2 Options

Table 2 Costings for the options considered in the options appraisal

	Option 1	Option 2	Option 3
Year 1	£1,600,000.00	**£414,000.00**	£262,000.00
Risk	£160,000.00	**£41,400.00**	£26,200.00
Year 2	£1,600,000.00	**£490,000.00**	£262,000.00
Risk	£160,000.00	**£49,000.00**	£26,200.00
Year 3	£1,600,000.00	**£490,000.00**	£262,000.00
Risk	£160,000.00	**£49,000.00**	£26,200.00
Year 4	£1,600,000.00	**£490,000.00**	£262,000.00
Risk	£160,000.00	**£49,000.00**	£26,200.00
Year 5	£1,600,000.00	**£390,000.00**	£262,000.00
Risk	£160,000.00	**£39,000.00**	£26,200.00

4.2.1 Do nothing

The do nothing option will not proceed with any catchment management activities and rely on monitoring at the point of abstraction and depend on treatment/blending options at the River Thames abstractions to solely manage pesticide raw water quality.

Benefits

- low capex cost.

Risks

- Will not fulfil regulatory expectations under WINEP/WFD.
- Will not meet our legal Undertakings for individual and total pesticides.
- Will not facilitate the reduction of metaldehyde and other "at risk" pesticides in the catchment and current work in AMP6 to reduce metaldehyde will be undone and increase concentrations in raw water will lead to greater risk of breaches of the drinking water standard as treatment ineffective.
- Defra, EA, DWI and Ofwat all have stated expectations that water companies will undertake increased catchment management activities as part of long term plans for water quality.
- No benefits in improved water quality and further deterioration resulting in increased treatment costs. The do nothing option will not proceed with the Catchment element of the DWSP process in AMP7 and rely on risk assessments and supporting information from AMP6 to feed into the next stages of Water Safety Plans.

4.2.2 Option 1 - Catchment Management Enhanced at whole catchment scale

Builds on current AMP6 metaldehyde pesticide reduction schemes and expands them to incorporate all "at risk" pesticides and increases the catchment area for these schemes to cover all high, medium and low risk sub-catchments of the Loddon, Lower Wey and Lower Colne catchments with an estimated scale (based on eligible arable crops grown in a given year) of ~50,000 hectares. This option also includes an enhanced Capital Grants scheme for infrastructure improvements to all farmers within these catchments and constructed wetlands upstream of all identified stream sinks.

Benefits

- Significant upscaling of priority catchments and number of potential farmers participating in schemes leading to greater reduction in diffuse pesticide losses to water.
- Will meet all regulatory expectations under WINEP and legal Undertakings for individual and total pesticides.

Risks

- the non-targeted approach could lead to a decrease level of participation from farmers due to a reduction in intensive engagement resulting from having to deliver pesticide reduction schemes in much larger areas.

- Focusing on low risk catchment areas does not represent good value for the customer.
- Would require a significant increase in human resource (insourced or outsourced) in order to maintain the level of engagement required to maintain a high level of participation.
- Dependency on Thames Water and South East Water delivering effective catchment management schemes in the wider Thames RBD and receiving funding through their respective Business Plans.

4.2.3 Option 2 - Catchment Management Enhanced at targeted catchment scale (preferred option).

Option 2 Builds on current AMP6 metaldehyde pesticide reduction schemes and expands them to incorporate all "at risk" pesticides in high risk sub-catchments of the Loddon, Lower Wey and Lower Colne catchments with an estimated scale (based on eligible arable crops grown in a given year) of ~15,000 hectares. This option also includes a grants scheme for infrastructure improvements that is focused on farm businesses in high risk catchments where specialist advisors have identified a specific water quality improvement that can be derived and where cost benefit for the investment can be demonstrated.

Benefits

- Will meet all regulatory expectations under WINEP and legal Undertakings for individual and total pesticides.
- Evidence-based approach enabling targeted interventions to focus where water quality improvements will achieve the greatest benefit.
- Represents the best value for the customer.
- Will help support potential reduction in treatment opex costs and reduction in future treatment capex investment.
- Enables targeting of resources where the need is greatest to ensure an intensive level of farmer engagement to ensure the highest level of participation of farmers with high/medium risk land in pesticide reduction schemes.
- Target catchments can be amended dependent on seasonal water quality results and subsequent changes in risk.

Risks

- Dependency on Thames Water and South East Water delivering effective catchment management schemes in the wider Thames RBD and receiving funding through their respective Business Plans.

4.2.4 Option 3 - Catchment Management Basic with no expansion of scope or scale from AMP6 (This option no longer valid due to metaldehyde ban)

Option 3 maintains the existing metaldehyde pesticide reduction schemes with limited expansion to "at risk" pesticides. This option has been discounted as metaldehyde has been banned for outdoor use from March 2020.

Benefits

- low cost option.

Risks

- No longer a viable option due to the metaldehyde ban.
- Will not fulfil regulatory obligations under WINEP/WFD.
- Will not meet our legal Undertakings for individual and total pesticides
- Defra, EA, DWI and Ofwat all have stated expectations that water companies will undertake increased catchment management activities as part of long term plans for water quality.
- Less certainty on reduction in pesticides compared to other options. This approach will not mitigate wider pollution issues affecting these abstractions.
- Greater residual risk at the end of AMP.

4.3 Cost Benefit Analysis

4.3.1 NPV assessment

A high-level assessment of NPV for the preferred option has been carried out. This investment is primarily driven by regulatory requirements under the Water Framework Directive delivered through the National Environment Programme and the Undertakings in the River Thames to be agreed with the DWI.

The primary method of calculation for this assessment was driven by cost avoidance of pesticide exceedances above the drinking water standard and associated costs of importing water during these events. It is difficult to quantify the profitability of catchment management activities due to the vast number of variables associated with delivering a challenging project of this nature and determining the benefits derived. in the NPV assessment, assumptions have been made with reduced levels of confidence on a reduction of drinking water standard (DWS) failures for pesticides and a reduction on the dependency of Grafham imports resulting from the potential reductions in DWS breaches.

This assessment does not account for reduction in future treatment investment (capex) or long-term reduction in GAC regeneration frequency (opex) resulting from catchment management schemes due to a high level of uncertainty. This assessment also does not take into account the wider ecosystem services benefits of the best value option.

The results based on these factors have determined a payback period of over 20 years the is currently a lack of evidence to support the quantification of benefits from catchment management activities.

In order to improve this quantification of the benefits of catchment management. the wider ecosystem services benefits of implementing the AMP7 River Thames pesticides catchment management scheme will be given further quantification using a Natural Capital approach. This approach is currently being developed using the data collected post AMP6 catchment management schemes as a baseline. This method will allow us to use real data linked to indicators of environmental improvements to calculate financial benefits with increased confidence.

The full NPV assessment can be made available on request. A summary of the outputs is shown in Appendix 4.

4.4 Recommendation

Option 2 - Catchment Management Enhanced at targeted catchment scale.

This is considered the best value option as it fulfils all regulatory obligations under WFD and Undertakings agreed with DWI. This option has been developed to ensure it meets the requirements of the EA PR19 driver guidance for DrWPA schemes (Appendix 4) and the DWI long term planning for water quality guidance (Appendix 5). This option builds on the catchment management project undertaken in AMP6 and expands the scope and scale of existing pesticide reduction schemes to all "at risk" pesticides to the River Thames abstraction based on robust evidence gathered from detailed catchment monitoring from 2010. The approach in this options targets catchment areas where pesticide reduction schemes can achieve the greatest benefit and utilises resources effectively to represent the best value to the customer. It supports Customer Outcome 2: Supplying high quality water that customers can trust by empowering farmers as producers of clean water through a Payment for Ecosystem Services mechanism that is being developed and trialled during AMP6. This approach seeks to reduce diffuse agricultural pollution at the source providing greater resilience to existing treatment and blending options.

The best value option for this project, in addition to the pesticide reduction schemes in high and medium risk catchments will incorporate additional measures including:

- an annual Pesticide Amnesty for banned and out of date pesticides;
- Pesticide Applicator training courses for farmers;
- Pesticide applicator calibration and servicing for farmers;
- access to a Capital Grants scheme for infrastructure investment focused on water quality (e.g. bunded pesticide handling areas);

- specialist workshops; 1:1 farm visits and incentives based on achieving clean water targets in high risk catchments.

The project will be delivered in partnership with a number of stakeholders including the EA, Natural England, Farming and Wildlife Advisory Group. Where specialist advice and delivery are required, consultancy service agreements will be established with specialist agricultural delivery partners for work beyond the expertise of Affinity Water staff.

5 Risks and Issues

- Changes in legislation around the Common Agricultural Policy arising from Brexit. This risk is being mitigated by developing an approach to this project that can be delivered around a changing regulatory landscape. The scope and delivery plan can be amended based on any changes which are under continual review by our Agricultural Advisor and Catchment Management Programme Manager.
- Changes in legislation on pesticides in focus for this scheme. Regardless of any restrictions (metaldehyde only) on future use, the impact on water quality of other pesticides used in the catchment will remain for much, if not all of AMP7. The project scope can be re-evaluated based on the outcomes of future legislative reviews, but will focus on key diffuse pollution risks which will remain/change in future.
- Effects of climate change resulting in greater diffuse pollution challenges. The preferred option has been developed on the assumption that climate change affects will exacerbate current diffuse pollution risks and produce new risks yet to be identified. The Payment for Ecosystem Services approach can be tailored to mitigate the current and future risks brought about by climate change.
- Farmers not willing to participate in our proposed schemes. The lessons learned from the AMP6 schemes including suitable incentive mechanisms to gain the highest level of participation from farmers have been evaluated. Each year in AMP6, post season surveys have been carried out with farmers to determine barriers and incentives to participation. This feedback informs the development of these schemes to ensure that the highest possible number of farmers could be encouraged to participate in future pesticide reduction schemes.

6 Procurement Strategy

This project will be delivered primarily by in-house expertise through the Catchment Management team. Where specialist agricultural expertise and/or specific local knowledge of high risk catchments is required then the preferred option will seek to appoint specialist agricultural consultants to deliver aspects of the project and provide administration services for the farmer incentive payments.

The preferred option will also seek specialist consultancy services for such aspects as remote sensing, machinery calibration and testing, training (e.g. pesticide applicator training) and pesticide amnesties.

As this builds on work undertaken in AMP6, suitable suppliers have been trialled and identified for different aspects of the pesticide reduction schemes. Many of these are already on the Approved Suppliers list and subject to consultancy services agreements. Where required, a framework contract can be implemented based on the size and scale of the aspects of delivery proposed. These are not in place currently, but can be implemented in advance of AMP7 based on the preferred option being accepted to ensure that no time is lost for delivery at the start of AMP7.

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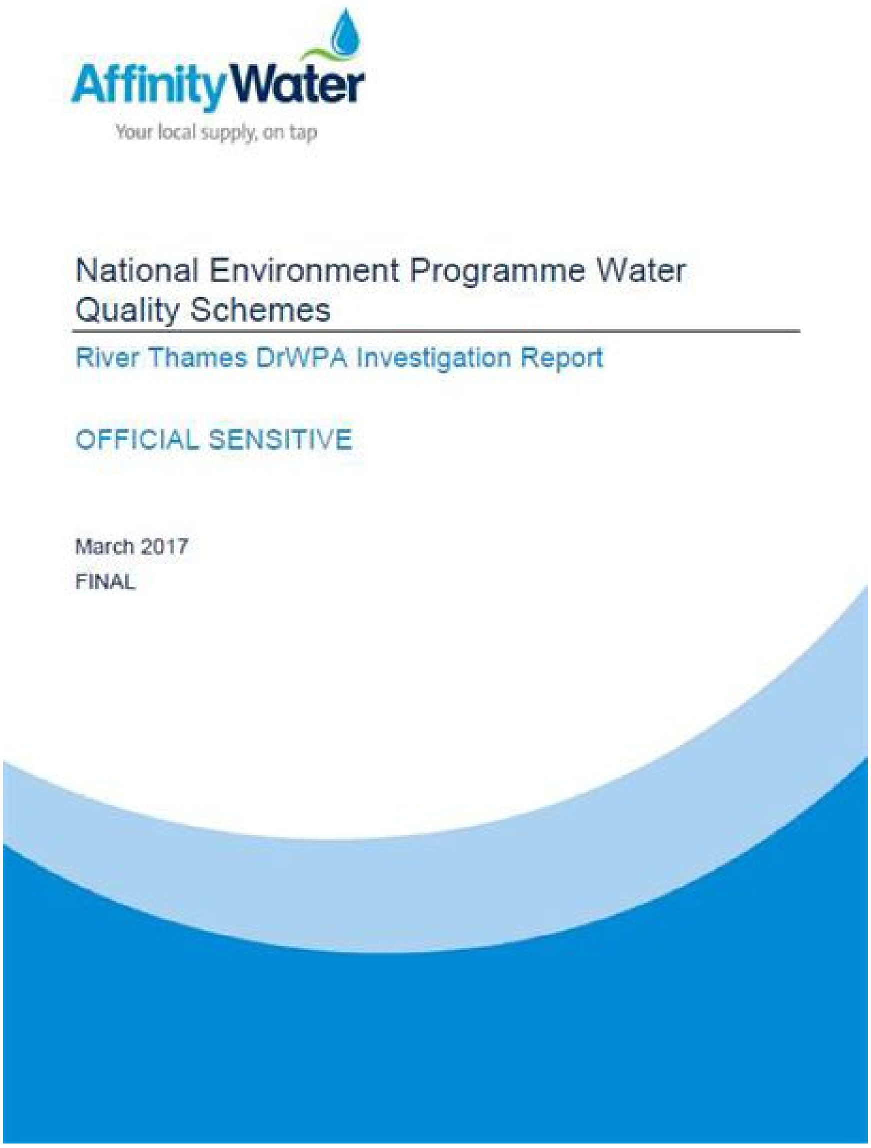
Appendices

7 Appendices

7.1 Appendix 1: National Environment Programme Water Quality Schemes: River Thames DrWPA Pesticides Investigation Report 2017

****** The Contents Pages and Executive Summary has been included below. The whole report can be made available on request ******



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National Environment Programme Water Quality Schemes

River Thames DrWPA Investigation Report

OFFICIAL SENSITIVE

March 2017

FINAL

Asset Strategy document control sheet

Document amendment history

Version	Status	Date	Amendment to this version
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NEP Water Quality Schemes:
River Thames DrWPA Investigation Report 2017

OFFICIAL SENSITIVE

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1 Executive Summary

Our catchment management for water quality programme has been established to investigate and deliver catchment based interventions to improve raw water quality. The programme also supports Affinity Water's obligations under Article 7 of the Water Framework Directive (WFD) delivered through the National Environment Programme for Water Quality (NEP WQ). The investigations and measures undertaken within these schemes for metaldehyde will also deliver the obligations set out in the Undertakings for metaldehyde agreed with the Drinking Water Inspectorate (DWI).

In 2015, we agreed a programme of fourteen NEP WQ investigations (DrW2) with the Environment Agency (EA), primarily focused on pesticides and nitrate. In addition, we had three Drinking Water Protected Area (DrWPA) schemes (DrW1) to deliver catchment interventions for metaldehyde for North Mymms, River Thames (covering our four River Thames abstractions) and Ardleigh (delivered by Anglian Water with co-funding and support from Affinity Water). Phase 5 of the NEP programme (NEP5) was issued by the EA on 29 January 2016 which included two additional sources for DrW2 investigations, Chartridge and Broome, which had been affected by nitrate following the flooding experienced across our regions in early 2014.

This report details the outcomes of our NEP WQ investigation agreed in NEP5 for the River Thames DrWPA (Lower Thames) and details our plans for the remainder of AMP6 (2017 – 2020). A review and appraisal of the substances considered 'at risk' in AMP5 is included with a recommendation on a revised list for the remainder of AMP6. This review and proposal forms provides the foundation for our PR19 options appraisal for developing catchment schemes in AMP7. This report also provides a progress update for the River Thames DrWPA metaldehyde schemes covering activities undertaken between 1 April 2016 and 31 March 2017.

Over the course of the past seven years we have gained substantial experience and understanding from these projects. There have been some successes, with water quality improvements reported for metaldehyde at the local sub-catchment scale. There is no 'one size fits all' approach for catchment management, but in most cases intensive one to one engagement is required with large numbers of landowners across catchment areas. It is apparent from results to date that changes in behaviour are required at a much larger scale than the sub-catchment in order to improve water quality at abstraction points.

The challenge during the remainder of AMP6 and beyond 2020 is in scaling up those methods that have been proven to work on a smaller scale and meeting the resourcing requirements. Because a high level of intensive and repeat engagement is required for voluntary schemes to be successful, additional financial and personnel resources will be needed plus commitments from other stakeholders that are key in assisting water companies to deliver their catchment management projects. Due to the extent of work required, the current voluntary/Safeguard Zone approach will not be sufficient to deliver the water quality improvements required in the specified timeframe.

Ultimately, regulatory mechanisms will be needed alongside the voluntary approach to ensure WFD outcomes are achieved.

2 River Thames DrWPA Investigation and DrWPA Catchment Management

Name of Water Treatment Works / Service Reservoir / Distribution System / Other Asset	Iver WTW; Egham WTW; Chertsey WTW and Walton WTW
Water quality hazard/drivers identified:	Pesticides
Catchment Investigation (DrW2)	Thames DrWPA Investigation DrW2: 6TWD10002a
Catchment Plan (DrW1)	Thames DrWPA Catchment Plan (metaldehyde) DrW1: 6AFD100018 DWI reference: AFW3325
Safeguard Zone ID	SWSGZ4015 (Wey) SWSGZ4016 (Thames)

2.1 Overview

The Thames River Basin District (RBD) covers over 11,000km^2 across south east and west England upstream of our Iver, Egham, Chertsey and Walton water treatment works (WTWs). All four WTWs abstract directly from the River Thames in West London and are susceptible to upstream pollution diffuse and point source pollution risks. Eighteen major river catchments flow into the Thames with thirty-eight major tributaries which includes drainage and waste water from sixteen cities and key towns.

This section of the report covers three main reporting requirements:

- Review of the Surface Water Drinking Protected Area (DrWPA) risk status
- Final report on our DrW2 Thames DrWPA Catchment Investigation
- Progress against agreed measures defined in DrW1Thames DrWPA Catchment Plan

The Thames DrWPA Investigation and Catchment Plan are being delivered in partnership by Affinity Water (AW), Thames Water (TW) and South East Water (SEW). Each company agreed to take the lead in high risk catchments identified during AMP5. This report will focus on the investigations and measures undertaken by AW in the following catchments:

- River Loddon
- Lower River Wey (downstream of Shalford WTW)
- River Colne (Hertfordshire)

2.2 Joint statement – River Thames DrWPA: Affinity Water, South East Water and Thames Water

Three water companies abstract water from the River Thames: Thames Water, Affinity Water and South East Water. In September 2010 we set up the TCMSG, to work collaboratively to investigate and identify interventions to reduce the impact of diffuse metaldehyde pollution. In AMP6 the remit has been extended to also include other pesticides and water quality issues as part of the NEP. The purpose of the partnership is to share data, evidence and information, coordinate work, avoid duplication, standardise target setting, share experiences and knowledge from engagement with farmers and agronomists, and support the EA with Water Framework Directive (WFD) delivery.

The steering group meets monthly to discuss progress with projects and how we can work together most efficiently. The group has worked to ensure that each company can lead on delivering catchment management in different areas of the Thames RBD. This ensures that overlap is minimised and company resources can be effectively deployed.

Thames Water has responsibility for delivering catchment management across the Upper Thames RBD as far as Maidenhead and in the Mole and Lee and upper Wey sub-catchments downstream (Figure 1). South East Water manages delivery in the lower Thames catchment (Maidenhead to Egham) and associated minor tributaries. Affinity Water has responsibility for the Colne (Hertfordshire), Loddon and lower Wey sub-catchments. Where overlap occurs, the companies work closely to share data and information on existing useful farmer contacts to ensure that water company/farmer liaison is managed as appropriately as possible.

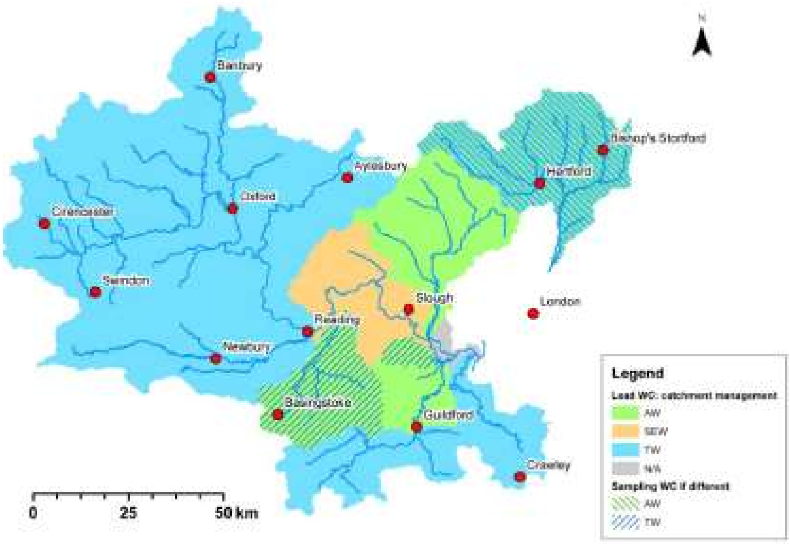


Figure 1: Map showing broad areas of responsibility for catchment management, as shared out between the three companies

Where a different water company is taking responsibility for sampling, this is shown with hatching. It should be noted that not all areas will actually require active catchment management; some remain a watching brief or have been identified as low risk.

Alongside allocating responsibility for catchment management in different areas, we have developed a coordinated river sampling strategy across the Thames RBD and are sharing the data (as shown in the above map). This arrangement minimises the travelling undertaken by personnel from both companies involved (i.e. Thames Water and Affinity Water). In addition, the three companies are working collaboratively on various projects; examples include:

- Thames Water and Affinity Water sharing the costs and results of a remote sensing exercise in the Wey catchment;
- All three companies sharing the cost of a satellite remote sensing project covering the lower Thames, Chertsey Bourne, Addlestone Bourne and parts of the Colne catchment;
- South East Water carrying out monitoring and catchment management activities on behalf of all three water companies in the lower Thames region;
- Affinity Water and South East Water, along with Natural England, jointly funding an advisor from the Hampshire and Isle of Wight Wildlife Trust to support projects in the Loddon catchment.

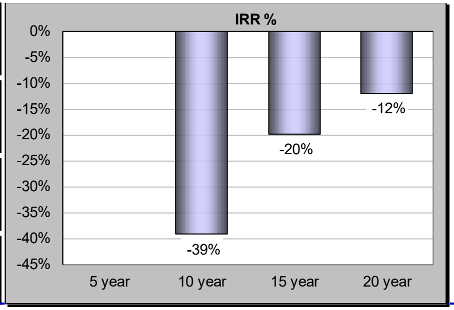
The TCMSG holds annual stakeholder events. Attendees over the years have included the DWI, EA, Catchment Sensitive Farming, National Farmers Union, Chemical Regulations Division, wildlife trusts, farm advice groups, pesticide manufacturers and agronomists.

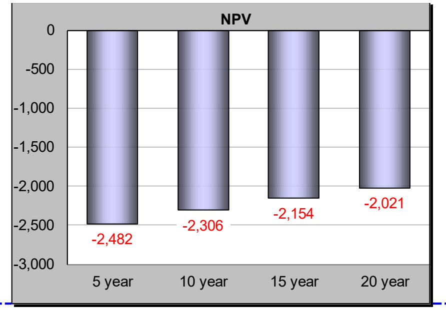
The primary aim of our project work to date has been to trial a number of different mitigation methods for metaldehyde, establish the efficacy of each approach and provide farmers and other catchment stakeholders with a variety of catchment management tools. Projects have investigated the impact on water quality of low dose metaldehyde slug pellets; product substitution (i.e. ferric phosphate pellets) across entire catchments; product substitution on high-risk fields only; Biofilters and swales. We have also developed relationships with a wide range of catchment stakeholders and carried out a number of awareness raising activities.

7.2 Appendix 4: NPV assessment summary

***** Detailed NPV assessment spreadsheet can be made available on request *****

5 year		
Financial internal rate of return (IRR)	%	
Financial net present value (NPV)	£'000	-2,482
10 year		
Financial internal rate of return (IRR)	%	-39%
Financial net present value (NPV)	£'000	-2,306
15 year		
Financial internal rate of return (IRR)	%	-20%
Financial net present value (NPV)	£'000	-2,154
20 year		
Financial internal rate of return (IRR)	%	-12%
Financial net present value (NPV)	£'000	-2,021





POSITIVE NPV IN YEAR: **20**

3.1 ASSUMPTIONS, DATA AND CONFIDENCE LEVEL OF COST BENEFIT ANALYSIS (CBA)

Total revenue	**Confidence (%)**	**Method of Calculation**	**How can the benefits be monitored?**	**When?**	**Contact Person or Department**
- Real cash benefit					
<Insert benefit description>	<Insert %>	<Insert information>	<Insert information>	<Date>	<Insert information>
<Insert benefit description>	<Insert %>	<Insert information>	<Insert information>	<Date>	<Insert information>
<Insert benefit description>	<Insert %>	<Insert information>	<Insert information>	<Date>	<Insert information>
- Cost avoidance		**Method of Calculation**	**How can the cost avoidance be monitored?**	**When?**	**Contact Person or Department**
Drinking Water Safety - One off / occasional PCV failure (controlled response)	50%	Reduction in pesticide losses from agriculture leading to long term reduction in PCV leading long term reduction in PCV failures. Estimated at 10 per year at £530 per incident = £5,300	Water quality monitoring at the point of abstraction	ongoing	Alister Leggatt / Water Quality Services
Avoiding water import from Grafham resulting from pesticide pollution incident	50%	Cost of Grafham import minus avge unit cost of water per ML. Egham (70ML/d) used as example of WTW outage for 3 days following pesticide exceedances 226.56 - 41.4 per ML = 185.06. 70 ML/d (Egham) * 185.06 * 3 (days) = £38,862.6 example given in year 3 of AMP and estimated as a once a year event	Number of outages resulting from WQ failures from pesticides	ongoing	Alister Leggatt

7.3 Appendix 5: EA PR19 Driver Guidance: DrWPA Final

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PR19 Driver Guidance	
Driver Name: Drinking Water Protected Areas (DrWPA)	
Strategic Lead(s): Elinor Smith (surface water) and Helen Bray (groundwater)	
Applicable for function (please tick) : Water Quality ☒ Water Resources ☐ FBG ☐ Catchment Solutions available ☒ To check a box: right click select "properties" and then "checked"	
Date: 3 February 2017	**Version: FINAL**
Summary of driver objective	
This guidance is for drinking water protected areas, which includes safeguard zones and surface water drinking water protected areas (DrWPAs). Refer to the groundwater guidance for groundwater DrWPA good status requirements. This driver can be used on its own or in combination with other drivers and partnerships. Water companies should develop measures to reduce pollution that is reaching their abstractions, these are known as catchment measures and should be developed for safeguard zones. Water companies may wish to use innovative approaches to catchment management such as: • Reverse auctions for measures to reduce pollution - where by the lowest bid that achieves the outcome wins • Payments for the production of clean water and ecosystem services • Long-term agreements with farmers on farming practices, such as which crops are grown, what pesticides are used etc. • Emissions trading • Valuing natural capital In addition to this document, the Environment Agency (EA) and Drinking Water Inspectorate (DWI) will issue joint Periodic Review 19 (PR19) guidance on metaldehyde, once we have an agreed policy position. Additional guidance for groundwater schemes is available in the groundwater guidance.	
Driver code:	**Description**
DrWPA_ND	Catchment scheme actions and measures recommended by either previous investigations; or, actions for water companies identified in safeguard zone action plans to prevent WQ deterioration to avoid the need for additional treatment (WFD 'must do'): subject to cost effectiveness, sustainability and measurement of effectiveness. Some limited post-scheme appraisal can be included in the catchment management driver. Ongoing surveillance monitoring does not form part of the WINEP and falls into the company's ongoing, business as usual operations, such as catchment monitoring for water safety plans.
DrWPA_IMP	Catchment scheme actions and measures recommended by either previous investigations; or, actions for water companies identified in safeguard zone action plans; or actions identified through other water company work, to improve WQ to reduce the level of existing treatment: subject to cost benefit and sustainability including monitoring of effectiveness of the measures. Some limited post-scheme appraisal can be included in the catchment management driver. Ongoing surveillance monitoring does not form part of the WINEP and falls into the company's ongoing, business as usual operations, such as catchment monitoring for water safety plans.

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DrWPA_INV	Catchment investigations by water companies to fully characterise groundwater and surface water SgZs, undertake an options appraisal and identify and recommend measures for catchment schemes to include in the next AMP period and carry out a cost benefit/cost effectiveness analysis. Monitoring as part of the investigation to understand the issue and identify the action can be included.

Methodology for identifying measures

Who should develop DrWPA schemes for the WINEP?
Groundwater and IEP teams should lead on developing measures for their respective safeguard zones. We encourage them to work together with all area teams and water companies to develop schemes that have wider benefits.

What can be included in the WINEP?
Where a catchment investigation has taken place in PR14, we would not support the inclusion of a further investigation for the same substance in the same area in PR19. The outcomes of the PR14 investigations (and other previous investigations) should be used to inform the catchment improvement schemes proposed for PR19.

Water companies that need to continue catchment measures from previous AMP periods into AMP7 can do so. These will now be funded from their revenue/maintenance budgets and should be included in their business plans accordingly, therefore do not need to be included in the WINEP.

Water companies may suggest a second round of catchment investigation or measures for the same substances if circumstances have changed e.g. where the catchment approach has evolved and new types of measures are now being used, or to meet newly agreed policy objectives. In these instances careful consideration as to whether to support the inclusion of schemes in the WINEP is required.

For both investigations and measures, before any scheme is included in the WINEP a scope detailing the geographic area, substance(s) to be addressed and description of the work that will be carried out must be completed.

Note: Water companies are able to do work outside of the WINEP

Catchment Investigations
Catchment investigations should include investigations to identify what is causing water quality deterioration and an options appraisal, together with an assessment of the costs and benefits to identify the appropriate measures. This will enable water companies to identify cost effective measures to prevent deterioration and cost beneficial measures to reduce treatment. Investigations must not be in the same area for the same substance as in previous AMP cycles.

Catchment measures
The main objectives of the catchment measures for a surface DrWPA and both groundwater and surface water SgZs are to avoid deterioration in water quality and to avoid an increase in the level of water purification treatment (DrWPA_ND). A definition of additional treatment is provided at the end of this section). There is a long term aspiration to improve the environment such that the level of treatment can be reduced over time (DrWPA_IMP). Catchment measures must have clear and measurable outcomes. For groundwater, catchment measures will contribute to meeting good status objectives for the wider groundwater body. There are both good status objectives and protected area objective for groundwater DrWPAs. Groundwater SgZ target measures where they will have most benefit to an abstraction and primarily meet protected area objectives, but will also contribute to good status. Water companies can submit schemes outside of SgZs using the WFD good status driver.

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Where contaminated land (as defined in the Environmental Protection Act 1990 Part 2A) needs to be remediated to protect drinking water supplies, refer to the groundwater guidance.
Catchment measures can include feasibility studies and monitoring to better understand where to target measures, as well as implementing measures to improve water quality. Catchment measures can use the 'payments for ecosystems services' approach or other measures to control the source(s) or pathways of pollution. Catchment measures should also be linked to delivering wider social and environmental benefits and these should be included in any economic analysis.

Water companies should include schemes where an upstream waste water treatment works is causing a deterioration in water quality in a drinking water protected area which may lead to the need for additional purification treatment.

In order to determine which catchment measures are likely to be viable, water companies need to:

- Investigate the source(s) of pollution (this should include all sources such as agriculture, industry, domestic etc.) and understand the mechanisms for pollution to reach the abstraction (DrWPA_INV) i.e. understand the sources, pathways and receptors
- Identify measures and actions to reduce pollution,
- Demonstrate that proposed catchment measures are:
  a) More cost effective than alternatives, where measures are needed to prevent deterioration (DrWPA_ND)
  b) More cost beneficial than alternatives, when seeking to improve water quality to reduce treatment (DrWPA_IMP)
- Not disproportionately costly where they contribute to groundwater DrWPA good status requirements. Refer to the groundwater guidance for more information.

Cost effective catchment measures need to be identified and implemented to prevent deterioration in water bodies and avoid the need for additional treatment. i.e. meet no deterioration objectives. Before proposing an increase in drinking water treatment, all water companies should implement cost effective measures to prevent deterioration. Cost effectiveness is used here as this is considered a 'must do' requirement, so measures must be implemented, but this should be the lowest cost package of measures needed to prevent deterioration and avoid the need for additional treatment.

Cost beneficial measures can be implemented where the water company seeks to improve water quality to reduce treatment.
Where a water company seeks to reduce treatment levels they must consider whether it would be cost-beneficial to develop catchment measures, rather than using treatment. Reducing treatment will provide a longer term more sustainable approach to producing wholesome drinking water. In these cases the EA will consider whether a catchment improvement scheme can be included in the WINEP for improving water quality in DrWPAs that are not 'at risk' and do not have a SgZ. Cost benefit is used here as this is considered a longer term ambition and not a 'must do', so there is a need to demonstrate that the measures are cheaper than using treatment. If the benefits do not outweigh the costs then these measures may not go ahead. Any measures proposed by water companies will also need to be supported by Customer Challenge Groups.

Measures for DrWPA must be supported by an economic analysis that values the wider benefits, such as reduced flood risk, habitat improvement, reduced CO_2 and reduced waste, as well as the direct benefits, such as the reduced capital and operational costs of treatment. These economic analyses and detailed scopes of exactly what works will be done must be shared with the EA before inclusion in the NEP. This is to quantify the total overall investment for drinking water protection, and ensure that there is a mutual understanding of what will be delivered.

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A framework for assessing the benefits of catchment schemes is provided by UKWIR *Quantifying the Benefits of Water Quality Catchment Management Initiatives*. For those schemes that involve contaminated land remediation further guidance is available in the statutory guidance and groundwater PR19 guidance.

Where a proposed scheme is a catchment scheme linked to a DWI legal instrument (Undertaking or Notice) water companies should clearly identify both the DWI Undertaking reference and the EA WINEP unique identifier in any submissions to the EA or DWI. The DWI and EA will share information on proposals submitted by water companies. This will prevent any duplication of schemes in submissions to Ofwat.

Level of confidence required and associated evidence levels

The Environment Agency will use a weight of evidence approach and work with Natural England, local councils and the Drinking Water Inspectorate to share information on proposals as appropriate.

To support inclusion of catchment measures in PR19, the following can be used:

- Evidence of an environmentally significant upward trend at an abstraction point, caused by anthropogenic activities;
- Evidence of a potential or actual water quality standard failure caused by anthropogenic activity;
- Poor DrWPA status for groundwater bodies
- Other evidence of water quality deterioration;
- Land use characteristics in the catchment
- Catchment risk assessment;
- Source-pathway-receptor linkages;
- Source apportionment;
- SgZ action plans;
- Future treatment requirements i.e. what's the risk of future treatment being required, when will treatment be required and to what level;
- Evidence of the wider ecosystem benefits the catchment measure could bring, e.g. recreation and eco-tourism, health benefits;
- Evidence that this is a less expensive way to achieve Article 7 than end of pipe alternatives (i.e. measure cost effectiveness).

Where a contaminated land site is affecting a drinking water supply, we will work with the water company to determine the level of confidence needed for remediation.

All measures need to be location specific, have clear outcomes and delivery timescales, and be supported by a holistic economic analysis (i.e. looking beyond the private sector to include environmental and societal costs and benefits). Area teams in the EA should work with water undertakers to develop SMART measures, including wider partnerships where there are opportunities for co funding.

NB: The DWI requires all proposals for drinking water quality measures to be supported with risk assessments (as required under Regulations 27 and 28 of the Water Supply (Water Quality) Regulations 2000 (amended), and the Welsh equivalent.

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Environmental outcome measure
In order to understand how these schemes protect our drinking waters it is important to understand the outcomes achieved. For drinking waters the schemes should identify: • the geographical area of land where measures are targeted and improvements achieved (km^2) • the length of river improved/no longer deteriorating from point of intervention to abstraction (km) • the area of lake/reservoir improved/no longer deteriorating (km^2) • the volume of water abstracted improved (m^3/d) • the number of people served where there has been an improvement • the number of Water Supply Zones where there has been an improvement • the cost savings achieved through improvements
Costing & Economics
• Cost effectiveness should be used where seeking to prevent deterioration to avoid the need for additional treatment. This is because no deterioration is a must do under WFD. • Cost benefit should be used where seeking to improve water quality to reduce treatment, as there must be a good case to state why it is better to invest in catchment management rather than continue with treatment. • Refer to the groundwater guidance for drinking water protected area good status, no deterioration and contaminated land measures in groundwater.
Links to technical documents/guidance
Legislative overview and technical detail Article 7.3 of the Water Framework Directive requires Member States to ensure the necessary protection for the bodies of water identified as DrWPAs. This is with the aim of preventing deterioration in water quality, to avoid an increase in the level of purification treatment required to produce drinking water, and over time seeking a reduction in the level of purification treatment required. There is a requirement to meet good status for groundwater DrWPAs as well as meet the Article 7 protected area objectives. Safeguard zones have been identified where any of these situations apply: • where there is a risk or actual deterioration of water quality • where the level of purification treatment may need to be increased • where treatment has increased since 2007/8 baseline For safeguard zones, a risk of deterioration means there is is a failure to meet good status or trend objectives (groundwater only), a need to increase treatment, ongoing WQ deterioration, a rising trend in anthropogenic pollution or where risk has already/will materialise 2015. For groundwater where a trend has materialised by 2015 measure must be put in place to reverse the trend. Catchment measures can provide cost effective alternatives to treatment, improve water companies deployable output and may provide wider benefits such as: • reduced energy consumption and treatment costs • reduced waste streams • reduced traffic movements associated with the treatment and waste • reduced carbon dioxide emissions/ increased carbon capture and storage • flood risk mitigation

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- improved ecology
- wider improvements/increases in ecosystem services

We will support catchment measures developed by water companies or as part of local partnerships to meet the requirements of Article 7.3. DrWPA objectives. These may include existing catchment schemes that were initially developed for other purposes, such as flood mitigation or ecological benefits, or new catchment measures. Further guidance on understanding the benefits of catchment measures can be found in UKWIR report 'Quantifying the benefits of water quality catchment management initiatives'.

A collaborative approach between the EA, DWI, water companies and third parties is needed to achieve improvements in water quality in DrWPAs and SgZs. Achievements cannot be made solely by one organisation.

Listed below are the most relevant support documents relating to DrWPAs and SgZs. These contain the current criteria for deciding when there is a significant upward trend at an abstraction; and roles and obligations for Water Companies and internal EA who are developing DrWPA/SgZ Action Plans or working with water companies to identify PR19 measures.

Internal EA guidance on groundwater and surface water DrWPAs and SgZs
Joint DWI/EA PR19 guidance on metaldehyde (not yet written and published)
Directive 2000/60/EC - Article 7
Common Implementation Strategy Document 16: Guidance on Groundwater in Drinking Water Protected Areas
UKTAG guidance - Assessing the achievement of Drinking Water Protected Area objectives
DEFRA - Statement of Obligations
Guidance on Water Company Safety Plans
The Contribution of the Water Supply (Water Quality) Regulations to the implementation of the Water Framework Directive in England & Wales
Joint Guidance on Contribution of Water Supply (Water Quality) Regulations to Water Framework Directive
Groundwater Chemical Status Assessment (Classification) and Trend assessment Method Statements
Existing water company schemes - SCaMP & Managing Water, Managing Land

Other considerations

Link to other Drivers
Prevent deterioration for surface water
Groundwater for achieving good status, preventing deterioration and contaminated land management
Biodiversity: Seeking wider benefits
Flood risk
Climate change

DWI Position
The level of treatment required to supply drinking water from any given source is based on the level of pollution in the source. Water companies are required carry out risk assessments of all their water supply systems, from source to tap, as part of a drinking water safety planning approach to ensure that consumers are supplied with wholesome water. Where a deterioration in raw water quality has been identified that presents a risk to consumers (for example the existing treatment process is not designed to deal with the type or level of contaminant), water companies should investigate the cause of deterioration and actions required to protect consumers. This should include investigations in the catchment and, where feasible, implementing actions to reduce the level of pollution entering the source. In some situations catchment actions alone may be insufficient to reduce the risk to

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consumers to an acceptable (or tolerable) level (i.e. to achieve compliance with a standard or to protect public health) and additional measures (including treatment) may be required to protect consumers. The DWI has statutory powers to put in place legal instruments which establish legally binding commitments on companies to implement all the actions required to protect consumers.

Definition of additional treatment

Additional treatment includes all of the following situations where there is clear evidence that they are a result of deterioration in raw water quality:

- The construction and operation of a new treatment plant;
- The development of a blending scheme (new boreholes or new pipelines);
- The change in blending ratio of an existing scheme;
- Increased use of chemicals in an existing plant;
- Increased workload on an existing plant;
- Additional modular treatment at an existing plant;
- The early replacement of an existing treatment plant;
- An increase in the frequency of carbon regeneration;
- A move from duty/standby to duty/assist status of existing plant; and
- A significant refurbishment and/or up-rating of an existing plant.

Multiple benefits from schemes for other drivers should be considered in any economic analysis. This will help ensure that the most benefit is being achieved with the money being invested. Where multiple benefits are achieved for other drivers, these drivers should be included in the NEP. All drivers where there are benefits should be recorded.

In reference to the government supported salmon 5 point plan, we believe that this driver could in part make a likely contribution to the recovery of salmon stock. More information on the salmon 5 point plan, including GIS shapefiles and maps etc. is available via your FBG NEP lead or from this link

O:\PR19 GENERAL\Strategy\EA\06 FBG Sub Group\Salmon 5PP information for NEP planners

Linked to outstanding policy decision (please tick)

Environment Agency ☐ DEFRA ☒for metaldehyde Ofwat ☐

External Organsiation Consultation:

DEFRA ☒ Ofwat ☐ DWI ☒ NE ☒

Other:

7.4 Appendix 6: Guidance Note: Long term planning for the quality of drinking water supplies Drinking Water Inspectorate Guidance to water companies

***** The catchment management section of this document has been included below. The rest of the guidance can be made available on request *****

Drinking Water Inspectorate
Guidance to water companies

dwi

Guidance Note: Long term planning for the quality of drinking water supplies

UNCONTROLLED IF PRINTED
LTP VERSION 01

Issue date: September 2017
Page 1 of 23

GUIDANCE NOTE ON LONG TERM PLANNING FOR THE QUALITY OF DRINKING WATER SUPPLIES

1. Purpose

1.1. The purpose of this Guidance Note is to provide water companies and other stakeholders with guidance on long term planning for the quality of drinking water supplies.

1.2. This long term planning guidance note is not intended to be a comprehensive review of water supply practice. There are no new policy initiatives set out herein, and no new legal obligations. The focus is on delivery of existing obligations, including recent and imminent legislative changes, using current good practice within a long term planning context.

1.3. The guidance note also provides advice on how the Inspectorate might assist companies in the periodic review process for setting of prices, led by Ofwat, including details of arrangements for information submissions to the Inspectorate; the Inspectorate's assessment processes; and a timeline for supporting current expectations of PR19 requirements. It takes account of current draft Ministerial guidance to Ofwat on strategic priorities and objectives from both the Welsh Government and the UK Government.

1.4. We will update this document as necessary to take account of developments in legislation, policy and industry good practice and future periodic reviews. The Inspectorate welcomes comments on the document, including suggestions for areas or matters not currently included.

1.5. The regulatory framework that sets the context for this Guidance Note is summarised in our Guidance on the Regulations: Introduction to the Public Water Supply Regulations in England and Wales.

2. Content summary

3. Principles of approach

3.1 The Inspectorate expects all water companies to take a source to tap approach to manage their water supplies to protect the health of their consumers, and maintain consumer confidence in the supply and services provided. Central to achieving these objectives is the mandatory use of drinking water safety plans. This is current national and international good practice for water supply management.

3.2 The delivery of this approach should be efficient and sustainable, and contribute to a lasting legacy of long term benefit for both the company and its consumers. To have legitimacy, and to gain the support of the Inspectorate, this approach needs to be transparent about short and long term investment requirements, for current consumers and future generations.

3.3 For all aspects of planning, whether for event management, drought management, water resource management, maintenance management or operations management, it is a fundamental requirement that drinking water quality is always central to, and accounted for, in all cost benefit assessments of options considered. It is expected that companies will always plan to meet their statutory obligations for drinking water quality.

3.4 The sustainability and resilience of the quality of supplies are important for services to consumers, and need to be an integral part of all planning and delivery functions of a company. It is expected that companies will plan for their needs from a stewardship perspective across generations of consumers. To do so, companies will need to foster and develop their supply chain to facilitate and retain the knowledge and skills that are the bedrock for building efficient and innovative solutions and service. In respect of routine operational resilience, it is expected that every company will proactively plan for the containment and recovery from potential events that might otherwise impact on consumers, with a view to maintaining levels of drinking water quality protection, confidence, acceptability and service.

3.5 Given the relative stability of the legislative framework for the quality of drinking water supplies, and the consistency of approach over time, the Inspectorate expects that

companies' operations and maintenance arrangements should consistently, proactively and sustainably meet all statutory obligations, while addressing any localised changes to risk profiles as happen from time to time, using established risk assessment reporting processes. We believe that this is at the heart of the relationship between a water company and its consumers, underpinned by the embedded company culture and staff behaviours that support the daily endeavour necessary to maintain a level of quality and service that meets consumers' expectations, and is how problems are dealt with when they arise. By its activities over time, the company demonstrates its trustworthiness, to gain the trust and confidence of its consumers.

3.6 References in this Guidance Note to the Act and the Regulations are to the Water Industry Act 1991 (and updates/amendments), and the Water Supply (Water Quality) Regulations 2016 for England and the Water Supply (Water Quality) Regulations 2010 (as amended) for Wales. Links to these and other relevant key legislation can be found here .

4. Broad considerations in planning for the long term

4.1 Risk assessments

4.1.1 It is mandatory for water companies to carry out risk assessments of all of their water supply systems, from source to tap, adopting a drinking water safety plan approach. The risk assessment reports subsequently submitted to the Inspectorate should identify the hazard (or partially mitigated hazard) and any associated parameters; evidence that the cause of the hazard has been identified and confirmed; and the range of options for mitigation considered including, where appropriate, catchment management measures. There must also be a clear statement of how the benefits delivered by the actions will be measured (to include the scope, frequency and location of monitoring).

4.1.2 Companies are required to keep under review, their risk assessments for all of their water supplies, and to report updates to the Inspectorate. In doing so, they should have regard to any learning from events or near misses that is circulated by the Inspectorate or companies from time to time.

4.1.3 If a regulatory risk assessment identifies clear actual or potentially significant risks, the company must manage and mitigate the risks from the hazard in a timely, effective and efficient manner to the benefit of consumers. The Inspectorate may consider putting in place a legal instrument to ensure that desired outcomes are achieved.

4.2 Catchment management

4.2.1 Catchment management schemes have been widely used by water companies to address both point source and diffuse pollution, such as nitrate and pesticides. There are many benefits to catchment management approaches that address pollution at source: such schemes benefit the wider water environment; reduce the need for, or burden on, water treatment facilities; and provide sustainable, long-term, cost effective solutions. They remain the first consideration of all source to tap risk assessments to reduce risks prior to treatment and ultimately mitigate all significant risks to public health, wholesomeness and acceptability of water supplies

4.2.2 The Inspectorate has actively promoted catchment management approaches for many years, including incorporating their use in legal instruments arising from compliance failures, or identified risks.

4.2.3 The likelihood of success of catchment management measures varies depending on the nature of the parameter, the size and nature of the catchment, the origin of the pollution and other factors. Therefore, individual proposals will be assessed on their merits.

4.2.4 The accumulation of catchment management improvements gained from a multiplicity of proactive integrated solutions (such as stakeholder engagement at both national and local levels; pollution control; raw water management; abstraction control; and raw and/or treated water blending) may negate or delay the need for, new and/or upgraded treatment processes. In addition catchment management offers protection of the quality of water supplies.

4.2.5 For such solutions to be effective and sustainable, they require the commitment of significant resources and multiple interactions over a prolonged period by companies, and often require the co-ordination of outputs to be delivered by various third parties. Although control of the hazard at source is always the primary objective, where catchment management solutions are specified, we recognise that the full delivery of outcomes via catchment management measures may be uncertain, or may prolong the period before benefits accrue to consumers. To ensure that a legal instrument is fit for purpose, the Inspectorate will need to understand these constraints, and the other actions that the company may need to take, or to make provision for, to supplement its catchment management activities, including the relative contribution of catchment management activities to outcome delivery; the potential impact on priorities; the timescale for completion; and the arrangements for programme recovery, if needed.

4.2.6 The Inspectorate will continue to pursue this policy, and will encourage companies to routinely incorporate catchment management solutions as a fundamental part of their source to tap management of their water supplies. This approach is consistent with wider environmental considerations, including delivery of the provisions of the Water Framework Directive (WFD), Article 7. We will support companies, working with the stakeholders and Regulators involved, to find and implement the most cost effective, efficient and sustainable solutions to deliver the required outcomes. We will continue to work with other Regulators to facilitate the scope and specification of catchment solutions where there are synergies with environmental drivers, and we expect companies to liaise with their local environmental Regulator representatives on the development of their catchment management solutions.

4.2.7 Whilst the most significant catchment management schemes, from a drinking water quality perspective, will continue to be incorporated within legal instruments, we expect companies to routinely engage in proactive catchment management activity as a matter of good practice for all of their water supplies.

4.3 Resource and supply management

4.3.1 The Inspectorate expects water companies to meet their statutory obligations under section 68 of the Act, including, their duty to supply wholesome water.

7.5 Appendix 7: Business requirements to support options appraisal

7.5.1 Requirements Priority Matrix

Table 3 Requirements Priority Matrix

Designation	Explanation
Must	The solution will not be accepted if a requirement that has a priority of 'Must' has not been delivered.
Should	The requirement with a priority of 'Should' would provide business benefit, but the business would accept a solution where this requirement was not delivered e.g. the solution could be delivered by other projects/changes of working practice. If possible the solution should deliver these requirements.
Could	The requirement with a priority of 'Could' may provide some business benefit, but not as much as the requirements that have been prioritised as 'should' and 'must'. The business would accept a solution where this requirement was not delivered.
Won’t	Won't do this now but may wish to implement in the future.

7.5.2 Functional Requirements

Table 4 Functional Requirements

	Requirement Description	Rationale	Priority
1	Implement an enhanced combined programme of Thames RBD catchment monitoring of all "at risk" pesticides and agree with Thames Water and South East Water for implementation in August 2020. This will build on the existing combined programme of monitoring for metaldehyde currently implemented in AMP6	This combined programme of monitoring enables the TCMSG to identify priority areas to focus catchment management resources and targeted pesticide reduction schemes where the greatest water quality benefit can be derived	Must
2	Implement pesticide reduction schemes for "at risk" pesticides using PES methodology in high risk sub-catchments identified through catchment monitoring by Sept 2021	To incentivize farmers in high risk areas to implement best practice measures to reduce pesticides affecting raw water quality at the source to reduce the risk of breaches of the drinking water standard at the River Thames abstractions	Must
3	Develop a Payment for Ecosystem Services methodology and incentive mechanism with appropriate menu of measures identified through AMP6 investigations by Sept 2020	This methodology and mechanism can be applied to pesticide reduction schemes and utilized to ensure a high level of farmer participation in identified schemes	Must
4	Undertake detailed catchment characterization activities including remote sensing, crop identification, field-	To provide robust evidence to support the focusing of pesticide reduction schemes to ensure they are targeted in	Should

	scale risk mapping and catchment walkovers where required for "at risk" pesticides by May 2021. Assumption based on additional need where there are gaps from work carried out in AMP6	the right areas to achieve the greatest benefit	
5	Develop a Capital Grants scheme available to farmers in high risk areas for funding towards farm infrastructure improvements (e.g. pesticide handling areas) that will ultimately improve raw water quality or mitigate the risk of pollution events.	To further enhance pesticide reduction schemes and provide a greater assurance of risk mitigation for pesticide losses to raw water in high risk areas	Could
6	Undertake an annual Pesticide Amnesty in all high-risk catchments available to farmers to safely remove all banned, out of date and unwanted pesticides	Building on the pesticide amnesties trialled in AMP6 with the benefit of a) removing the risk of pesticides ending up in raw water and b) Providing a cost effective route for engagement farmers to encourage higher level of participation in pesticide reduction schemes	Could

7.5.3 Non-Functional Requirements

Table 5 Non-Functional Requirements

	Requirement Description	Rationale	Priority
1	Identify and procure specialist agricultural delivery partners through either consultancy services agreements of a framework to support delivery of the pesticide reduction schemes and associated catchment characterization activities by Sept 2020	To provide specialist expertise on implementing pesticide reduction schemes where we are unable to source this expertise in-house. Experience from AMP6 has identified suitable delivery partners and the value of identifying partners with experience with local farmer groups	Must
2	Agree catchment management approach to DrWPA schemes with the EA and ensure sign off of WINEP Catchment Measures Specification for agreed PR19 approach by Mar 2020	To agree the scope of activities to be delivered through the River Thames and Lower Wey DrWPA schemes under WINEP. Ensure this is aligned with agreed options funded under PR19 business plan	Must
3	Annual progress reporting in accordance with agreed reporting requirements with the EA (WINEP driver)	To ensure we meet the regulatory requirements of EA and DWI and provide ongoing progress reporting with benefits realization on effectiveness of the implemented programme of work	Must
4	Improvement in raw water quality	Potentially lower treatment costs through extending life of GAC between regeneration / changes	Should

Appendix AFW.CE.A1.7

Action ref AFW.CE.A1

Sustainability Reductions Brett Community (WRZ8)

Affinity Water
Your local supply, on tap

Sustainability Reductions – Brett Community (WRZ8)

PR19 Business Case

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March 2019

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Asset Strategy document control sheet

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Version	Status	Date	Amendment to this version
1.0	Final	03/09/2018	For issue with draft business plan
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Document approval

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e-Document location				
	Name	**Signature**	**Title**	**Date**
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1 Document Purpose

The purpose of the Project Business Case is to describe the reasons for the project and the justification for undertaking it, based on the estimated costs of the project, the expected business benefits, savings and risks.

The Business case will also present all the options that have been assessed to deliver the project outcome and will indicate the preferred option out of all considered.

During the project a Business Case is a major controlled document that is referenced on a regular basis to ensure and confirm that the project remains viable. It is maintained throughout the lifecycle of the project, being reviewed by key stakeholders at key decision points, i.e. at the end of a phase.

2 Executive Summary

Our revised draft Water Resources Management Plan (rdWRMP19) includes sustainability reductions of 36.31Ml/d (average) and 23.66Ml/d (peak) for delivery by December 2024. These reductions have been identified by the Environment Agency as being required to contribute towards Water Framework Directive objectives. Investment of £58million has been included in our PR19 business plan submission to deliver green and amber sustainability reductions, in accordance with the associated regulatory guidance.

This business case covers the investment required to enable implementation of the sustainability reductions in the Brett Community (Water Resource Zone 8) and maintain supplies to customers. It includes option development, risk assessment and cost benefit assessment undertaken to identify the best value option.

Four options were identified to enable delivery of the sustainability reduction with two options selected for detailed consideration. The replacement of galvanised iron communication pipes (Option 3) was identified as the best value option at a cost of £8,447,090. These costs have been included in our business plan submission under Environmental Enhancements. This business case will be reviewed and updated at key milestones throughout the life cycle of the project.

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8 Introduction

3.1 Background

Sustainability reductions are decreases in water company deployable output due to a sustainability change (licence change), which are identified as being required to improve river flow and ecology, to meet Water Framework Directive (WFD) objectives. Our revised draft Water Resources Management Plan (rdWRMP19) includes sustainability reductions of 36.31Ml/d (average) and 23.66Ml/d (peak) for delivery by December 2024.

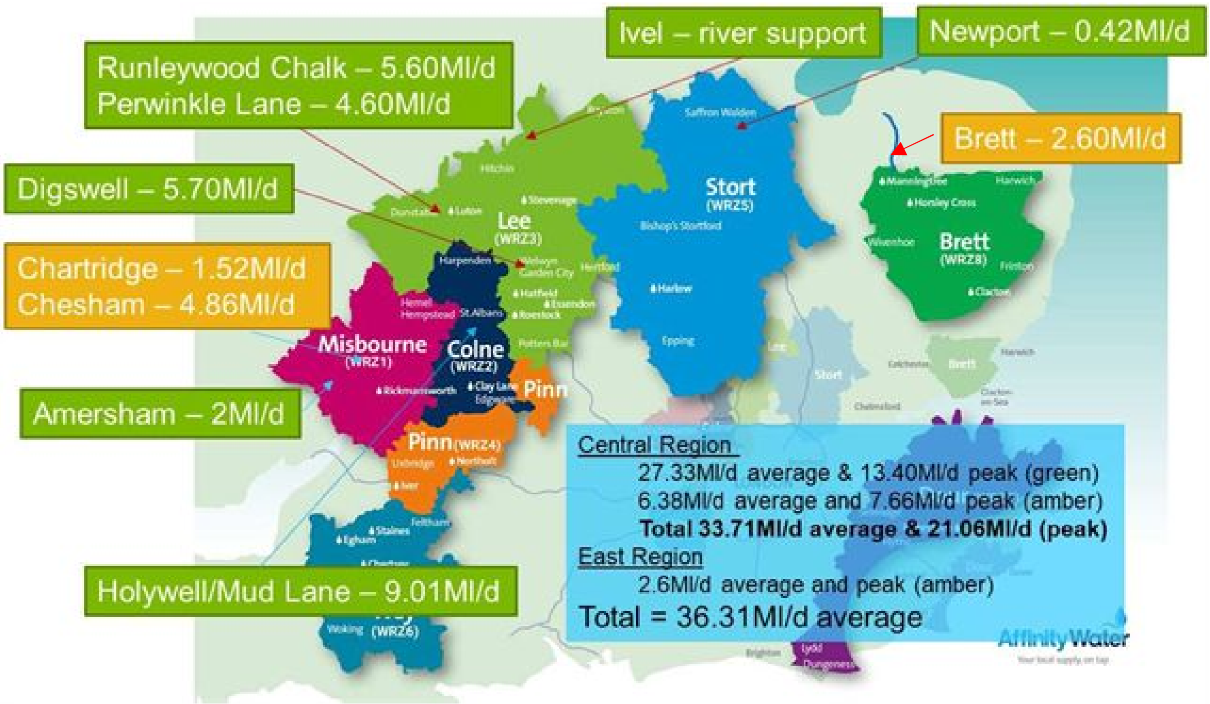

Figure 8 Location of sources subject to AMP7 sustainability reductions

The AMP7 sustainability reductions have been included in our Water Resources Management Plan and assessed the impact of a reduction in the Brett community on our supply demand balance. In addition to this we have used knowledge and information from Asset Strategy, Water Quality, Production and Community Operations to understand the need and identify options to maintain supplies to customers.

In our Brett community (WRZ8) a potential (amber - indicative) sustainability reduction of 2.6Ml/d was included on Water Industry National Environment Programme (WINEP) table from the Environment Agency (**WINEP ID code EAN00007**). This reduction has been included in our rdWRMP supply demand balance for implement by **December 2024**.

Across WRZ8 (Brett) options were identified to address the sustainability reduction and ensure customer supply is maintained following the AMP7 Sustainability Reductions. Two feasible options were taken forward for further assessment and are detailed in this report.

3.2 Drivers

3.2.1 Water Framework Directive

The Environment Agency (EA) has assigned the following Water Framework Directive (WFD) drivers to sustainability reductions in WRZ8, within their Water Industry National Environment Programme (WINEP).

Driver Code	Description
WFD_ND_WRFlow	Action to prevent deterioration of ecological status from flow pressures
WFD_IMP_WRFlow	Action to Improve hydrological regime to meet WFD objectives
WFD_NDINV_WRFlow	Action to investigate and undertake options appraisal for preventing deterioration of ecological status from flow pressures.

The EU WFD binds the UK as a whole to delivering its requirements and does not impose any legal obligations on water companies or the EA directly. The WFD is implemented in England and Wales by the Water Environment (Water Framework (England and Wales) Regulations 2017 (WFD Regs)). The WFD requires waterbodies to achieve good ecological status (GES) or potential (GEP).

Since 1990, a number of our abstraction licences have been identified by the EA to be potentially environmentally damaging. This has resulted in a series of environmental investigations and options appraisals (AMP2-6) through the Restoring Sustainable Abstraction (RSA) programme and National Environment Programme (NEP). The driver for these projects is a combination of WFD, Habitats Directive, Sites of Special Scientific Interest (SSSI) and local biodiversity drivers where there was considered to be the potential for impact on chalk streams, a biodiversity priority habitat.

3.2.2 Water Resources and Supply

The AMP7 sustainability reductions are included in our Water Resources Management Plan, which sets out how we will balance supply and demand over a 60-year planning horizon. We must ensure that we have adequate supplies to meet demand and maintain supplies to customers. In the Brett community we supply a population of 153,500 in 74,139 properties.

3.2.3 Customer Experience

We have listened to feedback from customers and stakeholders on our draft Water Resources Management Plan and included the Water Industry National Environment Programme (WINEP3) sustainability reductions in our plans. Feedback from our engagement indicates that 78% of our customers support us investing now to ensure there is sufficient water in future. We recognise the importance of sustainable abstraction and meeting the needs of customers and the environment. This business case supports delivery of our sustainability reductions whilst maintaining supplies to customers and communities.

3.3 Best Value Option

Option 1 – replacement of galavanised iron service pipes

This is the best value option as it mitigates the risk of discolouration as a result of bringing up to 13 Ml/d water from Ardleigh to our supply network, following a reversion to a 50:50 share of this resource with Anglian Water, as proposed in our dWRMP. Increasing the proportion of Ardleigh derived water into the Brett community will be required to maintain supply to customers and offset the sustainability reduction from our groundwater sources in the Brett catchment.

This option has been developed through engagement with internal stakeholders including Asset Strategy, Water Quality, Community Operations and Production. This option will require the replacement of an estimated 3,880 service pipes in the East Region by December 2024 (date by which the sustainability reductions are to be implemented). This will be done by systematically working across the area via a planned route, associated with customer communications with the areas identified at greatest risk first.

3.4 Costs Summary Table

	Y1	Y2	Y3	Y4	Y5	AMP7	20 Years
Costs (capex)	£520,000	£1,981,772	£1,981,772	£1,981,773	£1,981,773	£8,447,090	£8,447,090
Costs (opex)	£-	£-	£-	£-	£-	£-	£-
Risk	£52,000	£198,177	£198,177	£198,177	£198,177	£844,709	£844,709
Total costs (totex)	£520,000	£1,981,772	£1,981,772	£1,981,773	£1,981,773	£8,447,090	£8,447,090
Total revenue	£-	£-	£-	£-	£-	£-	£-
Funding requirement	£520,000	£1,981,772	£1,981,772	£1,981,773	£1,981,773	**£8,447,090**	£8,447,090
NPV (£k)						-£7,686,000	-£7,686,000

At this stage of option development we have detailed a 10% risk to all options for consistency but not included this figure within the options total funding required. We will seek to manage risk at a programme level across all projects and cover any risk funding requirement through the generation of efficiencies. These efficiencies will be generated through refinement during the life cycle of the programme, ensuring mitigation is included for all risk items and value engineering considered at key milestones. This approach reduces the total funding request across the AMP7 sustainability reductions programme by £5.84million.

3.5 Customer benefits and resilience benefits

The primary purpose of this investment is to ensure we **maintain supply of wholesome water to customers** following the implementation of the AMP7 sustainability reductions. There are a number of other additional benefits that will be realised through implementation of this work as follows:

Supply resilience - removing restrictions on area that can be supplied from Ardleigh derived water.

Reduced water quality risk – address corrosivity risk and monitor for metaldehyde.

Maintain security of supply following the implementation of the sustainability reductions.

Deliver regulatory expectations under the Water Industry National Environment Programme.

Contribute towards achieving **Water Framework Directive objectives**.

Improving our relationships with communities, customers and stakeholders through implementing the sustainability reductions and **demonstrating our commitment to the environment.**

The best value option **maintains supply resilience** and mitigating against operational incidents such as site failure and water quality. It will reduce the likelihood, duration and frequency of site shutdown due to turbidity, maintaining output to support the zone where other source reductions are to be made.

The importance our customers and stakeholders give to abstraction reductions is echoed in our bespoke **Performance Commitment relating to abstraction reduction** which this project will contribute towards.

The investment made in WRZ8 under the sustainability reductions programme is seeking only to **maintain supply to customers** in AMP7. We have consulted with colleagues preparing our plan for East region to capture links and any possible overlap. This assurance avoids double counting of options between sustainability reductions and other programmes so any opportunities/efficiencies are realise.

Innovation will be at the heart of delivering the preferred option as we seek to drive down costs and maximise benefits for both our customers and the environment. Associated to these reductions we are keen to ensure we continue to **improve our understanding of the chalk aquifer** and the relationship to river flows both pre and post reduction so future investment can be targeted in the correct areas. Furthering our understating of the chalk aquifer through monitoring and groundwater modeling, working with the EA, British Geological Survey and other stakeholders to achieve this. A continuation of our groundwater level, river flow and ecological monitoring pre and post reductions will allow us to fully understand benefits and use this knowledge to **inform future decision making**.

The Sustainability Reduction Programme drivers encourage us to think about how we can use our groundwater sources differently and to work with the new abstraction reform protocols to ensure the water we supply to customers is from more **sustainable** sources with **lower impacts upon the environment**.

The recommended best value option will also support achieving the target set out in the following performance commitment;

Performance Commitment Supported by this project

Bespoke and Legacy PC	Current Performance	Base Plan J	SWR Plan L	SOP Plan K	Stakeholders / Customers	Final
Abstraction Reduction (Ml/d)	n/a	10	39	10	36	36

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3.6 Methodology

The investment requirement has been identified and developed by our Asset Strategy team in collaboration with Production and Supply, Water Quality, Community Operations and Asset Delivery teams (Appendix 8.1)

1. Investigating and quantifying supply risk due to sustainability reductions in WRZ8, in combination with reductions in other zones. Initial risk workshop and discussions with internal stakeholders.

2. Identifying and optioneering solutions, systematically exploring options to identify opportunities with highest cost benefit. Options developed through engagement with stakeholders from Production, Operations Centre, Network, Water Quality, Leakage, Modelling, Trunk Mains and Mains Renewals, Asset Strategy and current AMP6 sustainability reductions programme team.

3. Further liaising with internal stakeholders through workshops to review proposed solutions and identify additional risks

4. Data was gathered from the company's systems to establish requirements. This includes, Asset Management Information System (AMIS), the corporate Geographic Information System (GIS) and water quality data. Engaged with contractor base for asset information and validation of costs for likely asset replacement/installation.

5. PIONEER scheme builder and the unit cost model have been used for estimations of costs. With regards to trunk mains, the current PR19 mains laying summary costs were used where possible.

Options have been developed using a standardised company process through the utilisation of Scheme Builder (a module of the PIONEER software tool). Scheme Builder allows us to cost the addition or modification of assets on a project basis for delivery purposes. The optimiser uses our asset data, deterioration curves, consequences and unit costs, to determine the optimal investment to meet a defined need.

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9 Defined Need and Dependencies

4.1 Defined need

Four of our groundwater sources within the River Brett catchment were included on WINEP3 with an indicative (amber) sustainability change of 2.6Ml/d. The River Brett is a heavily modified water body (EA Catchment Data Explorer) that has been identified by the EA as suffering serious damage. The Old River Brett is listed separately and is not listed as heavily modified. We undertook an investigation in AMP3 in collaboration with Anglian Water and Essex and Suffolk Water (ESW). This concluded that there was no direct link between groundwater abstraction from Shelley and Stoke-by-Nayland and river flows. The Brett was not included in our AMP6 NEP. As a consequence of this, there is no specific funding allocation to identify environmental impacts or evaluate options to address this in AMP6.

Recognising the short timescales for completing an investigation and options appraisal by 31 March 2021 (as directed by the EA) and the significant implication this could have on WRZ8, we have started work early to assess the effect of our abstraction on river flow and groundwater levels. We have commenced monitoring, drilled a number of new observation boreholes and undertaken signal testing. We will cross reference these findings with output from the regional groundwater model and continue to work collaboratively with EA colleagues, Anglian Water (AWS) and Essex and Suffolk Water.

As no detailed investigation has been completed since AMP3, there are uncertainties associated with the effect of our groundwater abstraction on river flows and hence the benefit of any reduction in abstraction would have on the River Brett. The EA have indicated that reductions of 15-20Ml/d could be required in the catchment to meet the calculated flow thresholds for the River Brett. We exchanged correspondence with the EA regarding the level of uncertainty over this volume and have included a cost adjustment mechanism in our business plan to account for this.

River Brett Catchment Sustainability Reductions

<table>
<tr><th rowspan="2">Source</th><th colspan="2">Current Licence</th><th colspan="2">WINEP3 Sustainability Change</th><th colspan="2">PR19 DO (1 in 200 drought)</th><th colspan="2">rdWRMP Modelled AMP7 Reduction</th><th colspan="2">Resultant DO</th></tr>
<tr><th>Ave (Ml/d)</th><th>Peak (Ml/d)</th><th>Ave (Ml/d)</th><th>Peak (Ml/d)</th><th>Ave (Ml/d)</th><th>Peak (Ml/d)</th><th>Ave (Ml/d</th><th>Peak (Ml/d)</th><th>Ave (Ml/d)</th><th>Peak (Ml/d)</th></tr>
<tr><td>Higham</td><td>6.50</td><td>10.00</td><td rowspan="4">2.60</td><td rowspan="4">2.60</td><td>5.02</td><td>6.88</td><td rowspan="4">2.60</td><td rowspan="4">2.60</td><td>5.02</td><td>6.88</td></tr>
<tr><td>Shelley</td><td>3.90</td><td>7.00</td><td>2.89</td><td>4.17</td><td>2.89</td><td>4.17</td></tr>
<tr><td>Lattinford</td><td>2.47</td><td>4.00</td><td>1.81</td><td>2.70</td><td>1.81</td><td>2.70</td></tr>
<tr><td>Stoke-by-Nayland</td><td>11.70</td><td>13.00</td><td>8.00</td><td>10.93</td><td>8.00</td><td>8.33</td></tr>
<tr><td>Total</td><td></td><td></td><td>2.60</td><td>2.60</td><td></td><td></td><td>2.60</td><td>2.60</td><td></td><td></td></tr>
</table>

In our dWRMP we have identified the need to revert to a 50:50 share of Ardleigh with Anglian Water in order to deliver the Brett sustainability reductions. This will allow us in future to bring up to 13 Ml/d of water from Ardleigh in our supply area. Under all scenarios Ardleigh water must move into areas that are currently fed by groundwater to resolve local supply demand imbalances caused by sustainable abstraction reductions from our Brett groundwater sources by December 2024.

The chemical composition of Ardleigh water is different to that of our own groundwater. Investment is therefore required to mitigate the discolouration, taste and odour risk. If no action is taken then there is a very high probability that customer water quality will deteriorate in the Groundwater Zone.

4.1.1 Identifying the risk

If a sustainability reduction at our Brett groundwater sources is implemented we will need to increase our utilisation of water from Ardleigh.

Through our on-going Drinking Water Safety Plan (DWSP) risk assessments we have identified the following risks for water input to our network from Ardleigh WTW: -

1. Discolouration, due to corrosion of galvanised iron supply pipes
2. Pesticides (in particular metaldehyde), largely due to agricultural diffuse pollution.

4.1.2 Asset Background Information

Water flows from our dedicated treated water reservoir at Ardleigh WTW to a pumping station which pumps direct to Elmstead Market service reservoir via a trunk main. Smaller pumps at Ardleigh draw a supply from that same pumping main for Dedham, which is supplied at a higher pressure. Elmstead Market reservoir is the first point of entry for the Ardleigh water into our network. See the schematic in Appendix 8.4 for further detail on the arrangement of the Ardleigh transfer.

Pumps draw a dedicated feed from Elmstead Market reservoir to supply the Wivenhoe area. The result is a water quality zone called the Surface Water zone that only receives Ardleigh derived water. Another set of pumps at Elmstead Market pump water in the direction of West Clacton service reservoir. This water is mixed with some water from Horsley Cross. Water flows past West Clacton reservoir and on into the town of Clacton. Water is also supplied to this area directly from Horsley Cross. Together these supply the water quality zone referred to as the Mixed Zone.

4.1.3 Water Chemistry

Water from Ardleigh WTW (a surface water treatment works) has a different chemical composition from the groundwater that is supplied to our customers in the Groundwater Zone of the Brett Community. A table showing this difference, particularly with respect to chloride, sulphate and alkalinity concentrations, can be found in Appendix 8.3. When it is necessary to increase the volume of water input from Ardleigh WTW in the short term (typically due to increased demand or operational incidents) the proportion of Ardleigh water in the network increases and takes on more characteristics of the surface water.

4.1.4 Impact

If we do not address the different chemistry of water from Ardleigh WTW, when we move this water into particular areas and towns in the Brett Community that are used to receiving chalk groundwater, it will result in discolouration of the water at customer taps, which in turn will result in complaints and customer contacts.

4.1.5 Discolouration

The chemical composition of Ardleigh derived water is different to the groundwater that comprises the bulk of our supply in the Brett Community. It is known that that the chemistry of these two waters are different and therefore we currently manage the network to avoid bringing Ardleigh water into areas where it is not commonly used.

Corrosive water is a term used to describe aggressive water that can dissolve materials with which it comes in contact. While aggressive water is usually not dangerous to consume by itself, it can cause serious drinking water quality problems by dissolving metals from metal distribution pipes and plumbing systems.

Corrosion in the water network affects pipe structural integrity. Heavy corrosion can increase the frequency of network disruptions such as bursts. It can also increase the rate of required mains renewal projects, thus incurring significant capital and operational expenditure. Corrosion also affects leakage, which then directly affects Water Available for Use (WAFU), and the quality of service that our customers receive. Corrosive water can impact the inside of properties too, causing damage to pipework and fittings made from copper or lead, and increasing concentrations of these dissolved metals. This can lead to discolouration issues and customer complaints in areas with galvanised iron service pipes.

There is a need to **remove the risk of discolouration** due to corrosion.

4.1.6 Pesticides

While high concentrations of metaldehyde have been measured historically in the final water from Ardleigh WTW (see Appendix 8.3.3), since the 2012-13 season the final water has only exceed the 0.1µg/l Prescribed Concentration or Value (PCV) during a single event. This event lasted from approximately October 2016 to March 2017, and the maximum concentration recorded during that period was a single value at 0.15µg/l. It should be noted that there were no exceedances detected in the Affinity Water distribution network during this period.

4.2 Assumptions

- The full 13Ml/d flow can be transferred through the existing pumps and main from Ardleigh WTW to Elmstead Market reservoir.
- The outdoor use ban on metaldehyde, and the abstraction and catchment management programs delivered by Anglian Water will successfully reduce the concentration to below PCV.
- All galavanised iron pipes can be identified and replaced by December 2024 when sustainability reduction due to come in to effect.

4.3 Constraints

- The identification and access to supply and communication pipes and other third party assets may constrain our ability to replace like for like and alternative routes may need to be considered.
- Gaining consents from landowners and required permissions for installation of required assets where we are not the landowner.
- Where new assets are required Environmental constraints relating to working within SSSI’s and other protected areas need to be considered and permissions and mitigation put in place.

- Failure to achieve network outages for construction, commissioning and testing during times of high demand and drought conditions could lead to project delays.
- Availability of specialist supply chain designers and contractors to carry out large volume of work over a relatively tight time frame on a programme with limited free float.
- December 2024 WINEP deadline allows limited time frame for planning, design, consultation, implementation, commissioning, testing and handover of assets.

4.4 Dependencies

- The option is dependent the outcome of the AMP7 investigation and options appraisal on our River Brett groundwater sources, confirming the volume of reduction required.
- This option is dependent on a reverting to a 50:50 share of Ardleigh Reservoir with Anglian Water, as per our rdWRMP.
- This option is dependent on the remaining groundwater sources post sustainability reduction being treated at Horsley Cross WTW.
- This project is dependent on availability of resource from Production & Asset Strategy staff to facilitate the project’s progress.
- This project’s timeline is dependent on any other CAPEX schemes occurring at Ardleigh the treatment works.
- Delivery of other AMP 7 programmes; Water Quality Strategy programme.
- Regular stakeholder meetings (meeting required personnel each week to discuss options and best way to progress).

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10 Options Appraisal

5.1 Approach

Our Water Quality team have advised that the Larson-Skold index provides the best indication of whether water in our network will be corrosive and lead to discolouration issues. This index uses concentrations of chloride and sulphate ions as well as alkalinity to calculate a metric. They also provided a comparison of the local groundwater quality and Ardleigh surface derived water, as well as a number of corrosion indices (see Appendix 8.3).

The lower concentrations of metaldehyde present in the raw and final water at Ardleigh for the majority of the time indicate that the Anglian Water catchment management activities, alongside use of abstraction management, have resulted in improved control of the base load of metaldehyde present in the Ardleigh reservoir.

DEFRA recently announced that a ban on the outdoor use of metaldehyde will come into effect from April 2020, with sale of the product banned from the summer of 2019.

With these two factors in mind – the ongoing success of abstraction and catchment management activities, and the upcoming ban on outdoor use – the perceived risk of metaldehyde quality failures is low from 2020 onwards. As such, no treatment or additional monitoring measures are proposed as part of this investment.

We will give Undertakings to the DWI for metaldehyde in the Surface and Mixed Zones of our network, as we did for AMP6. This will mean that we cannot supply water containing metaldehyde above the PCV to our Groundwater Zone.

In order to gain a common understanding between stakeholders on the importance of delivery requirements under sustainability reductions programme, the MoSCoW (Must have, Should have, Could have ad Won't have) method was used to evaluate functional and non-functional requirements (see Appendix 8.5).

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5.2 Options

Costings for the Feasible Options

	Option 3	Option 4
Year 1	£520,000	£2,345,083
Risk	£52,000	£390,847
Year 2	£1,981,772	£10,162,025
Risk	£198,177	£1,693,671
Year 3	£1,981,772	£3,126,777
Risk	£198,177	£521,129
Year 4	£1,981,773	-
Risk	£198,177	-
Year 5	£1,981,773	-
Risk	£198,177	-
TOTAL ex risk	**£8,447,090**	**£15,633,885**
TOTAL inc risk	£9,291,799	£18,239,532

Final option cost excludes risk, see section 2.4.

Options 1 and 2 were not costed as the more detailed assessment concluded that these options would not fully address the implementation requirements for the sustainability reductions and maintain security of supply.

5.2.1 Unconstrained Options

An initial unconstrained list of four options were identified to enable delivery of the WRZ8 sustainability reductions and maintain supplies to customers.

5.2.1.1 Rejected Options

1. Do nothing – rejected as not carrying out the sustainability reductions would mean not fulfilling our regulatory requirement to comply with WINEP objectives, which have a combination of drivers including WFD and local biodiversity drivers. This would also mean not achieving our bespoke performance commitment relating to abstraction reduction.

2. Make licence reductions at sustainability reduction sources, with no investment in wider network – this option was rejected as this would result in an increased risk of water quality failures and have the potential to impact supply to customers. The following additional risks have been identified:

    a. The risk of discolouration of water at customers taps would remain where Ardleigh derived water is used in areas historically fed by groundwater or increased proportion of water in the mixed zone.

    b. Increase the likelihood and frequency of customer contact.

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c. Increased risk of corrosion in the network, leading to increased bursts and failures.

d. Limit our ability to implement regulatory and legislative requirements associated with the Brett sustainability reductions.

5.2.2 Feasible Options

Two feasible options (Option 3 and 4) were brought forward and considered for further analysis. These were discussed with internal stakeholders and scheme costs built up as described in the methodology.

3. **Replacement of galavanised iron communication pipes** – replacement of galavanised iron communication and supply pipes to properties.

4. **Blending of Ardleigh derived water at Horsley Cross treatment works** – new main from Elmstead market to Horsley Cross to allow Ardleigh derived water to be blending with the existing groundwater sources.

5.2.3 Option 3 – Replacement of galvanised iron communication pipes

This option involves the systematic identification and replacement of galvanised iron supply pipes (SP) and communication pipes (CP) at customer properties. The locations of properties where replacement is to be undertaken spans the entire Brett community. Information on the location of galvanised iron (GI) communication pipes in the Brett community was collated from Community Operations. This was compared with information on our corporate GIS to identify the number of properties with GI communication and or supply pipes. The average length of GI service pipes were then calculated based on logical connections. Pesticide risks would not be mitigated in this option.

Option	Project name	Outcome	Cost
3	Galvanised iron pipe replacement	Allow Ardleigh derived water to supply historic groundwater fed areas post sustainability reduction	£8,447,092
			£8,447,092

<u>Benefits</u>

- B1. This option will mitigate against discolouration due to use of Ardleigh Water anywhere in the Brett Community.
- B2. The investment addresses the cause of the complaints.
- B3. Investment can be focused on properties that are likely to be affected, rather than blending all of the water from Ardleigh at Horsley Cross.
- B4. Fulfils the driver of leaving more water in the environment.
- B5. The option is deliverable prior to December 2024 deadline.
- B6. Meets the expectations of our customers in terms of our commitment to the environment and ensuring water sources are sustained.

Risks

- R1. Customers will experience a large amount of disruption as both SP and CP are replaced.
- R2. Replacement of CP/SP will not be sufficient to prevent discolouration if there is additional iron present within the properties (as pipework/fittings).
- R3. Some properties with galvanised iron CP/SP may be missed and these customers may be impacted by the water source change.
- R4. The solution does not mitigate the risks of pesticides.

5.2.4 Option 4 – Blending of water at Horsley Cross

This option would require the blending of Ardleigh derived water at our existing Horsley Cross treatment works. This treatment works currently takes raw water from the groundwater sources in the River Brett catchment for treatment and onward distribution to customers. A new main would need to be constructed to bring water from Elmstead Market to Horsley Cross, 6.5km in length.

Option	Project name	Outcome	Cost
4	Blending of water at Horsley Cross	Allow Ardleigh derived water to supply historic groundwater fed areas post sustainability reduction	£15,633,885
			£15,633,885

Benefits

- B1. By blending the Ardleigh water with our local groundwater we can reduce the Larson-Skold index of the water and thereby reduce the risk of corrosion.
- B2. This will negate the need for extensive replacement of service pipes and disruption to customers.
- B3. Allows for potential blending of other parameters including pesticides to meet drinking water standards.

Risks

- R1. This option introduces a single point of failure at Horsley Cross, as loss of the WTW will result in us not being able to supply Ardleigh water to parts of our network without introducing a risk of corrosion.
- R2. We will be reliant on the stable quality of the abstracted water from groundwater sources to provide a suitable blending ratio.
- R3. This option requires installation of a new main with major trunk road crossings to be considered, with potential for local traffic disruption during construction.

5.3 Cost Benefit Analysis

The nature of this investment is focussed on a number of clear drivers, the most important of these being fulfilling our regulatory commitments by undertaking the sustainability reductions and maintaining water supply to our customers. As a result of these drivers the feasible options will not provide direct monetary benefits to us following implementation. Where expenditure is needed we have focussed on maximising efficiency to ensure the best value option is selected and future operational costs are kept to a minimum.

The monetary benefits of implementing the AMP7 sustainability reductions will be given further quantification using a Natural Capital approach. This approach is currently being developed using the data collected post AMP6 sustainability reductions as a baseline. This method will allow us to use real data linked to indicators of environmental improvements to calculate financial benefits with increased confidence.

The River Brett has been classified as a seriously damaged water body. It is therefore subject to **cost effectiveness assessment**, rather than cost benefit assessment, in accordance with the Water Resources Planning Guidance supporting document on sustainable abstraction (June 2017). This guidance states that the must do nature of these sustainability changes negates the need to assess the balance of costs and benefits, therefore the cost of the solution could exceed the benefits. This requires the delivery of the best outcome for the environment at the lowest overall cost.

Option 3 is the best value option as it removes the galavanised iron service pipes in the areas that would be affected by a greater utilisation of Ardleigh derived water. The AMP7 cost for this option is **£8,447,092**.

Option 4: The AMP7 cost for this option is £15,633,885. This option requires a greater level of investment and there was deemed to be insufficient evidence to justify the cost.

The lowest cost solution that has been identified in this business case is the replacement of galvanised iron pipes.

5.4 Recommendation

The recommended option proposed in this business case is replace the galavanised iron service pipes in the Brett community.

Option	Project name	Outcome	Cost
3	Galvanised iron pipe replacement	Allow Ardleigh derived water to supply historic groundwater fed areas post sustainability reduction	£8,447,092
			£8,447,092

This option has been selected based on cost benefit analysis (section 0) and a risk-based review of the benefits and risks (section 0).

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11 Risks, Issues and Mitigation

The following risk and mitigation actions have been identified:

Risk/Issue	Mitigation
Disruption to customers and the community through replacement works.	Careful planning and good communication of planned works to minimise disruption and keep customers informed.
Replacement of pipes may not be sufficient if there is additional iron present within the property itself	Preliminary surveys of properties before works commence, followed with water quality monitoring.
Some properties with galvanised pipes could be missed	Careful planning and assessment of pipes prior to commencing work., Identifying high risk areas, mapping pipework information to allow trend analysis, with other asset information e.g. age of property.
The outdoor use ban on metaldehyde combined with catchment management will not be sufficient to achieve the required reduction in metaldehyde in the raw water.	This is low risk because, this is a regulatory risk rather than public health risk. In the last 5 years there has been only one period during which the final water from Ardleigh WTW exceeded the PCV for metaldehyde. This was in the 2016-17 period. There is a regulatory ban coming in for a regulated industry. This will have a positive effect by the time we are expecting to move Ardleigh water regularly into areas not covered by the Undertaking (2025). AWS are delivering their own catchment management programme, and actively reducing the concentration in Ardleigh reservoir through abstraction management. AWS supply is managed using the strategies above, and additionally we have a dilution factor when the Ardleigh water mixes with our local groundwater in our distribution network. High risk period is during the Autumn / Winter when demand is lower, so we are less likely to need to move the water as widely (i.e. outside zones covered by the Undertaking) at those times.
Timescales for procurement of equipment and installation and other operational outages.	Detailed programme planning to ensure works are planned in advance and other planned operational outage are considered.

12 Procurement Strategy

Affinity Water has Framework Agreements in place with Principle Contractors to deliver Above Ground Asset construction works. In addition, Framework Agreements are in place at a Tier 2 level (Pumps, MCCs, VSDs, Valves, Pipework, Security) to encourage standardisation and cost certainty. A process is ongoing to review the most cost-effective way procuring projects; at a high level, the process is considering:

- Early engagement beginning in the Concept stage to drive Innovation
- Allocation of grouping of projects to benefit from economies of scale
- The use of incentivisation in contracts, to improve early completion of projects and lower project costs
- Some competitive tendering (where appropriate) and KPI driven allocation to improve the level of competitive tension

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Appendices

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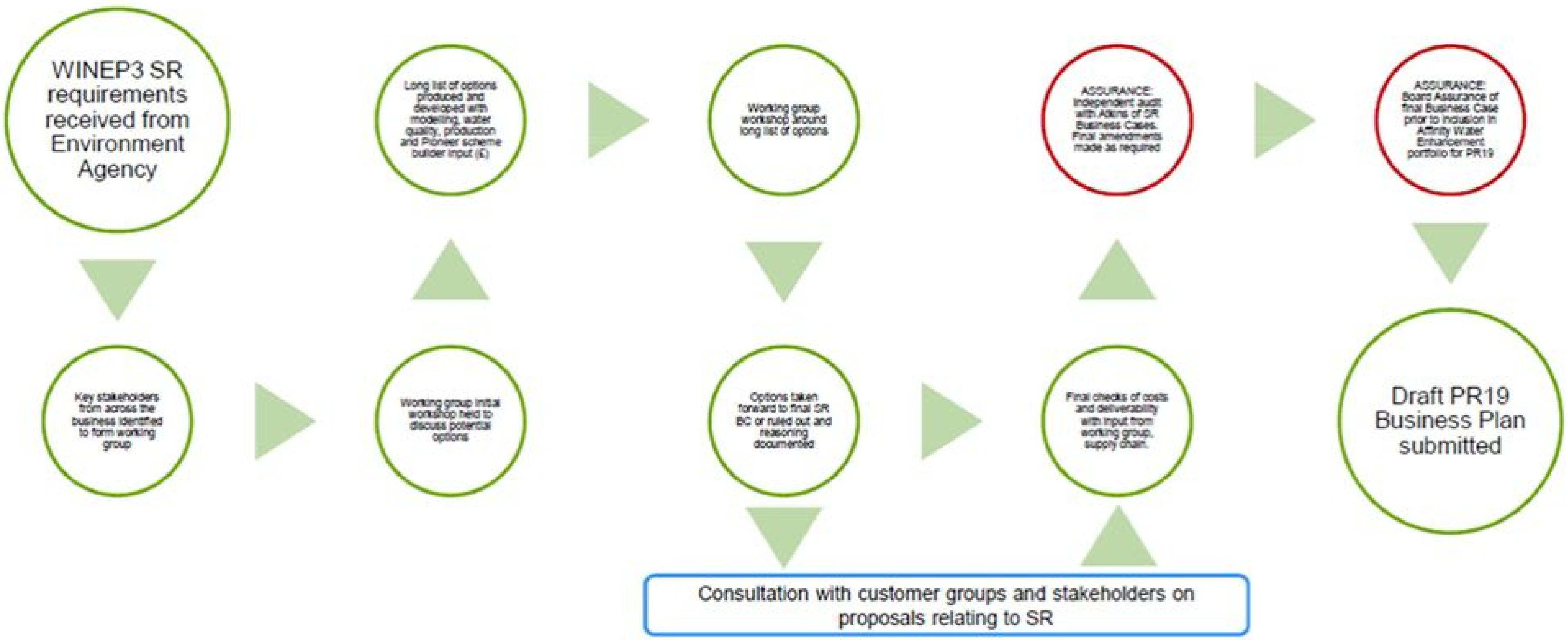
13 Appendices

8.1 Methodology

AMP7 Sustainability Reductions Business Case process

From WINEP3 requirements to submitted PR19 Business Case



8.2 WINEP3 – confirmed reductions as per EA letter

Source	WRZ	WINEP3 Level of certainty	WINEP3 Date	Current Licence Average	Current Licence Peak	WINEP3 Sustainability Change Average	WINEP3 Sustainability Change Peak	Proposed WINEP3 New Licence Average	Proposed WINEP3 New Licence Peak	Current 1:200 drought DO Average	Current 1:200 drought DO Peak	Proposed Sustainability Reduction Average	Proposed Sustainability Reduction Peak	Post SR 1:200 Drought Average	Post SR 1:200 Drought Peak	Comment	Comment from EA
Amersham	1	Green	22/12/2024	4.00	9.00	2	2	2.00	7.00	4.00	9.00	2.00	2.00	2.00	7.00	Replaces Chalfont SR included at PR14 WINEP3 included Chalfont daily peak licence and not Amersham. Error confirmed in email from Marta Pluta 4th April 2018	
Chartridge	1	Amber	22/12/2024	group licence	2.05	-	2.05			1.52	1.66	1.52	1.66	0	0	This source is part of a group licence and has no individual annual average licence. Assumes cessation of abstraction as per email from Marta Pluta on the 1st May 2018	
Chesham	1	Amber	22/12/2024	5.22	7.09	5.22	7.09			4.86	6.00	4.86	6.00	0	0	Error on WINEP3 relating to licence volume and hence SC. Assumes cessation of abstraction as per email from Marta Pluta on the 1st May 2018	
Holywell	2	Green	22/12/2024	-	20.46	8.84	0	5.61	11.80	11.80	11.80	6.19	0	5.61	11.80	The split between these sources has been amended due to change in DO assessment between PR14 and PR19. NB Mud Lane is Holywell BH6	Agregated licence with max daily rate from Mud Lane (11.37Ml/d). Operated almost as one source. New licence will review operations at both sites and potentially update maximum daily rate for Mud Lane to reflect operation needs. No change is proposed to total peak rate on the licence.
Mud Lane	2	Green	22/12/2024	-			0	3.78	8.66	6.60	6.60	2.82	0	3.78	6.60		
Mud Lane/Holywell					*20.46*	*8.84*		*9.39*	*20.46*	*18.40*	*18.40*	*9.01*	*0*	*9.39*	*18.40*		
Baldock Road	3	Green	22/12/2024	4.55	4.55		0		4.55	3.20	3.60					Sources to be capped to recent actual. Bowring and Fuller DO constrained by DAPWL. AMP7 scheme to included river support of c0.4Ml/d from existing licence but no impact on DO Also listed as Amber SC	
Bowring	3	Green	22/12/2024	7.96	7.96		0		7.96	3.60	3.90						
Fuller	3	Green	22/12/2024	7.96	7.96		0		7.96	3.70	4.80						
Willian Road Group			22/12/2024	*14.77*	*20.47*	*0.63*	*0*	*14.14*	*20.47*	*10.50*	*12.30*	0	0	10.5	12.3		
Digswell	3	Green	22/12/2024	11.37	11.37	9.87	2.45	1.50	8.92	7.20	8.10	5.7	0.00	1.5	8.10	No reduction in peak DO included at PR14. The s20 agreement allows peak abstraction of 8.92Ml/d which is already a reduction from the LoR of 11.37Ml/d. We believe this is an error on WINEP3	Changes reflect recent discussions with Affinity Water.
Perwinkle Lane	3	Green	22/12/2024	4.99	5.00	4.99	5.00	0.00	0.00	4.60	5.00	4.60	5.00	0	0	Assumes cessation of abstraction	
Runleywood Chalk	3	Green	22/12/2024	9.55	9.55	9.55	9.55	0.00	0.00	5.60	6.40	5.60	6.40	0	0	Assumes cessation of abstraction	
Debden Road	5	Green	22/12/2024	3.41	3.49	0.34	0	3.07	3.49	3.07	3.40	0	0	3.07	3.40	Cap to recent actual.	
Newport	5	Green	22/12/2024	1.36	2.27	0.48	0	0.88	2.27	1.30	1.70	0.42	0	0.88	1.70	Cap to recent actual. Recent pump replacement so impacts DO.	
Springwell Farm	5	Green	22/12/2024	13.68	13.64	6.77	0	11.47	13.64	0.00	0.00	0	0	0	0	Dormant source	
Uttlesford Bridge	5	Green	22/12/2024	13.68	13.64	6.77	0	11.47	13.64	6.00	6.00	0	0	6	6	Assumes no reduction in DO due to existing licence condition. AMP7 to include provision of river support of up to 5.47Ml/d from licence capped to recent actual Also listed as Amber SC	Licence volume for supply at 6 ML/d confirmed by EAN Area. Morphological change/river restoration project planned to mitigate flow support volume needed during drought conditions.
Uttlesford Group			*22/12/2024*	*15.95*	*18.18*	*0.48*	*0*	*11.47*	*18.18*								
Wenden	5	Green	22/12/2024	4.55	4.55	2.01	0	2.53	4.55	2.30	2.60	0	0	2.30	2.60	Cap to recent actual. Option to increase DO removed from EBSD	
Central Region Green/Amber Total						**44.42**	**28.14**					**33.71**	**21.06**				
Central Region Green Total	**1, 2, 3 & 5**	Green				**39.20**	**19.00**					**27.33**	**13.40**				
Central Region Amber Total	**1**	Amber				**5.22**	**9.14**					**6.38**	**7.66**			Difference between the WINEP3 SC and SR relates to Chartridge not having an individual annual average licence and an error on WINEP3 relating to Chesham licence volume and hence SC.	
Higham	8	Amber	31/03/2021	6.50	10.00	2.597	2.597			5.02	6.88	2.60	2.60	5.02	6.88	Sources subject to two group licences with daily, annual and 5 year totals. Volume of reduction uncertain. EA have indicated reduction of 15 and 20Ml/d may be required	
Shelley	8	Amber	31/03/2021	3.90	7.00					2.89	4.17			2.89	4.17		
Lattinford	8	Amber	31/03/2021	2.47	4.00					1.81	2.70			1.81	2.70		
Stoke-by-Nayland	8	Amber	31/03/2021	11.70	13.00					8.00	10.93			8.00	8.33		
East Region Amber Total	**8**					**2.597**	**2.597**					**2.60**	**2.60**				

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8.3 Water Quality Risks

8.3.1 Corrosivity Risk Measures

The table below presents data from the past 5 years, for Ardleigh and Horsley Cross WTWs. There are also lines showing data relating to Grafham WTW and Redbourn (which is a predominantly groundwater fed zone) for comparison.

Water	Temp	Electrical Conductivity (µS/cm)	Hydrogen Ion / pH	Chloride as Cl (mg/l)	Sulphate as SO4 (mg/l)	Total Hardness as Ca (mg/l)	Alkalinity as HCO3 (mg/l)	Larson_Skold Value	Index of Larson (Corrosivity)	Langelier index	Ryzner Stability Index
Ardleigh	12.4	707.8	7.43	97.2	89	243.5	151.4	0.43	1.85	0.22	7.00
Horsley Cross	8.2	790.0	7.23	73.7	78.2	148.7	344.4	0.35	0.66	0.07	7.09
Grafham	11.8	718.0	7.52	69.7	113.6	124.7	225.6	0.55	1.17	0.17	7.17
AF035 (Redbourn Zone)	12.9	603.4	7.14	32.4	20.3	132.8	325.8	0.14	0.25	0.01	7.12

The chart below demonstrates the relative differences between these four waters based on the Larson-Skold index.

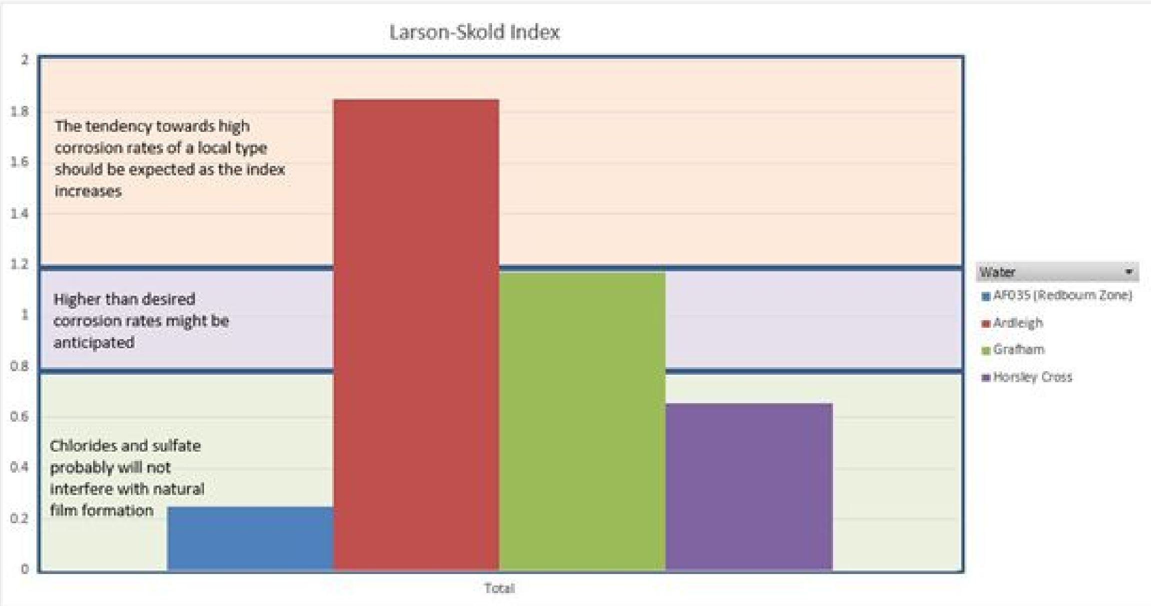

Figure 9 Larson-Skold Index of Ardleigh, Grafham, Horsley Cross and Redbourn Waters

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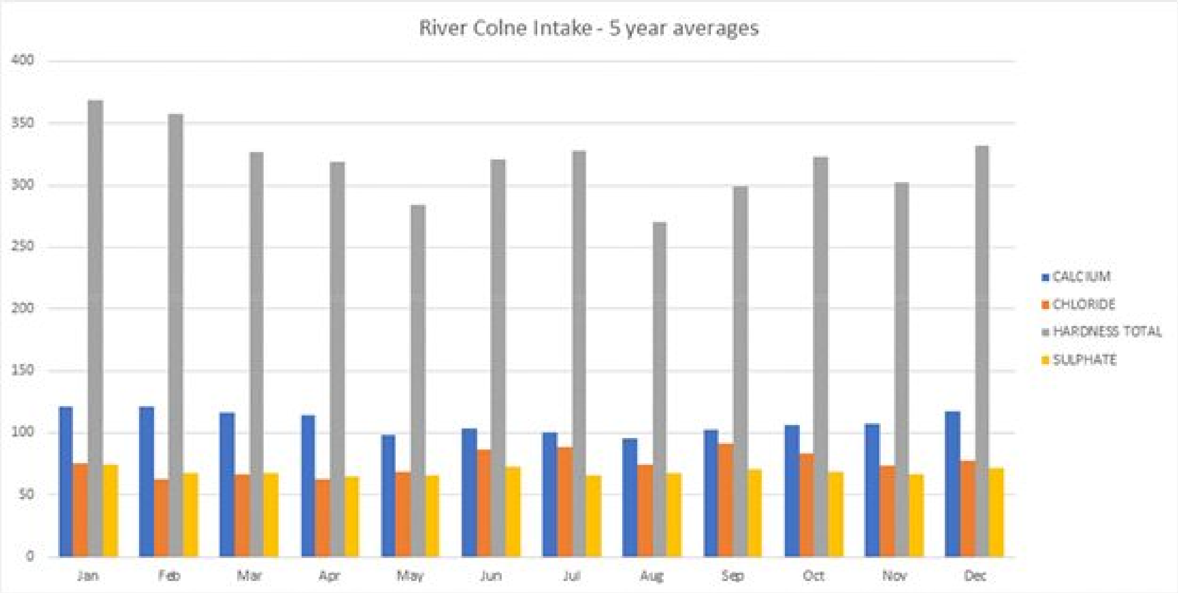
8.3.2 Sulphate/Chloride concentrations in the River Colne abstraction

The chart below shows the seasonal variability in the River Colne intake to Ardleigh Reservoir, using 5-year averages for the 5 most recent years.



8.3.3 Metaldehyde concentrations

The charts below show that, since January of 2013, there has only been one period during which the metaldehyde concentration of the final water from Ardleigh WTW has exceeded the individual pesticide PCV of 0.1µg/l. The maximum concentration was approximately 0.15 µg/l.

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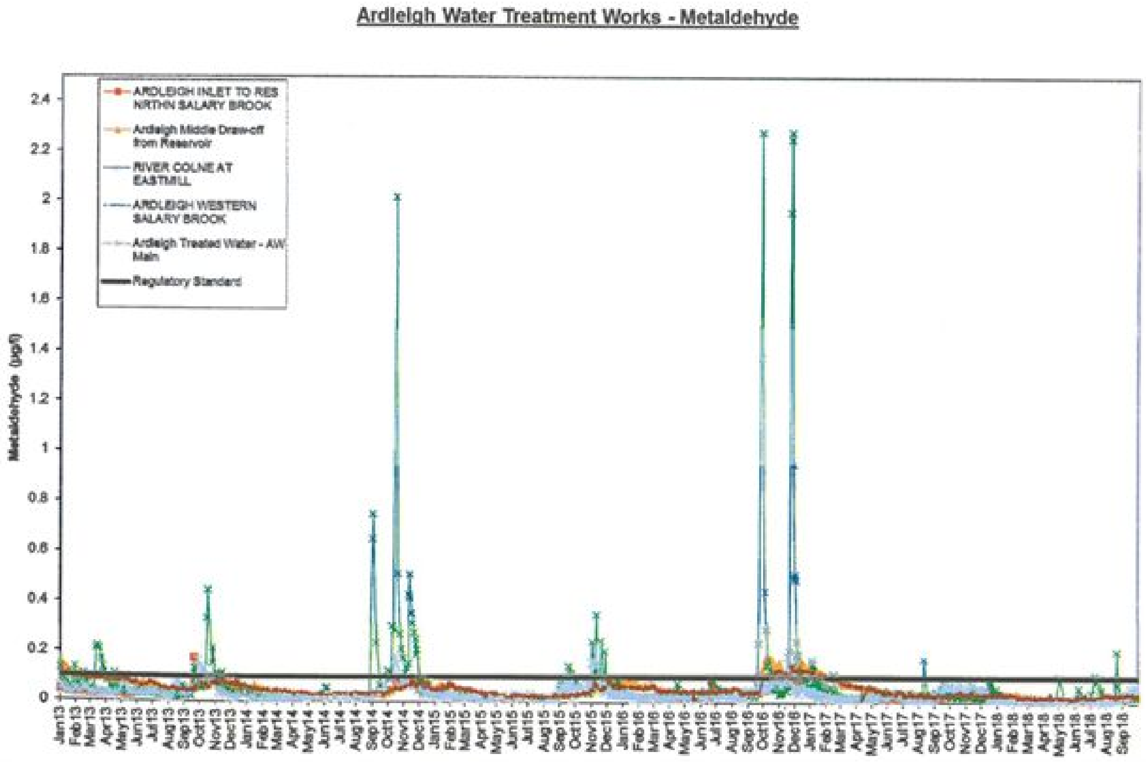

Figure 10 Metaldehyde at Ardleigh WTW 2013 - 2018

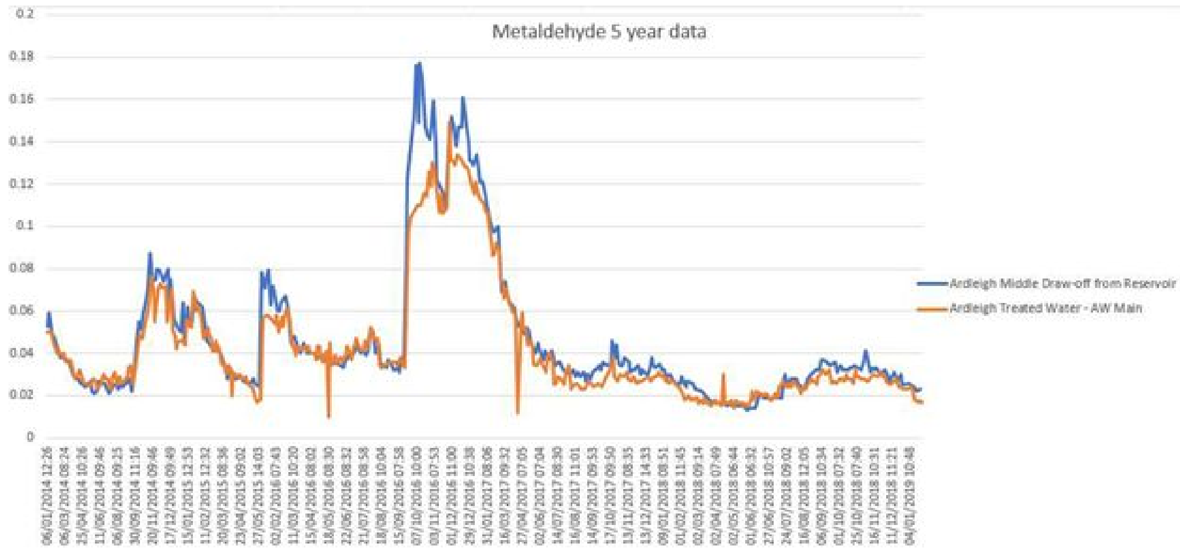

Figure 11 Metaldehyde at Ardleigh reservoir and treated water

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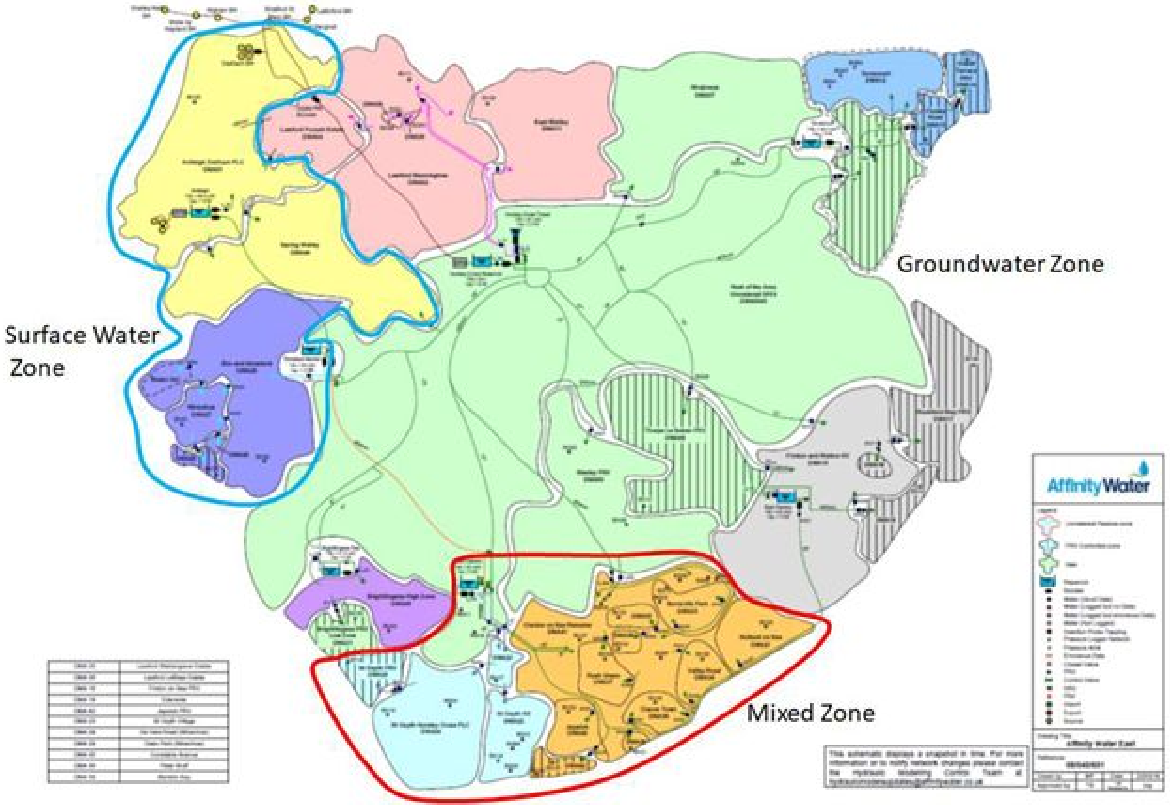
8.4 Schematic of network in Brett Community

The Surface Water Zone to the west of the community area is only supplied with surface derived water, from Ardleigh. The Mixed Zone to the south of the community area is supplied with a mixture of water from Ardleigh and Horsley Cross WTWs. These two zones are covered by an Undertaking for metaldehyde. The rest of the community area is the Groundwater Zone which is currently supplied exclusively with groundwater from Horsley Cross WTW.



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8.5 Business Requirements

8.5.1 Requirements Priority Matrix

Designation	Explanation
Must	The solution will not be accepted if a requirement that has a priority of 'Must' has not been delivered
Should	The requirement with a priority of 'Should' would provide business benefit, but the business would accept a solution where this requirement was not delivered e.g. the solution could be delivered by other projects/changes of working practice. If possible the solution should deliver these requirements
Could	The requirement with a priority of 'Could' may provide some business benefit, but not as much as the requirements that have been prioritised as 'should' and 'must'. The business would accept a solution where this requirement was not delivered.
Won't	Won't do this now but may wish to implement in the future

8.5.2 Functional Requirements

	Requirement Description	Rationale	Priority
1	The solution must remove the risk of discolouration.	Business Plan commitment to make sure our customers have high quality water they can trust.	Must
2	The solution must ensure water from Ardleigh can be used within the Brett community.	Water available for use	Must
3	The solution should be sufficiently robust such that it does not become a limiting factor on the site.	Water available for use	Should
4	Provide resilience to supply area and flexibility in network operation.	To supply wholesome drinking water in accordance with water quality standards.	Must
5	Provide security of supply	To avoid DG2 and DG3 issues in supply area.	Must
6	Treat all water produced on Affinity water sites to acceptable standard.	To supply wholesome drinking water in accordance with water quality standards.	Must

8.5.3 Non-Functional Requirements

	Requirement Description	Rationale	Priority
1	The solution should not impact on the operability of the rest of the process, and should not increase the site's operator input on the rest of the process through adverse downstream or upstream effects.	Leaving an intelligent operating legacy – maintaining or improving existing site operability so as not to put unnecessary strain on Production staff.	Should
2	Compliance with relevant Affinity Water standards and policies.	Ensure high quality of work.	Must
3	Governance documentation completed in line with project lifecycle	Ensure business case is valid and all stakeholders retain buy-in throughout project.	Must
4	Health and Safety will be a project priority. Risk Assessments and Method Statements will be required for all site work. HAZOP, HAZID and HAZCOM will be completed through the project lifecycle. Additionally, hazards for on-going maintenance will be reviewed through the design phase. The project will comply with CDM regulations.	Ensure all works are risk assessed and conducted in the safest way possible to promote zero harm.	Must
5	Update operational and maintenance manuals, update AMIS and tagging, update existing telemetry and SCADA software, update site drawings, update GIS information.	To ensure all site information and software is up to date.	Must
6	Improve overall security of supply and maintain resilience of network in supply area.	To ensure customers are provided with clean drinking water, and we meet our regulatory requirements.	Should

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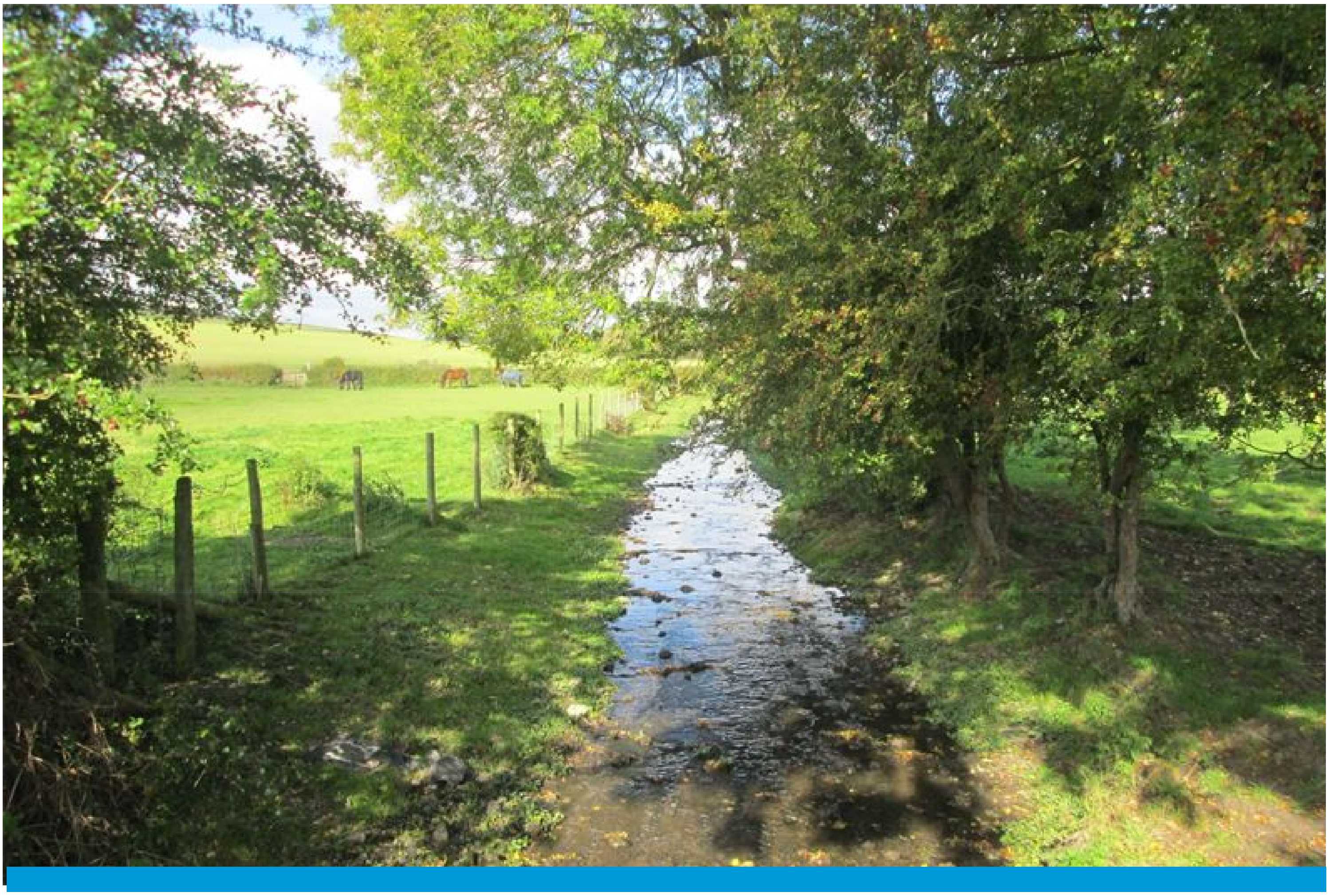
Appendix AFW.CE.A1.8

Action ref AFW.CE.A1

Sustainability Reductions: Misbourne Community (WRZ1)



Sustainability Reductions - Misbourne Community (WRZ1)

PR19 Business Case

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March 2019

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Asset Strategy document control sheet

Document amendment history

Version	Status	Date	Amendment to this version
1.0	Final	03/09/2018	For issue with draft business plan
2.0	Final	14/03/2019	Updated to new template for resubmission

Document approval

Document title	Sustainability Reduction WRZ1 Business Case			
e-Document location				
	Name	**Signature**	**Title**	**Date**
Author/originator	David Watts		Programme Delivery Manager Asset Manager	11/03/19
Technical Reviewer 1	Ellie Powers		Senior Asset Manager	12/03/19
Technical Reviewer 2	Alice Elder		Senior Asset Engineer	12/03/19
Approver 1	Affie Panayiotou		Head of Water Strategy	15/03/19
Approver 2	Marie Whaley		Asset Strategy Director	27/03/19

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1 Document Purpose

The purpose of the Project Business Case is to describe the reasons for the project and the justification for undertaking it, based on the estimated costs of the project, the expected business benefits, savings and risks.

The Business case will also present all the options that have been assessed to deliver the project outcome and will indicate the preferred option out of all considered.

During the project a Business Case is a major controlled document that is referenced on a regular basis to ensure and confirm that the project remains viable. It is maintained throughout the lifecycle of the project, being reviewed by key stakeholders at key decision points, i.e. at the end of a phase.

14 Executive Summary

Our revised draft Water Resources Management Plan (rdWRMP19) includes sustainability reductions of 36.31 Ml/d (average) and 23.66 Ml/d (peak) for delivery by December 2024. These reductions have been identified by the Environment Agency as being required to contribute towards Water Framework Directive objectives. Investment of £58million has been included in our PR19 business plan submission to deliver Green and Amber sustainability reductions, in accordance with the associated regulatory guidance. Three sustainability reductions were identified for the Misbourne Community (Water Resource Zone 1).

This business case covers the investment required to enable implementation of the sustainability reductions in the Misbourne Community and maintain supplies to customers. It includes option development, risk assessment and cost benefit assessment undertaken to identify the best value option.

Eight options were identified to enable delivery of the sustainability reductions and maintain security of supply, with three options taken forward for detailed consideration.

The final preferred option identified in WRZ1 is Option 7, which includes measures to enable implementation of both Green and Amber sustainability reductions. The measures comprise of a Berkhamsted/Kingshill pump upgrade, Heronsgate to Bovingdon network reinforcements, iron removal at Hunton Bridge and a chlorination plant at Cholesbury. This is considered the best value option as it ensures that security of supply to WRZ1 would be maintained following implementation of the sustainability reductions. The AMP7 cost for this option is £10,116,363, these costs have been included in our business plan submission under Environmental Enhancements. This business case will be reviewed and updated at key milestones throughout the life cycle of the project.

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15 Introduction

3.1 Background

Sustainability reductions are decreases in water company deployable output due to a sustainability change (licence change), which are identified as being required to improve river flow and ecology, to meet Water Framework Directive (WFD) objectives. Our revised draft Water Resources Management Plan (rdWRMP19) includes sustainability reductions of 36.31 Ml/d (average) and 23.66 Ml/d (peak) for delivery by **December 2024**.

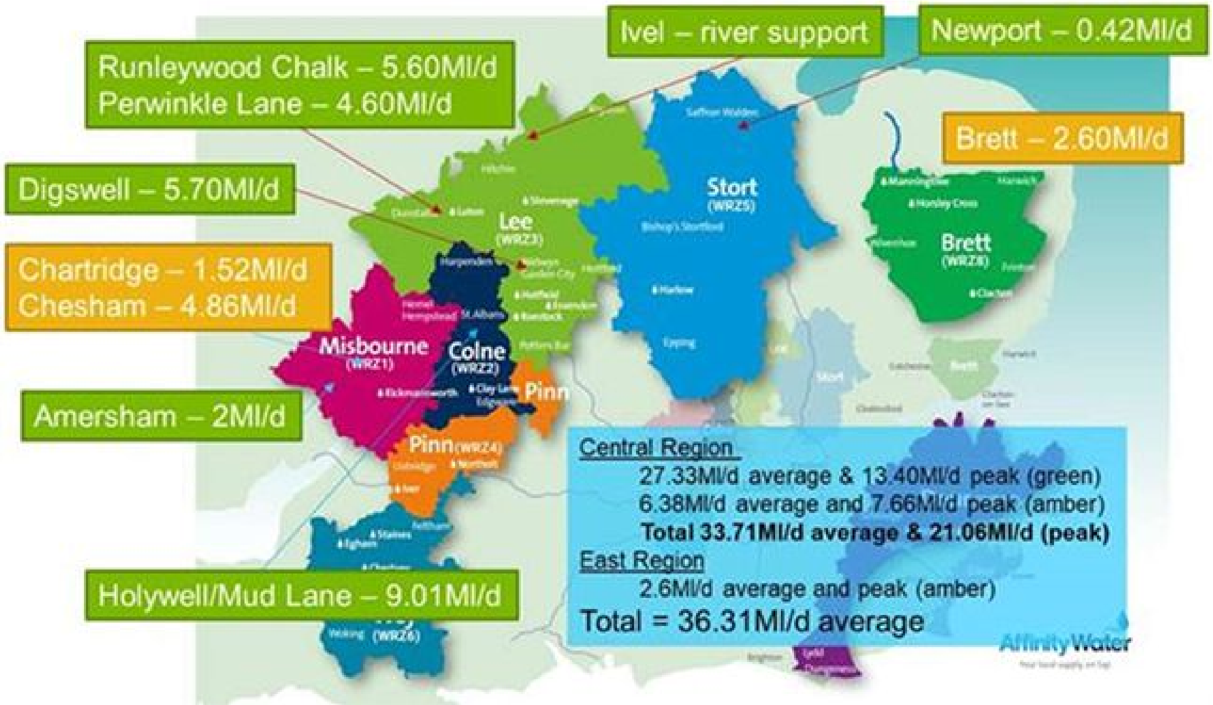

Figure 1 Location of sources subject to AMP7 sustainability reductions

The AMP7 sustainability reductions have been modelled at a water resource zone (WRZ) level using our Economic Balance of Supply and Demand (EBSD) model and transfers within and between zones have also been modelled using MISER (our bespoke model that simulates transfers between hydraulic demand zones (HDZs)). Our MISER modelling has helped identify network constraints and has been used to inform implementation requirements. This modelling work has confirmed that we cannot implement these sustainability reductions using demand management options alone and that we need to undertake works on both above and below ground assets, to ensure we can maintain supply to our customers.

In our Misbourne Community (WRZ1) there are three proposed sustainability reductions (Amersham, Chesham and Chartridge) totaling to an 8.38 Ml/d reduction in deployable output; by leaving this additional water in the environment we will aim to safeguard the local groundwater and support river flows in the Rivers Misbourne and Chess. The Amersham reduction was classified as Green on Water Industry National Environment Programme (WINEP) (**WINEP ID Code HNL00065**). The Chesham and Chartridge reductions are currently classified as Amber on WINEP3 as they are still under-going options appraisal under AMP6 National Environment Programme (NEP) (**WINEP ID Codes HNL00063 and HNL00066** respectively). These reductions are included in the WINEP3 table as shown in Appendix 8.2.

Across WRZ1 (Misbourne) an unconstrained list of eight options was identified to enable delivery of the AMP7 sustainability reductions and ensure customer supply is maintained once these have been implemented. Three feasible options were taken forward for further assessment and are detailed in this report.

3.2 Drivers

3.2.1 Water Framework Directive

The Environment Agency (EA) have assigned the following Water Framework Directive (WFD) and Natural Environment and Rural Community (NERC) Act drivers to sustainability reductions in WRZ1, within their Water Industry National Environment Programme (WINEP).

Driver Code	Description
WFD_IMP_WRFlow	Action to Improve hydrological regime to meet WFD objectives
NERC_IMP2	Changes to permits or licences, where there is evidence and it contributes towards biodiversity priorities and the NERC Act.

The EU WFD binds the UK as a whole to delivering its requirements and does not impose any legal obligations on water companies or the EA directly. The WFD is implemented in England and Wales by the Water Environment (Water Framework (England and Wales) Regulations 2017 (WFD Regs)). The WFD requires waterbodies to achieve good ecological status (GES) or potential (GEP).

Since 1990, a number of our abstraction licences have been identified by the EA to be potentially environmentally damaging. This has resulted in a series of environmental investigations and options appraisals (AMP2-6) through the Restoring Sustainable Abstraction (RSA) programme and NEP. The driver for these projects is a combination of WFD, Habitats Directive, Sites of Special Scientific Interest (SSSI) and local biodiversity drivers where there was considered to be the potential for impact on chalk streams, a biodiversity priority habitat.

3.2.2 Water Resources and Supply

The AMP7 sustainability reductions are included in our Water Resources Management Plan, which sets out how we will balance supply and demand over a 60-year planning horizon. We must ensure that we have adequate resilient supplies to meet demand and maintain supplies to customers. Within the Misbourne WRZ we supply approximately 141,430 properties, with a total population of 326,000.

3.2.3 Customer Experience

We have listened to feedback from customers and stakeholders on our draft Water Resources Management Plan and included the Water Industry National Environment Programme (WINEP3) sustainability reductions in our plans. Feedback from our engagement indicates that 78% of our customers support us investing now to ensure there is sufficient water in future. We recognise the importance of sustainable abstraction and meeting the needs of customers and the environment. This business case supports delivery of our sustainability reductions whilst maintaining supplies to customers and communities.

3.3 Best Value Option

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Option 7 – Implementation of measures within WRZ1 with Green and Amber sustainability reductions

The best value option for WRZ1 is to implement four identified measures to ensure customer supply and network resilience is maintained following the AMP7 sustainability reductions. For each measure a best value option has been selected. Together with the best value option for each measure discounted options applicable to each of the measures are listed with evidence as to why these have been discounted.

The best value option is comprised of the following four measures;

a.) Berkhamsted Kingshill pump upgrade

b.) Heronsgate to Bovingdon network reinforcements

c.) Hunton Bridge iron removal

d.) Cholesbury Chlorination plant.

These measures in combination will allow the implementation of **sustainability reductions totalling 8.38 Ml/d in WRZ1** to be made and customer supply maintained with no reduction in the resilience of our water supply network.

3.4 Costs Summary Table

Costings for the Best Value Option

	Y1	Y2	Y3	Y4	Y5	AMP7	20 Years
Costs (capex)	£1,554,083	£3,335,136	£3,205,697	£2,016,149	£-	£10,111,065	£10,111,065
Costs (opex)	£-	£-	£1,766	£1,766	£1,766	£5,298	£70,640
Risk	£155,408	£333,514	£320,570	£201,615	£-	£1,011,107	£1,011,107
Total costs (totex)	£1,554,083	£3,335,136	£3,207,463	£2,017,915	£1,766	£10,116,363	£10,181,705
Total revenue	£-	£-	£-	£-	£-	£-	£-
Funding requirement	£1,554,083	£3,335,136	£3,207,463	£2,019,681	£-	**£10,116,363**	£10,116,363
NPV (£k)	£-	£-	£-	£-	£-	-£9,409,000	-£9,428,000

At this stage of option development, we have detailed a 10% risk to all options for consistency but not included this figure within the options total funding required. We will seek to manage risk at a programme level across all projects and cover any risk funding requirement through the generation of efficiencies. These efficiencies will be generated through refinement during the life cycle of the programme, ensuring mitigation is included for all risk items and value engineering considered at key milestones. This approach reduces the total funding request across the AMP7 sustainability reductions programme by £5.84million.

3.5 Customer Benefits and Resilience

The primary purpose of this investment is to ensure we **maintain supply of wholesome water to customers** following the implementation of the AMP7 sustainability reductions. There are a number of other additional benefits that will be realised through implementation of this work as follows:

Supply resilience – will be maintained within the Misbourne community as a result of the combination of four requirements implemented.

Reduced water quality risk – addresses age of water issue associated with bringing water further through the network to support local demand.

Maintain security of supply following the implementation of the sustainability reductions.

Deliver regulatory expectations under the Water Industry National Environment Programme.

Contribute towards achieving **Water Framework Directive objectives**.

Improving the relationships with the local community, customers and stakeholders via **demonstrating our commitment to the environment** through implementation of the sustainability reduction which we know through our consultation is important to our customers.

The importance our customers and stakeholders place on abstraction reductions is demonstrated in our bespoke **Performance Commitment relating to abstraction reduction** which this project will contribute towards.

The best value option **maintains supply resilience** and mitigates against operational incidents such as water quality issues. Through investment we are maintaining resilience of water supply to our customers, whilst considering future growth of local developments which put pressure on our network and capacity.

The investment made in WRZ1 under the Sustainability Reduction Programme is seeking only to **maintain supply to customers** in AMP7. We have consulted with colleagues preparing our Plan for Central region to capture links and any possible overlap. This assurance avoids double counting of options between sustainability reductions and other programmes so any opportunities/efficiencies are realised.

Innovation will be at the heart of delivering the preferred option as we seek to drive down costs and maximise benefits for both our customers and the environment. Associated with these reductions we are keen to ensure we continue to **improve our understanding of the chalk aquifer** and the relationship to river flows both pre- and post-reduction so future investment can be targeted in the correct areas.

The Sustainability Reduction Programme drivers encourage us as a water company to think about how we can use our groundwater sources differently and to work with the new abstraction reform protocols to ensure the water we supply to customers is from more sustainable sources with lower impacts upon the environment.

The recommended best value option will also support achieving the target set out in the following performance commitments;

Performance Commitments supported by this project

Bespoke and Legacy PC	Current Performance	Base Plan J	SWR Plan L	SOP Plan K	Stakeholders / Customers	Final
Abstraction Reduction (Ml/d)	n/a	10	39	10	36	36

3.6 Methodology

The investment requirement has been identified and developed by our Asset Strategy team in collaboration with Production and Supply, Water Quality, Community Operations and Asset Delivery teams. The process is represented in Appendix 0 and details provided below.

6. Investigating and quantifying supply risk due to sustainability reductions in WRZ1, in combination with reductions in other zones. Initial risk workshop and discussions with internal stakeholders.

7. Identifying and optioneering solutions, systematically exploring options to identify best value options. Options developed through engagement with stakeholders from Production, Operations Centre, Network, Water Quality, Leakage, Modelling, Trunk Mains and Mains Renewals, Asset Strategy and current AMP6 sustainability reductions programme team.

8. Further liaising with internal stakeholders through workshops to review proposed solutions and identify additional risks

9. Modelling of network configurations, with data gathered from the company's systems to establish site failure rates etc. This includes: TRACE - our asset performance analysis tool (TRACE - Trackdown, Reliability, Availability, Cause & Effect), telemetry, Asset Risk Module (ARM), Asset Management Information System (AMIS), Geographic Information System (GIS) and business objects. Engaged with contractor base for asset information and validation of costs for likely asset replacement/installation.

10. PIONEER scheme builder, Economics of Balancing Supply and Demand (EBSD), and the unit cost model have been used for estimations of costs. With regards to trunk mains, the current PR19 mains laying summary costs were used where appropriate.

Options have been developed using a standardised company process through the utilisation of Scheme Builder (a module of the PIONEER software tool). Scheme Builder allows us to cost the addition or modification of assets on a project basis for delivery purposes. The optimiser uses our asset data, deterioration curves, consequences and unit costs, to determine the optimal investment to meet a defined need.

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16 Defined Need and Dependencies

4.1 Defined Need

The River Misbourne in Buckinghamshire is a chalk stream where a significant reduction in public water supply abstraction has been implemented over the last 20 years. The original Alleviation of Low Flows (ALF) study (c.1990) resulted in a Phase 1 reduction in abstraction in 1997 of 15 Ml/d, split between ourselves and Thames Water. This reduction resulted in some improvements in flow and ecology but a further reduction in abstraction (Phase 2) was considered likely. We included at PR14 a further reduction of 3 Ml/d from Amersham (2018) and 2 Ml/d from Chalfont St Giles (2020). A river support scheme was also considered, and after investigation it was agreed with the EA not to include plans for this in PR19.

The EA confirmed in a letter dated 27 March 2018 that evidence suggests that it would be more effective for the AMP7 reduction to occur from Amersham rather than Chalfont St Giles. This upstream reduction would also negate the need for the river support scheme.

Amersham sustainability reduction

Source	Current Licence		WINEP3 Sustainability Change		PR19 DO (1 in 200 drought)		rdWRMP Modelled AMP7 Reduction		Resultant DO	
	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)
Amersham	4.00	9.00	2.00	2.00	4.00	9.00	2.00	2.00	2.00	7.00

We have included a 2 Ml/d reduction in our rdWRMP for Amersham from December 2024. We have also included investment in our business plan for the continuation of the river restoration and habitat enhancement programme and to monitor the benefit of works in the Misbourne catchment. This programme includes some significant planform restoration work, realigning the river to its original course, subject to landowner and other relevant consents. Further work to address the significant flow losses in the reach of the river past the London Road Depot need to also be considered.

Upper Chess sustainability reductions

Source	Current Licence		WINEP3 Sustainability Change		PR19 DO (1 in 200 drought)		dWRMP Modelled AMP7 Reduction		Resultant DO	
	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)
Chartridge	-	2.05	-	2.05	1.52	1.66	1.52	1.66	0	0
Chesham	5.22	7.09	5.22	7.09	4.86	6.00	4.86	6.00	0	0

Work is ongoing on the Upper River Chess investigation and options appraisal in collaboration with Thames Water. We have included a sustainability reduction in our rdWRMP19 for our Chartridge and Chesham sources to cover the potential need for a reduction. These reductions have been modelled as a full cessation of abstraction in line with WINEP3 amended figures as per letter by the EA dated 5 September 2018. It should however be noted that we have not completed the investigation and options appraisal and therefore the requirement for these reductions remains uncertain. We have included a cost adjustment mechanism in our business plan for these sources should the investment associated with these reductions not be required.

4.1.1 Identifying the risk

Through our MISER modelling (our bespoke hydraulic demand zone model) we have identified that we cannot deliver the AMP7 sustainability reductions through the implementation of EBSD options (demand management, per capita consumption and leakage reductions) alone and that **capital works are required in WRZ1 to maintain supplies** to customers. Without undertaking this work we will not be able to maintain supplies to customers. The reduction in local source water, as a result of the sustainability reductions, will be offset by **increased import of water from Grafham (Anglian Water)** along with demand side measures included in our rdWRMP. There are **distribution and storage requirements** that need to be addressed as a result of this, as well as local **source specific requirements** associated with increased criticality of sources and ensuring assets are appropriately sized for **efficient post sustainability reduction use**.

The imposition of sustainability reductions in the catchment at our Amersham, Chesham and Chartridge sources increases site criticality across WRZ1 and requires a solution to ensure we can maintain supply to customers and there is no negative impact on resilience across our network.

4.1.2 Asset background information

The Amersham source consists of two boreholes which currently provide an average deployable output of 4 Ml/d. The water from this source is treated on site before supplying customers in the Amersham, Buckinghamshire area. The Chartridge source consists of one borehole which currently provides an average deployable output of 1.52 Ml/d. The water from this source is treated on site before supplying customers in the Chartridge, Buckinghamshire area. The Chesham source consists of one borehole which currently provides an average deployable output of 5.22 Ml/d. The water from this source is treated on site before supplying customers in the Chesham, Buckinghamshire area.

4.2 Assumptions

- AMP6 sustainability reduction schemes are delivered before the AMP7 work commences.
- Assuming that there is capability to transfer the required flow rate from Chaul End/ Boxted with no volumetric limitations; trial required before project commences.
- Sundon Conditioning Plant will be commissioned to allow derived water to support the overall mass balance of the network.
- Assumed compulsory land purchase is available for new treatment site; location as identified later in planning and definition process.
- Operations Centre will be able to manage network to enable effective use of the chlorination plant.
- Chesham and Chartridge will remain off, and will not be recommissioned in the future.
- At this point the definition cost estimate assumes AMP 7 project for new chlorination plant will follow a similarly scaled cost schedule to those installed in AMP 6.
- Land available at Cholesbury reservoir or Chesham for new chlorination plant

4.3 Constraints

- Approval from governing bodies, such as the EA, is given for all schemes to be carried out.
- Limited space on sites within our ownership for new assets.
- The largest infrastructure project taking place in Europe over the next 5 years, HS2, will have an impact upon several of our assets within WRZ1. Availability of sources for output and outages for commissioning/testing will be more constrained than usual.
- Where new assets are required Environmental constraints relating to working within SSSI's and other protected areas need to be considered and permissions and mitigation put in place.
- Failure to achieve network outages for construction, commissioning and testing during times of high demand and drought conditions could lead to project delays.
- Availability of specialist supply chain designers and contractors to carry out large volume of work over a relatively tight time frame across number of complex projects with limited free float.
- December 2024 WINEP deadline allows limited time frame for planning, design, consultation, implementation, commissioning, testing and handover of assets.

4.4 Dependencies

- This project's timeline is dependent on any other Capex schemes occurring at the treatment works and in the network in question.
- This project is dependent on availability of resource from Production & Asset Strategy staff to facilitate the project's progress.
- Delivery of other AMP 7 programmes; Water Quality Strategy programme and treatment programme work across similar sites and use similar supply chain resource.
- Commissioning of Sundon Conditioning Plant to enable Grafham derived water to support the overall mass balance of the network.
- Hydraulic modelling outputs (frequent engagement with modellers, discussed output with other relevant stakeholders).
- Regular stakeholder meetings to discuss options and best way to progress.
- Alterations to flows and supply needs in areas dependant on MISER and Water Resource Management Plan output (frequent engagement with colleagues running these programmes, speak with senior managers to check latest plans and estimations).
- Remaining non-sustainability reduction sources are available and in supply (Regular communication with Production colleagues to understand situation at the time).
- Successful delivery of AMP 6 programmes (noted in risk register - communicated dependency with stakeholders).

- Successful implementation of demand management schemes as included within dWRMP.

- Interdependency with other sustainability reduction projects to maintain overall mass balance of supply system.

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17 Options Appraisal
5.1 Approach

The best value solution has been identified through taking a holistic approach to the sustainability reductions programme. We have utilised output from our EBSD modelling for the WRMP, with more detailed MISER and InfoWorks hydraulic demand zone modelling. This in combination with stakeholder engagement has enabled us to identify the best value solution, taking into account the effects of the sustainability reductions and the identification of efficiencies.

In order to gain a common understanding between stakeholders on the importance of delivery requirements under sustainability reductions programme, the MoSCoW (Must have, Should have, Could have and Won't have) method was used to evaluate functional and non-functional requirements (see Appendix 0).

5.2 Options

Costings for the Feasible Options

	Option 6	Option 7	Option 8
Year 1	£1,411,411	£1,554,083	£4,079,239
Risk	£141,141	£155,408	£407,923
Year 2	£3,207,463	£3,335,136	£7,565,392
Risk	£320,746	£333,514	£756,539
Year 3	£3,207,463	£3,207,463	£13,843,085
Risk	£320,746	£320,570	£1,384,309
Year 4	£2,019,681	£2,017,915	£2,019,681
Risk	£201,968	£201,615	£201,968
Year 5	-	£1,766	-
Risk	-	-	-

Options 1, 2, 3, 4 and 5 were not costed as the more detailed assessment concluded that these options would not fully address the implementation requirements for the sustainability reductions and maintain security of supply.

The final option does not include risk, see Section 2.4.

5.2.1 Unconstrained Options

An initial un-constrained list of options was developed to enable delivery of the sustainability reductions and maintain supplies to customers.

5.2.1.1 Rejected options:

1. **Do nothing option** – rejected as not carrying out the sustainability reductions would result in us not fulfilling our regulatory requirement to comply with WINEP. This has a combination of drivers including WFD and local biodiversity responsibilities under the NERC act. This would also result in not achieving our bespoke performance commitment relating to abstraction reduction. Thirdly this option would go against feedback from our customer base who we know support the implementation of works seeking to sustain and enhance the local environment.

2. **Make licence reductions at sustainability reduction sources, with no investment in wider network** – this option was rejected as this would result in an increased risk of failures, a higher number of single points of failure across our network impacting supply to customers.

3. **Measure to supply WRZ1 post sustainability reductions: Construction of a new main from Harefield to Hunton Bridge** – this option was rejected as the investment costs associated with it are prohibitively high. The construction of the new main would cause widespread disruption to our customer base and more risks are associated with this option than the alternative of local treatment at our Hunton Bridge source to increase deployable output.

4. **Measure to supply WRZ1 post sustainability reductions: Treatment plant at West Hyde, Northmoor, Amersham and Chalfont St. Giles** – rejected as this work will be delivered as part of HS2 work – these will be permanent if necessary and paid for by HS2.

5. **Implementation of measures within WRZ1 without network reinforcements** – this option was rejected as this would impact supply to customers – increased risk of asset failure in WRZ1, asset criticality and number of single points of failure would increase.

5.2.2 Feasible Options

Three potential options were brought forward for more detailed examination: -

6. **Implementation of measures within WRZ1 not including for Amber sustainability reductions**. Measures comprise: a.) Berkhamsted/Kingshill pump upgrade, b.) Heronsgate to Bovingdon network reinforcements, and c.) Hunton Bridge iron removal.

7. **Implementation of measures within WRZ1 including Amber sustainability reductions**. Measures comprise: a.) Berkhamsted/Kingshill pump upgrade, b.) Heronsgate to Bovingdon network reinforcements, c.) Hunton Bridge iron removal, and d.) Cholesbury chorination plant.

8. **Implementation of above measures within WRZ1 including Amber sustainability reductions with additional improvements to resilience – alternative Heronsgate main**. Measures comprise: a.) Berkhamsted/Kingshill pump upgrade, c.) Hunton Bridge iron removal, d.) Cholesbury chorination plant and e.) Replacement of Heronsgate main

The measures included in the options above are described as follows:

a.) <u>Berkhamsted/Kingshill pump upgrade</u>

It has been proven through data analysis and stakeholder engagement that output from Berkhamsted to Kingshill reservoir is not reaching maximum licence; maximum flow is 6.57 Ml/d against a licence of 7.96 Ml/d. There is a need to review this pumping system to allow for maximum abstraction, and flexibility in the network – thus providing resilience to the Heronsgate, Amersham and Hemel Hydraulic Demand Zones (HDZs). A number of solutions have been identified to be implemented in parallel to each other, to improve the network and provide the necessary flexibility and resilience after the AMP7 sustainability reductions are in place. These are: 1.) installing four actuated valves and four full bore flow meters, around the intersection of the Bovingdon to Cholesbury main, Ashley Green Village District Metered Area (DMA), and the Hill Farm Road main. These actuated valves will enable increased flow in that area, allowing pressure and flow to be monitored and adjusted as required. This will help to avoid level of service issues. Current operation of this area in a resilience scenario requires manual valve operations which both increases risk and error leading to potentially more bursts, and poor control of water transfers. 2.) Install parallel main for the 8" trunk main in Ashley Green Village DMA. This main is prone to bursts and when maximising the output of Berkhamsted pressure will increase in that area, hence the need to provide resilience to the DMA. This main is estimated to be 3km in length; a price for a 10" polyethylene main has been included. 3.) Install new booster near Berkhamsted to allow for movement of water to Boxted from Berkhamsted. The new booster station is required to move more water to Boxted and also act as contingency pumps in case of failure at the source.

b.) Heronsgate to Bovingdon network reinforcement

Work to increase the transfer capability between Heronsgate reservoir and Bovingdon reservoir is ongoing in AMP6. Due to this increased transfer, pressure in the trunk main between the two reservoirs is predicted to increase by nearly 30m. There are a number of DMAs directly fed off this trunk main which would be subject to this increase, with a risk of increasing bursts, or supplying water under extremely high pressure to customers' properties. The output from the hydraulic models demonstrate that a suitable solution would be to install 2km of 180mm polyethylene main and new Pressure Reducing Valve (PRV) to protect the DMAs near Heronsgate – Bovingdon.

c.) Hunton Bridge iron removal treatment

The criticality of this site increases with the sustainability reductions and there is a need to both increase output (within license) and improve resilience this will require utilisation of borehole 3 (BH3) in AMP7 as output from BH2 and BH4 is limited to 8 Ml/d.

Borehole 3 has an average iron concentration of 237.5 ug/l (averaged from the last 10 years of data from the sample manager) which cannot be reliably blended with BH2 and BH4 water due to fluctuating annual iron concentration.

Further to this, the effect of increased iron in the treated water from this site (although still below Prescribed Concentration or Value (PCV) at site) can build up in the distribution network and potentially affect our Distribution Operation and Maintenance Strategy (DOMS) statistics negatively by increasing the 'aesthetic serviceability' for iron within our network for water coming from Hunton Bridge.

Considerable investment was made in AMP5 to remove iron build-up in the network and manage customers' water supply and although this option was initially discounted from the water quality programme it is required to allow the implementation of sustainability reductions within WRZ1.

Taking the new information into consideration the decision was made to cost up an additional treatment process, along with other pumps and ancillary equipment required for this site to remove iron from the water. The additional treatment, pumps and ancillary equipment will be sized to treat the current 13.5 Ml/d (12 Ml/d + 1.5 Ml/d) site licence.

d.) Cholesbury chlorination plant

This measure is for the construction of a new chlorination plant at the Cholesbury service reservoir site to ensure that water quality within the network is maintained. The planned sustainability reduction at Chesham and Chartridge will remove the local (therefore low age) input of water that usually blends the water travelling in the trunk main between Bovingdon and Cholesbury reservoirs. Modelling has suggested that water age in the main could increase by 25 hours post sustainability reductions. In this part of the network water will be pumped from Heronsgate Reservoir through Bovingdon Reservoir and west to Cholesbury, a distance of approximately 23 km. The solution to install a new chlorination plant would ensure water quality meets the required standard. Plant has been sized based on flows in the area from Cholesbury boosters at Bovingdon, modelled future flows through boosters and flow through the Lee boosters.

e.) <u>Replacement of Heronsgate main</u>

This option involves replacing and upsizing the existing main from Heronsgate Reservoir to Bovingdon Reservoir. The 13.5km route is predominantly rural in classification and the main is used to send water north to maintain reservoirs at a number of locations around Hemel Hempstead, Berkhamsted and Amersham. It has been identified through modelling work that the volume of water and related pressure will increase during AMP7 following sustainability reductions and therefore at increased risk of bursts and failures.

5.2.3 Option 6 – Implementation of measures within WRZ1 without Amber sustainability reductions

This option comprises implementation of the WINEP Green sustainability reduction – Amersham, and associated measures to ensure security of supply is maintained, at a total cost of £9,846,018.

The measures comprise:

Measure	Project name	Outcome	Cost
a	Berkhamsted/Kingshill pump upgrade	Maintain supply in Heronsgate, Amersham and Hemel hydraulic demand zones, post sustainability reductions.	£2,718,334
b	Heronsgate to Bovingdon	Increase transfer capability between service reservoirs to offset sustainability reductions and associated pressure management.	£910,008
c	Hunton Bridge iron removal	Address site criticality post sustainability reduction	£6,217,676
			£9,846,018

<u>Benefits</u>

- B1. Resilience to WRZ1 (which supplies approximately 326,000 customers) would be maintained following sustainability reductions.
- B2. Continued supply to customers achieved.
- B3. Green WINEP requirements for WRZ1 achieved.

- B4. Delivery of AMP7 sustainability reductions which will aim to leave more water in the environment.

Risks

- R1. Amber sustainability reductions not addressed by this option. These reductions may be changed to Green and be confirmed post business case submission and implementation mandated by Environment Agency.

- R2. Lack of available space on site for construction of required treatment at Hunton Bridge.

- R3. Condition of existing Heronsgate to Bovingdon main is not consistent with condition assessment undertaken in 2018.

- R4. Additional output from Berkhamsted source can be achieved in line with licence with no deterioration impacts on local groundwater and/or river flows. Monitoring to be undertaken.

5.2.4 Option 7 – Implementation of measures within WRZ1 with Amber sustainability reductions

This option comprises implementation of the WINEP Green and Amber sustainability reductions – Amersham, Chartridge and Chesham, and associated measures to ensure that security of supply is maintained subsequent to their implementation, at a total cost of £10,116,363.

The measures comprise:

Measure	Project name	Outcome	Cost
a	Berkhamsted/Kingshill pump upgrade	Maintain supply in Heronsgate, Amersham and Hemel hydraulic demand zones, post sustainability reductions.	£2,718,334
b	Heronsgate to Bovingdon	Increase transfer capability between service reservoirs to offset sustainability reductions and associated pressure management.	£910,008
c	Hunton Bridge iron removal	Address site criticality post sustainability reduction	£6,217,676
d	Cholesbury chlorination plant	Maintain water quality in network post sustainability reduction	£270,345
			£10,116,363

Benefits

- B1. Resilience to WRZ1 (which supplies approximately 326,000 customers) would be maintained following sustainability reductions.
- B2. Continued supply to customers achieved.
- B3. Both Green and Amber sustainability reductions can be achieved in WRZ1 in line with WINEP requirements.
- B4. Option delivers against the expectations of our customers to leave more water in the environment.
- B5. Option meets the defined need of the business case for the lowest cost.
- B6. Addresses increased pressures in Heronsgate to Bovingdon main and reduces risks of bursts.
- B7. Feasible option for successful delivery by December 2024.

Risks

- R1. There is not available space on site for construction of required treatment at Hunton Bridge.
- R2. Condition of existing Heronsgate to Bovingdon main is not consistent with condition assessment undertaken in 2018.
- R3. Additional output from Berkhamsted source can be achieved in line with licence with no deterioration impacts on local groundwater and/or river flows.
- R4. There is not available space on site for construction of required treatment at Cholesbury booster for chlorination plant.
- R5. Customer acceptability issues due to increased water age and booster chlorination

5.2.5 Option 8 – Implementation of measures within WRZ1 with Amber sustainability reductions and alternative Heronsgate main

This option comprises implementation of the WINEP Green and Amber sustainability reductions – Amersham, Chartridge and Chesham, and associated measures to ensure that security of supply is maintained subsequent to their implementation, at a total cost of £27,507,397.

The measures comprise:

Measure	Project name	Outcome	Cost
a	Berkhamsted/Kingshill pump upgrade	Maintain supply in Heronsgate, Amersham and Hemel hydraulic demand zones, post sustainability reductions.	£2,718,334

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Measure	Project name	Outcome	Cost
c	Hunton Bridge iron removal	Address site criticality post sustainability reduction	£6,217,676
d	Cholesbury chlorination plant	Maintain water quality in network post sustainability reduction	£270,345
e	Heronsgate to Bovingdon main	Replacing and upsizing existing main between Heronsgate reservoir and Bovingdon reservoir	£18,301,042
			£27,507,397

Benefits

- B1. Resilience to WRZ1 (which supplies approximately 326,000 customers) would be maintained and improved following sustainability reductions.
- B2. Continued supply to customers achieved.
- B3. Both Green and Amber sustainability reductions can be achieved in WRZ1 in line with WINEP requirements.
- B4. Option delivers against the expectations of our customers to leave more water in the environment.
- B5. New 13.5km main between Heronsgate reservoir and Bovingdon reservoir would be adequate to meet increased water pressures and maintain supply.

Risks

- R1. Implementation of this option would mean improving resilience as part of the Sustainability Reduction Programme in WRZ1. This is above the scope of the Sustainability Reduction Programme which is maintaining the current level of resilience. Resilience improvements in line with our WRMP are included for elsewhere within our Supply 2040 business plan proposal.
- R2. Higher Capex cost associated with option when compared to best value option.
- R3. Not enough available space on site for construction of required treatment at Hunton Bridge.
- R4. Additional output from Berkhamsted source can be achieved in line with licence with no deterioration impacts on local groundwater and/or river flows.
- R5. Not enough available space on site for construction of required treatment at Cholesbury for chlorination plant.

5.3 Cost Benefit Analysis

The nature of this investment is focussed on a number of clear drivers, the most important of these being fulfilling our regulatory commitments by undertaking the sustainability reductions and maintaining water supply to our customers. As a result of these drivers the feasible options will not provide direct monetary benefits to us following implementation. Where expenditure is needed we have focussed on maximising efficiency to ensure the best value option is selected and future operational costs are kept to a minimum.

Option 6 has been ruled out as it does not include delivery of Amber WINEP sustainability reductions; Chartridge and Chesham. The AMP7 cost for this option would be £9,846,018.

Option 7 is the best value option as it ensures that security of supply to WRZ1 (with approximately 326,000 customers) would be maintained following implementation of Green and Amber sustainability reductions. The AMP7 cost for this option is **£10,116,363**. Operational costs relating to the network and our assets have been incorporated into our business plan.

The AMP7 cost for Option 8 is £27,507,397. This option requires the largest investment, and there was deemed to be insufficient evidence to justify the cost, as reservoir storage in the area effectively negates the need for main twinning.

The EA updated the Operational Catchment Economic Appraisals for the Colne in February 2018. The bundle of measures identified to meet WFD objectives includes the proposed AMP7 sustainability reductions and morphological actions (river restoration and habitat enhancement). The EA updated their operational catchment economic appraisals in February and March 2018, using costs prepared for our dWRMP and river restoration costs for delivering our ongoing AMP6 programme of works.

The Colne Operational Catchment Economic Appraisal used costs prepared for our dWRMP. The Colne catchment includes sustainability reductions at the following sources: Amersham, Chartridge, Chesham, Holywell and Mud Lane and river restoration works on the Colne, Ver, Gade, Misbourne and Chess. This assessed costs of £421 million to deliver the recommended bundle of measures with a **Benefit Cost Ratio of 1.76** (EA[1], 2018).

The monetary benefits of implementing the AMP7 sustainability reductions will be further quantified using a Natural Capital approach. This approach is currently being developed using the data collected post AMP6 sustainability reductions as a baseline. This method will allow us to use real data linked to indicators of environmental improvements to calculate financial benefits with increased confidence.

5.4 Recommendation

[1] Environment Agency, 2018. Operational Catchment Economic Appraisal – Final Appraisal Report and Audit Trail: Colne – Version number 3. February 2018

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Option 7 – Implementation of measures within WRZ1 with Amber sustainability reductions is the recommended option to ensure all drivers for the need are achieved. This option will implement measures within WRZ1 comprising:

Measure	Project name	Outcome	Cost
a	Berkhamsted/Kingshill pump upgrade	Maintain supply in Heronsgate, Amersham and Hemel hydraulic demand zones, post sustainability reductions.	£2,718,334
b	Heronsgate to Bovingdon	Increase transfer capability between service reservoirs to offset sustainability reductions and associated pressure management.	£910,008
c	Hunton Bridge iron removal	Address site criticality post sustainability reduction	£6,217,676
d	Cholesbury chlorination plant	Maintain water quality in network post sustainability reduction	£270,345
			£10,116,363

This option has been selected based on cost benefit analysis (Section 4.3) and a risk-based review of the benefits and risks (Section 4.2).

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18 Risks, Issues and Mitigation

The following risk and mitigation actions have been identified:

Risk/Issue	Mitigation
Disruption to customers and the community through replacement works.	Careful planning and effective communication of planned works to minimise disruption and keep customers informed.
Major national rail infrastructure project will be constructed running through WRZ1 in AMP7. Potential to impact on sources within the zone, which we are relying on replace the water lost through sustainability reductions.	Regular communication with internal and external HS2 project team to ensure conflicts avoided and outages required can be programmed well in advance.
Getting the right people in the project team with correct skillset to deliver best value option within time and budget whilst ensuring quality.	Programme Manager to identify required resources early to ensure correct team in place with correct skillset for effective and efficient delivery.
Additional land purchase, easements and permissions/consents are required to allow construction of required assets.	Early identification of routes for new mains to minimise risk and disruption required. Any land purchase or easements required to be identified early in concept phase and supporting resource made available to progress.
Timescales for procurement of equipment and installation and other operational outages.	Detailed programme planning to ensure works are planned in advance and other planned operational outages are considered.
Berkhamsted and Hunton Bridge sites will be run at maximum license output following Sustainability Reductions. This could have a negative impact on groundwater / river flows.	No deterioration assessment and monitoring will have to be undertaken post implementation in agreement with Environment Agency.
Additional modelling/detailed investigations lead to increase in scope/costs.	Ongoing engagement with modelling teams and stakeholders.
Customer perception of changing water quality associated with increased water age.	Engagement with External Communications and Customer Relations teams, with proactive communication of the expected changes.

19 Procurement Strategy

Affinity Water has Framework Agreements in place with Principle Contractors to deliver Above Ground Asset construction works. In addition, Framework Agreements are in place at a Tier 2 level (Pumps, MCCs, VSDs, Valves, Pipework, Security) to encourage standardisation and cost certainty. A process is ongoing to review the most cost-effective way procuring projects; at a high level, the process is considering:

- Early engagement beginning in the Concept stage to drive Innovation
- Allocation of grouping of projects to benefit from economies of scale
- The use of incentivisation in contracts, to improve early completion of projects and lower project costs
- Some competitive tendering (where appropriate) and KPI driven allocation to improve the level of competitive tension

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Appendices

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20 Appendices

8.1 Business Requirements

8.1.1 Requirements Priority Matrix

Designation	Explanation
Must	The solution will not be accepted if a requirement that has a priority of 'Must' has not been delivered
Should	The requirement with a priority of 'Should' would provide business benefit, but the business would accept a solution where this requirement was not delivered e.g. the solution could be delivered by other projects/changes of working practice. If possible the solution should deliver these requirements
Could	The requirement with a priority of 'Could' may provide some business benefit, but not as much as the requirements that have been prioritised as 'should' and 'must'. The business would accept a solution where this requirement was not delivered.
Won’t	Won't do this now but may wish to implement in the future

3.2.1 Functional Requirements

	Requirement Description	Rationale	Priority
1	The solution must remove the risk of iron in the network.	Business Plan commitment to make sure our customers have high quality water they can trust.	Must
2	The solution must ensure abstraction from the source can be maximised (within licence)	Water available for use	Must
3	The solution should be sufficiently robust such that it does not become a limiting factor on the site.	Water available for use – site downtime reduces output capacity and leads to poor pressure or even no water within the network, and therefore customer complaints.	Should
4	Provide resilience to supply area and flexibility in network operation, considering future sustainability reductions and predicted reliance on various imports to the supply region.	To supply wholesome drinking water in accordance with water quality standards.	Must
5	Provide security of supply	To avoid DG2 and DG3 issues in supply area.	Must
6	Treat all water produced on Affinity water sites to acceptable standard.	To supply wholesome drinking water in accordance with water quality standards.	Must

3.2.2 Non-Functional Requirements

	Requirement Description	Rationale	Priority
1	The solution should not impact on the operability of the rest of the process, and should not increase the site's operator input on the rest of the process through adverse downstream or upstream effects.	Leaving an intelligent operating legacy – maintaining or improving existing site operability so as not to put unnecessary strain on Production staff.	Should
2	Compliance with relevant Affinity Water standards and policies.	Ensure high quality of work.	Must
3	Governance documentation completed in line with project lifecycle	Ensure business case is valid and all stakeholders retain buy-in throughout project.	Must
4	Health and Safety will be a project priority. Risk Assessments and Method Statements will be required for all site work. Additionally, hazards for on-going maintenance will be reviewed through the design phase. The project will comply with CDM regulations.	Ensure all works are risk assessed and conducted in the safest way possible to promote zero harm.	Must
5	Update operational and maintenance manuals, update AMIS and tagging, update existing telemetry and SCADA software, update site drawings, update GIS information.	To ensure all site information and software is up to date.	Must
6	Improve overall security of supply and resilience of network in supply area.	To ensure customers are provided with clean drinking water, and we meet our regulatory requirements.	Should

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8.2 WINEP3 – confirmed reductions as per EA letter

Source	WRZ	WINEP3 Level of certainty	WINEP3 Date	Current Licence Average	Current Licence Peak	WINEP3 Sustainability Change Average	WINEP3 Sustainability Change Peak	Proposed WINEP3 New Licence Average	Proposed WINEP3 New Licence Peak	Current 1:200 drought DO Average	Current 1:200 drought DO Peak	Proposed Sustainability Reduction Average	Proposed Sustainability Reduction Peak	Post SR 1:200 Drought Average	Post SR 1:200 Drought Peak	Comment	Comment from EA
Amersham	1	Green	22/12/2024	4.00	9.00	2	2	2.00	7.00	4.00	9.00	2.00	2.00	2.00	7.00	Replaces Chalfont SR included at PR14 WINEP3 included Chalfont daily peak licence and not Amersham. Error confirmed in email from Marta Pluta 4th April 2018	
Chartridge	1	Amber	22/12/2024	group licence	2.05	-	2.05			1.52	1.66	1.52	1.66	0	0	This source is part of a group licence and has no individual annual average licence. Assumes cessation of abstraction as per email from Marta Pluta on the 1st May 2018	
Chesham	1	Amber	22/12/2024	5.22	7.09	5.22	7.09			4.86	6.00	4.86	6.00	0	0	Error on WINEP3 relating to licence volume and hence SC. Assumes cessation of abstraction as per email from Marta Pluta on the 1st May 2018	
Holywell	2	Green	22/12/2024	-	20.46	8.84	0	5.61	11.80	11.80	11.80	6.19	0	5.61	11.80	The split between these sources has been amended due to change in DO assessment between PR14 and PR19. NB Mud Lane is Holywell BH6	Agregated licence with max daily rate from Mud Lane (11.37Ml/d). Operated almost as one source. New licence will review operations at both sites and potentially update maximum daily rate for Mud Lane to reflect operation needs. No change is proposed to total peak rate on the licence.
Mud Lane	2	Green	22/12/2024	-			0	3.78	8.66	6.60	6.60	2.82	0	3.78	6.60		
Mud Lane/Holywell					*20.46*	*8.84*		*9.39*	*20.46*	*18.40*	*18.40*	*9.01*	*0*	*9.39*	*18.40*		
Baldock Road	3	Green	22/12/2024	4.55	4.55		0		4.55	3.20	3.60					Sources to be capped to recent actual. Bowring and Fuller DO constrained by DAPWL. AMP7 scheme to included river support of c0.4Ml/d from existing licence but no impact on DO Also listed as Amber SC	
Bowring	3	Green	22/12/2024	7.96	7.96		0		7.96	3.60	3.90						
Fuller	3	Green	22/12/2024	7.96	7.96		0		7.96	3.70	4.80						
Willian Road Group			22/12/2024	*14.77*	*20.47*	*0.63*	*0*	*14.14*	*20.47*	*10.50*	*12.30*	0	0	10.5	12.3		
Digswell	3	Green	22/12/2024	11.37	11.37	9.87	2.45	1.50	8.92	7.20	8.10	5.7	0.00	1.5	8.10	No reduction in peak DO included at PR14. The s20 agreement allows peak abstraction of 8.92Ml/d which is already a reduction from the LoR of 11.37Ml/d. We believe this is an error on WINEP3	Changes reflect recent discussions with Affinity Water.
Perwinkle Lane	3	Green	22/12/2024	4.99	5.00	4.99	5.00	0.00	0.00	4.60	5.00	4.60	5.00	0	0	Assumes cessation of abstraction	
Runleywood Chalk	3	Green	22/12/2024	9.55	9.55	9.55	9.55	0.00	0.00	5.60	6.40	5.60	6.40	0	0	Assumes cessation of abstraction	
Debden Road	5	Green	22/12/2024	3.41	3.49	0.34	0	3.07	3.49	3.07	3.40	0	0	3.07	3.40	Cap to recent actual.	
Newport	5	Green	22/12/2024	1.36	2.27	0.48	0	0.88	2.27	1.30	1.70	0.42	0	0.88	1.70	Cap to recent actual. Recent pump replacement so impacts DO.	
Springwell Farm	5	Green	22/12/2024	13.68	13.64	6.77	0	11.47	13.64	0.00	0.00	0	0	0	0	Dormant source	
Uttlesford Bridge	5	Green	22/12/2024	13.68	13.64	6.77	0	11.47	13.64	6.00	6.00	0	0	6	6	Assumes no reduction in DO due to existing licence condition. AMP7 to include provision of river support of up to 5.47Ml/d from licence capped to recent actual Also listed as Amber SC	Licence volume for supply at 6 ML/d confirmed by EAN Area. Morphological change/river restoration project planned to mitigate flow support volume needed during drought conditions.
Uttlesford Group			*22/12/2024*	*15.95*	*18.18*	*0.48*	*0*	*11.47*	*18.18*								
Wenden	5	Green	22/12/2024	4.55	4.55	2.01	0	2.53	4.55	2.30	2.60	0	0	2.30	2.60	Cap to recent actual. Option to increase DO removed from EBSD	
Central Region Green/Amber Total						**44.42**	**28.14**					**33.71**	**21.06**				
Central Region Green Total	**1, 2, 3 & 5**	Green				**39.20**	**19.00**					**27.33**	**13.40**				
Central Region Amber Total	**1**	Amber				**5.22**	**9.14**					**6.38**	**7.66**			Difference between the WINEP3 SC and SR relates to Chartridge not having an individual annual average licence and an error on WINEP3 relating to Chesham licence volume and hence SC.	
Higham	8	Amber	31/03/2021	6.50	10.00	2.597	2.597			5.02	6.88	2.60	2.60	5.02	6.88	Sources subject to two group licences with daily, annual and 5 year totals. Volume of reduction uncertain. EA have indicated reduction of 15 and 20Ml/d may be required	
Shelley	8	Amber	31/03/2021	3.90	7.00					2.89	4.17			2.89	4.17		
Lattinford	8	Amber	31/03/2021	2.47	4.00					1.81	2.70			1.81	2.70		
Stoke-by-Nayland	8	Amber	31/03/2021	11.70	13.00					8.00	10.93			8.00	8.33		
East Region Amber Total	**8**					**2.597**	**2.597**					**2.60**	**2.60**				

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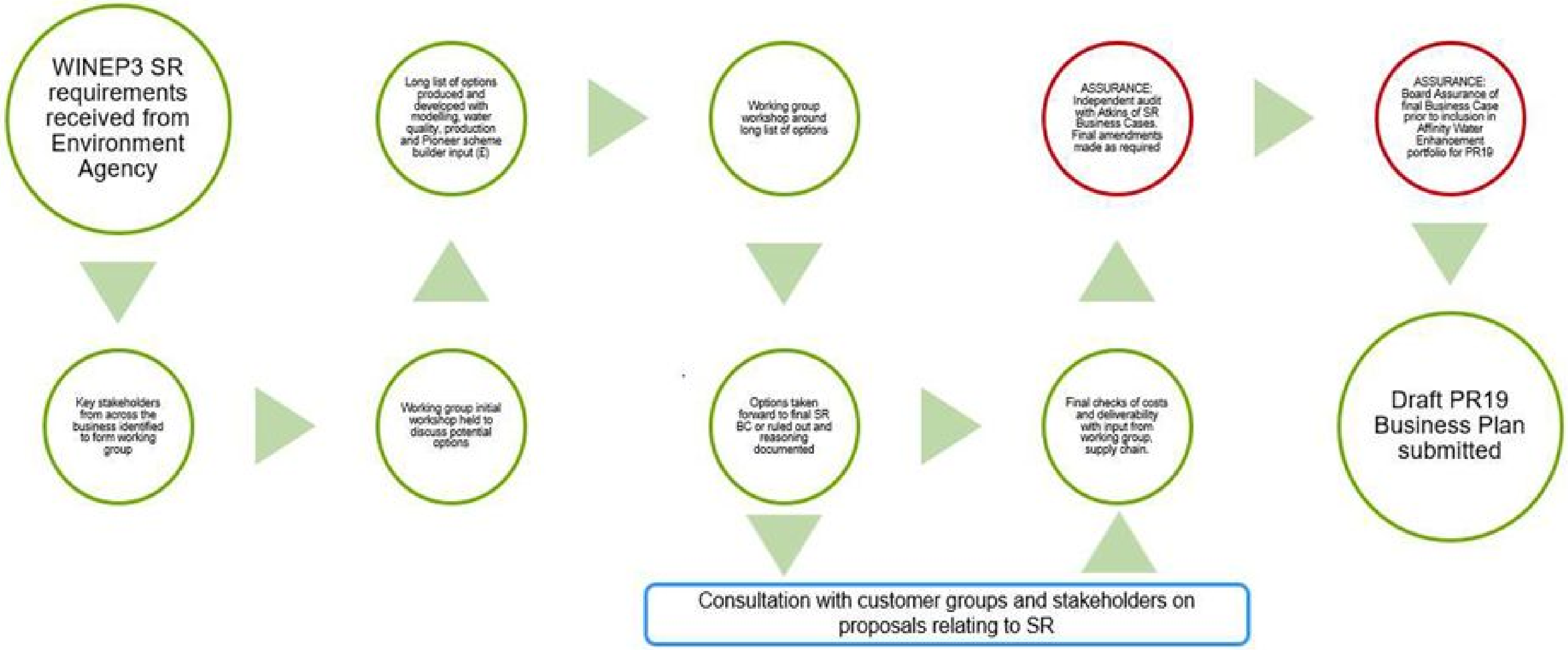
8.3 Sustainability reductions business case process



Appendix AFW.CE.A1.9

Action ref AFW.CE.A1

Sustainability Reductions Colne and Pinn Community

Sustainability Reductions - Colne Community (WRZ2)

PR19 Business Case

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March 2019

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Asset Strategy document control sheet

Document amendment history

Version	Status	Date	Amendment to this version
1.0	Final	03/09/2018	For issue with draft business plan
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Document approval

Document title	Sustainability Reduction WRZ2 Business Case			
e-Document location				
	Name	**Signature**	**Title**	**Date**
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Document Purpose

The purpose of the Project Business Case is to describe the reasons for the projects and the justification for undertaking them, based on the estimated costs of the project, the expected business benefits, savings and risks.

The Business case will also present all the options that have been assessed to deliver the project outcomes and will indicate the preferred options for each requirement out of all considered.

During the project a Business Case is a major controlled document that is referenced on a regular basis to ensure and confirm that the project remains viable. It is maintained throughout the lifecycle of the project, being reviewed by key stakeholders at key decision points, i.e. at the end of a phase.

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1. Executive Summary

Our revised draft Water Resources Management Plan (rdWRMP19) includes sustainability reductions of 36.31 Ml/d (average) and 23.66 Ml/d (peak) for delivery by December 2024. These reductions have been identified by the Environment Agency as being required to contribute towards the Water Framework Directive objectives. Investment of £58million has been included in our PR19 business plan submission to deliver Green and Amber sustainability reductions, in accordance with the associated regulatory guidance. Two sustainability reductions were identified for the Colne Community (Water Resource Zone 2).

This business case covers the investment required to enable implementation of the sustainability reductions in the Colne Community and maintain supplies to customers. It includes option development, risk assessment and cost benefit assessment undertaken to identify the best value option.

Nine options were identified to enable delivery of the sustainability reductions and maintain security of supply, with three options taken forward for detailed consideration.

The best value option to deliver sustainability reductions in WRZ2 is Option 8, which comprises of six measures; a new St Albans trunk main, changing booster pumps at Ickenham, a 6km main between Ickenham and Hillside Road, a booster pump at Oxhey Woods Reservoir, pressure reducing valves (PRVs) in district metered area (DMA) 6419 and granular activated carbon (GAC) treatment at Stonecross. This is considered the best value option as it maintains security of supply to WRZ2 following implementation of the sustainability reductions. The AMP7 cost for this option is £22,395,668, these costs have been included in our business plan submission under Environmental Enhancements. This business case will be reviewed and updated at key milestones throughout the life cycle of the project.

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2. Introduction

2.2 Background

Sustainability reductions are decreases in water company deployable output due to a sustainability change (licence change), which are identified as being required to improve river flow and ecology and meet the Water Framework Directive (WFD) objectives. Our revised draft Water Resources Management Plan (rdWRMP19) includes sustainability reductions of 36.31 Ml/d (average) and 23.66 Ml/d (peak) for delivery by **December 2024**.

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Figure 1 Location of sources subject to AMP7 sustainability reductions

The AMP7 sustainability reductions have been modelled at a water resource zone (WRZ) level using our Economic Balance of Supply and Demand (EBSD) model and transfers within and between zones have also been modelled using Miser (our bespoke model that simulates transfers between hydraulic demand zones (HDZs)). Our Miser modelling has helped identify network constraints and has been used to inform implementation requirements. This modelling work has confirmed that we cannot implement these sustainability reductions using demand management options alone and that we need to undertake works on both above and below ground assets, to ensure we maintain supply to our customers.

In our Colne Community (WRZ2) there are two sustainability reductions included on Water Industry National Environment Programme (WINEP) 3 (Holywell and Mud Lane, **WINEP ID Codes HNL00008 and HNL00009** respectively) totaling to a 9.01 Ml/d reduction in deployable output, this additional water left in the environment will aim to safeguard the local groundwater and support river flows in the River Ver. The WINEP3 reductions are provided in Appendix 7.2.

Across WRZ2 (Colne) an unconstrained list of nine options were identified to enable delivery of the AMP7 sustainability reductions and ensure customer supply is maintained once these have

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been implemented. Four feasible options were taken forward for further assessment and are detailed in this report.

2.3 Drivers

2.2.1 Water Framework Directive

The Environment Agency (EA) have assigned the following Water Framework Directive (WFD) drivers to sustainability reductions in WRZ2, within their WINEP.

Driver Code	Description
WFD_ND_WRFlow	Action to prevent deterioration of ecological status from flow pressures
WFD_IMP_WRFlow	Action to Improve hydrological regime to meet WFD objectives

The EU WFD binds the UK to delivering its requirements and does not impose any legal obligations on water companies or the EA directly. The WFD is implemented in England and Wales by the Water Environment (Water Framework (England and Wales) Regulations 2017 (WFD Regs)). The WFD requires waterbodies to achieve Good Ecological Status (GES) or Potential (GEP).

Since 1990, several of our abstraction licences have been identified by the EA to be potentially environmentally damaging. This has resulted in a series of environmental investigations and options appraisals (AMP2-6) through the Restoring Sustainable Abstraction (RSA) programme and National Environment Programme (NEP). The drivers for these projects are a combination of WFD, Habitats Directive, Sites of Special Scientific Interest (SSSI) and local biodiversity drivers which was considered to have the potential for impact on chalk streams, a biodiversity priority habitat.

2.2.2 Water resources and supply

The AMP7 sustainability reductions are included in our Water Resources Management Plan, which sets out how we will balance supply and demand over a 60-year planning horizon. We must ensure that we have adequate supplies to meet demand and maintain supplies to customers. Within the Colne Community (WRZ2) we supply approximately 187,144 properties, with a total population of 464,800.

2.2.3 Customer experience

We have listened to feedback from customers and stakeholders on our draft Water Resources Management Plan and included the Water Industry National Environment Programme (WINEP3) sustainability reductions in our plans. Feedback from our engagement indicates that 78% of our customers support us investing now to ensure there is sufficient water in future. We recognise the importance of sustainable abstraction and meeting the needs of customers and the environment. This business case supports delivery of our sustainability reductions whilst maintaining supplies to customers and communities.

2.4 Best Value Option

Option 8 – Implementation of measures within WRZ2 with network reconfiguration

The best value option for WRZ2 is to implement four identified measures to ensure customer supply and network resilience is maintained following the AMP7 sustainability reductions. For each measure a best value option has been selected. Together with the best value option for each measure discounted options applicable to each of the measures are listed with evidence as to why these have been discounted.

The best value option is comprised of the following six measures;

a) St Albans trunk main

b) Ickenham booster pumps change

c) 6km main, Ickenham to Hillside Road

d) Booster pump at Oxhey Woods Reservoir

e) Pressure Reducing valves in District Metered Area 6419

f) Stonecross granular activated carbon (GAC)

These measures in combination will allow the implementation of **sustainability reductions totalling 9.01 Ml/d in WRZ2** to be made and customer supply maintained with no reduction in the resilience of our water supply network.

2.5 Costs Summary Table

Costings for the best value option

	Y1	Y2	Y3	Y4	Y5	AMP7	20 Years
Costs (capex)	£885,000	£8,502,934	£8,502,933	£4,504,801	£-	£22,395,668	£22,395,668
Costs (opex)	£-	£-	£-	£-	£-	£-	£-
Risk	£88,500	£850,293	£850,293	£450,480	£-	£2,239,567	£2,239,567
Total costs (totex)	£885,000	£8,502,934	£8,502,933	£4,504,801	£-	£22,395,668	£22,395,668
Total revenue	£-	£-	£-	£-	£-	£-	£-
Funding requirement	£885,000	£8,502,934	£8,502,933	£4,504,801	£-	**£22,395,668**	£22,395,668
NPV (£k)	£-	£-	£-	£-	£-	-£20,724,000	-£20,724,000

At this stage of options development, we have detailed a 10% risk to all options for consistency but not included this figure within the options total funding required. We will seek to manage risk at a programme level across all projects and cover any risk funding requirement through the generation of efficiencies. These efficiencies will be generated through refinement during the life cycle of the programme, ensuring mitigation is included for all risk items and value engineering considered at key milestones. This approach reduces the total funding request across the AMP7 sustainability reductions programme by £5.84million.

2.6 Customer benefits and resilience

The primary purpose of this investment is to ensure we **maintain supply to customers** following the implementation of the AMP7 sustainability reductions. There are several other additional benefits that will be realised through implementation of this work as follows:

Supply resilience – The resilience of supply in zone WRZ2 will be maintained post implementation of sustainability reductions and further taking into account relationships with other projects such as Supply 2040.

Reduced water quality risk – raw water turbidity will be addressed to allow efficient utilisation of sources.

Improved security of supply following the implementation of the sustainability reductions.

Deliver regulatory expectations under the Water Industry National Environment Programme.

Contribute towards achieving **Water Framework Directive objectives**.

Improving the relationships with the local community, customers and stakeholders by **demonstrating our commitment to the environment** which we know through our consultation is important to our customers.

The importance our customers and stakeholders give to abstraction reductions is echoed in our bespoke **Performance Commitment relating to abstraction reduction** which this project will contribute towards.

The best value option **maintains supply resilience** and mitigates against operational incidents such as water quality. Through investment we are maintaining resilience of water supply to our customers, whilst considering future growth of local developments which put pressure on our network and capacity.

The investment made in WRZ2 under the Sustainability Reduction Programme is seeking only to **maintain supply to customers** in AMP7. We have consulted with colleagues preparing our Plan for Central region to capture links and any possible overlap. This assurance avoids double counting of options between sustainability reductions and other programmes so any opportunities/efficiencies are realised.

Innovation will be at the heart of delivering the best value option as we seek to drive down costs and maximise benefits for both our customers and the environment. Associated with these reductions we are keen to ensure we continue to **improve our understanding of the chalk aquifer** and the relationship to river flows both pre and post reduction so future investment can be targeted in the correct areas.

The Sustainability Reduction Programme drivers encourage us as a water company to think about how we can use our groundwater sources differently and to work with the new abstraction reform protocols to ensure the water we supply to customers is from more sustainable sources with lower impacts upon the environment.

The recommended best value option will also support achieving the target set out in the following performance commitment;

Performance Commitment supported by this project

Bespoke and Legacy PC	Current Performance	Base Plan J	SWR Plan L	SOP Plan K	Stakeholders / Customers	Final
Abstraction Reduction (Ml/d)	n/a	10	39	10	36	36

2.7 Methodology

The investment requirement has been identified and developed by our Asset Strategy team in collaboration with Production and Supply, Water Quality, Community Operations and Asset Delivery teams. The process is represented in Appendix 7.3 and details provided below.

11. Investigating and quantifying supply risk due to sustainability reductions in WRZ2, in combination with reductions in other zones. Initial risk workshop and discussions with internal stakeholders.

12. Identifying and optioneering solutions, systematically exploring options to identify highest cost benefit options. Options developed through engagement with stakeholders from Production, Operations Centre, Network, Water Quality, Leakage, Modelling, Trunk Mains and Mains Renewals, Asset Strategy and current AMP6 sustainability reductions programme team.

13. Further liaising with internal stakeholders through workshops to review proposed solutions and identify additional risks.

14. Modelling of network configurations, with data gathered from the company's systems to establish site failure rates etc. This includes: TRACE - our asset performance analysis tool (TRACE - Trackdown, Reliability, Availability, Cause & Effect), telemetry, Asset Risk Module (ARM), Asset Management Information System (AMIS), Geographic Information System (GIS) and business objects. Engaged with contractor base for asset information and costings for likely asset replacement.

15. Pioneer scheme builder, Economics of Balancing Supply and Demand (EBSD) model, and unit cost models have been used for estimation of costs. With regards to trunk mains, the current PR19 mains laying summary costs were used where appropriate.

Options have been developed using a standardised company process through the utilisation of Scheme Builder (a module of the PIONEER software tool). Scheme Builder allows us to cost the addition or modification of assets on a project basis for delivery purposes. The optimiser uses our asset data, deterioration curves, consequences and unit costs, to determine the optimal investment to meet a defined need.

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3 Defined Need and Dependencies

3.1 Defined need

Our groundwater abstractions at Holywell and Mud Lane in the River Ver catchment have been assessed under our AMP5 and AMP6 NEP. This has resulted in planned sustainability reductions (Green) under WINEP3. These proposed changes result in a sustainability reduction of 6.19 Ml/d from Holywell and 3.78 Ml/d from Mud Lane. These sources supply the local area of St Albans, and the criticality of the remaining available sources in the zone therefore increases with these changes.

There have been significant reductions in abstraction in the Ver catchment. In 1993, as part of the original Alleviation of Low Flow (ALF) schemes, the daily (average) abstraction at our Friars Wash source was reduced by c.13 Ml/d from 15.91 Ml/d to c2 Ml/d. An emergency provision on the licence remains, which allows us to revert to the pre-reduction volumes upon the declaration of an emergency. On 31 March 2016, Bow Bridge pumping station was closed as a planned sustainability reduction. This resulted in a reduction of abstraction of 6.82 Ml/d under average conditions.

WRZ2 (Colne) sustainability reductions

Source	Current Licence		WINEP3 Sustainability Change		PR19 DO (1 in 200 drought)		rdWRMP Modelled AMP7 Reduction		Resultant DO	
	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)
Holywell	-	20.46	8.84	0.00	11.80	11.80	6.19	0.00	5.61	11.80
Mud Lane	-			0.00	6.60	6.60	2.82	0.00	3.78	6.60
Sub-group	**-**	**20.46**	**8.84**	**0.00**	**18.40**	**18.40**	**9.01**	**0.00**	**9.39**	**18.40**

The implementation of these further reductions (Holywell and Mud Lane) in the Ver catchment are reliant on maintaining our abstraction capability at other groundwater sources in the area that are considered not to have a negative effect on river flows. Should these sources not be available due to water quality and/or other considerations, then this may delay our ability to implement sustainability reductions in the Ver catchment. We will work with the EA to follow up the polluter pays principle, so that costs for addressing third party pollution are not borne by our customers.

3.1.1 Identifying the risk

The imposition of a sustainability reductions at Holywell and Mud Lane will reduce our deployable output from these sources and, without intervention, put at risk our ability to supply customers within WRZ2.

Through our MISER modelling (our bespoke hydraulic demand zone model) we have identified that we cannot deliver the AMP7 sustainability reductions through the implementation of EBSD options (demand management, per capita consumption and leakage reductions) alone and that **capital works are required in WRZ2 to maintain supplies** to customers. Without undertaking this work we will not be able to maintain supplies to customers. The reduction in local source water, as a result of the sustainability reductions, will be offset by **increased import of water from Grafham** along with demand side measures included in our dWRMP. There are **distribution and storage requirements** that need to be addressed as a result of this, as well as local **source specific requirements** associated with increase criticality of sources and ensuring assets are appropriately sized for **efficient post sustainability reduction use**.

3.1.2 Asset background information

The Holywell source consists of three boreholes which currently provide an average deployable output of 8.20 Ml/d. The water from this source is treated on site before supplying customers in the St Albans area. The Mud Lane source consists of one borehole which currently provides an average deployable output of 10.03 Ml/d. The water from this source is treated on site before supplying customers in the St Albans area. These sources are part of the St Albans group licence along with Shakespeare Road, Stonecross and Redbourn. At present the St Albans area can be supported at peak times by an import via the Nethwerwild valve (Clay Lane derived water) but this will not be of sufficient capacity to replace water lost through the sustainability reductions.

3.2 Assumptions

- AMP6 sustainability reduction schemes are delivered before the AMP7 work commences.
- Sundon Conditioning Plant will be commissioned to allow Grafham derived water to support the overall mass balance of the network.
- Assumed compulsory land purchase is available for new treatment site (GAC contactor); location as identified later in planning and definition process
- The power supply and transformer for the unused Harefield pumps can be reused for the Ickenham transfer pumps
- The Harefield pumps can be removed, and a fifth pump can be sited in that space
- The existing suction and surge vessels need replacing to cater for increase surge pressures
- Assumed from modelling that the new trunk main will be able to operate under gravity feed, no need for boosters, therefore these are not included in final cost.
- Transfer through Walkers Road valve to St Albans is limited to 3.6 Ml/d due to operational constraints
- Planning permission would be granted for construction of new trunk main
- No loss of deployable output from Wheathampstead or other sources in area by the time the St Albans sustainability reductions are implemented, and we therefore have use of Harpenden import (at least 3.6 Ml/d) through the Walkers Road valve.
- The definition cost estimate assumes AMP 7 project for new trunk main will follow a similarly scaled cost schedule to the AMP 6 Sacombe to Whitehall project.
- Assumed that transients experienced in the Holywell/ Stonecross pumps have been dealt with as planned in the network calming programme.
- Transfer of up to 7 Ml/d into St Albans from the west is available.

- Further resilience infrastructure will be required to support future developments and the proposed rail freight centre to the south of St Albans.

- Main between Oxhey and Bushey can take up to 43 Ml/d.

- Existing building on site large enough to house Ickenham booster pumps and power supply to site adequate to meet demand.

- Existing building on site large enough to house new booster at Oxhey Woods Reservoir and existing power supply is adequate to meet revised demand.

3.3 Constraints

- Approval from governing bodies, such as the EA, is given for all schemes to be carried out.

- Import through Netherwild control valve may be limited to 5 Ml/d through the target the Operations Centre are working to in future supply scenarios.

- Limited space on site for new assets at Stonecross, Ickenham and Oxhey Woods Reservoirs.

- Gaining consents from landowners and required permissions for installation of required assets where we are not the landowner.
- Where new assets are required Environmental constraints relating to working within SSSI's and other protected areas need to be considered and permissions and mitigation put in place.
- Failure to achieve network outages for construction, commissioning and testing during times of high demand and drought conditions could lead to project delays.
- Availability of specialist supply chain designers and contractors to carry out large volume of work over a relatively tight time frame on a programme with limited free float.

- December 2024 WINEP deadline allows limited time frame for planning, design, consultation, implementation, commissioning, testing and handover of assets.

3.4 Dependencies

- Timeline is dependent on other Capex schemes occurring at the treatment works in question.

- This project is dependent on availability of resource from Production & Asset Strategy staff to facilitate the project's progress.

- Delivery of other AMP 7 programmes; Water Quality Strategy programme, including Sundon Conditioning Plant.

- Outputs of hydraulic modelling which accurately reflect future scenarios (frequent engagement with modellers, discussed output with other relevant stakeholders).

- Regular stakeholder meetings to discuss options and best way to progress.
- Alterations to flows and supply needs in areas dependant on MISER and Water Resource Management Plan output (frequent engagement with colleagues running these programmes, speak with senior managers to check latest plans and estimations).
- Potential AMP8 reductions – ensure plans for AMP7 consider potential AMP8 impact on supply and continue to meet with the EA to understand future plans.
- Sources are available and in supply (engage with treatment programme team to understand project progress).
- Successful delivery of AMP 6 programmes (noted in risk register - communicated dependency with stakeholders).
- Successful delivery of demand management options and savings as per rdWRMP, as part of the overall supply-demand balance.
- Interdependencies with other sustainability reduction projects in WRZ3 to maintain overall mass balance of supply system.
- Investment into Clay Lane site provides reliability of site output to support St Albans demand.

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21 Options Appraisal

4.1 Approach

The best value option has been identified through taking a holistic approach to the sustainability reductions programme. We have utilised output from our EBSD modelling for the WRMP, with more detailed MISER and InfoWorks hydraulic demand zone modelling. This in combination with stakeholder engagement has enabled us to identify the best value solution, taking in to account in combination effects of the sustainability reductions and the identification of efficiencies.

In order to gain a common understanding between stakeholders on the importance of delivery requirements under sustainability reductions programme, the MoSCoW (Must have, Should have, Could have and Won't have) method was used to evaluate functional and non-functional requirements (see Appendix 7.1).

4.2 Options

Costings for the Feasible Options

	Option 7	Option 8	Option 9
Year 1	£470,000	£885,000	£2,601,000
Risk	£47,000	£88,500	£260,100
Year 2	£3,510,104	£8,502,934	£7,508,134
Risk	£351,010	£850,293	£750,813
Year 3	£3,510,104	£8,502,933	£12,421,133
Risk	£351,010	£850,293	£1,241,133
Year 4	-	£4,504,801	-
Risk	-	£450,480	-
Year 5	-	-	-
Risk	-	-	-

Options 1, 2, 3, 4 and 5 were not costed as the more detailed assessment concluded that these options would not fully address the implementation requirements for the sustainability reductions and maintain security of supply.

The final option does not include risk, see Section 2.4.

4.2.1 Unconstrained Options

An initial un-constrained list of options was developed to enable delivery of the sustainability reductions and maintain supplies to customers.

4.2.2.1 *Rejected options:*

9. **Do nothing** – This option was rejected as not carrying out the sustainability reductions would mean not fulfilling our regulatory requirement to comply with WINEP objectives, which have a combination of drivers including WFD and local biodiversity drivers. This would also result in not achieving our bespoke performance commitment relating to abstraction reduction. Thirdly this option would go against listening to our customer base who we know support the implementation of works seeking to sustain and enhance the local environment.

10. **Twinning of 600mm trunk main from Clay Lane treatment works -** This option was discounted early in the process by the sustainability reductions working group, due to limited network flexibility and it being difficult and expensive to implement. The likely outcome of this option would be that resilience in the network would not be adequate, with an increased risk of water supply issues after the sustainability reductions have been implemented.

11. **Continued temporary GAC at Stonecross to deal with water quality issues** – this option was rejected as the effectiveness of temporary GAC filters hired in as required is deemed an unacceptable risk post sustainability reduction, due to lead times, process availability and site reconfiguration constraints.

12. **Turn around Nomansland as a source to support St Albans** – Install necessary infrastructure to allow this. This option was not progressed as the source is required for Welwyn given the sustainability reduction at Digswell. Too critical to supply-demand balance to use for supply elsewhere.

13. **Friars Wash to St Albans (Stonecross Reservoir)** – This option was discounted as it would be more disruptive to customers and more expensive (£15.8million) to implement than the St Albans trunk main solution.

14. **Implementation of all measures within WRZ2 with network reconfiguration and future resilience measures –** This option was considered as the scope would go above and beyond the drivers for sustainability reductions. The future requirements of our network to meet growth in population and demand will be covered by an alternative programme (Supply 2040).

10. Make licence reductions at sustainability reduction sources, with no investment in wider network – this option was rejected as this would result in an increased risk of failures, a higher number of single points of failure across our network impacting supply to customers

4.2.3 Feasible Options

Three potential options were brought forward for more detailed examination: -

15. **Implementation of measures within WRZ2 without network reconfiguration -** The measures within this option comprise of a) St Albans trunk main only with no network configuration to bring additional water into WRZ2.

16. **Implementation of measures within WRZ2 with network reconfiguration –** The measures within this option comprise of a) St Albans trunk main and network reconfiguration including b) Ickenham booster pumps change, c) 6km main, Ickenham to

Hillside Road, d) Booster pump at Oxhey Woods reservoir, e) pressure reducing valves in DMA 6419 and f) Stonecross granular activated carbon treatment.

17. **Implementation of measures within WRZ2 with alternative network reconfiguration –** The measures within this option comprise of a) St Albans trunk main and network reconfiguration including; f) Stonecross granular activated carbon treatment and g) Harefield reservoir to Oxhey Woods reservoir.

The measures **a** to **g** included in the feasible options above are described as follows:

a) St Albans trunk main

This measure looks to construct a new trunk main to bring water in from Friars Wash booster into Stonecross reservoir. The current network configuration allows for water to be transferred into Harpenden from Hemel Road to Walkers Road - however the import south into St Albans is limited by the way the current boosters work in the area. This means that we cannot use this current configuration to help support St Albans in the future sustainability reductions scenario. In addition, Stonecross Reservoir 2 cannot operate below 50%, - low levels in the reservoir can lead to water quality issues due to elevated levels of trichloroethene and tetrachloroethene. Stonecross source is also known to suffer from water quality issues during drought periods. This is an additional factor to be taken into consideration when assessing the need for investment in the St Albans supply area. At present imports in the St Albans supply area account for 44% of the supply. Review of our Serck (telemetry system) shows Stonecross reservoirs 1 and 2 usually operating between 30-70% and, 60-90% respectively. If we lose one or both imports in the future scenario there is a high risk of DG2 or DG3 issues, due to a loss of local sources Holywell and Mud Lane post sustainability reductions.

A connection into the old Bow Bridge main and then extension into St Albans is proposed. This main could be used daily to transfer at least 2 Ml/d into St Albans - with a capability of 7 Ml/d at peak, with 5 Ml/d from Clay Lane, or to support the area if a loss of Clay Lane import occurs.

A condition assessment on the old Hemel Road to Bow Bridge main needs to be undertaken during the definition phase, as this will have been out of use since 2016. Once this has been completed a decision can be taken as to whether or not to recommission this main, or slip-line it to Bow Bridge. A new connection will then be made from Bow Bridge into the outlet of Stonecross Reservoir. The current proposed route that has been costed as part of this business case follows the main road (Redbourne Road) into St Albans – this route location could change after further analysis in the definition phase to avoid the road and go across farmland from Bow Bridge to the north of St Albans.

b) Ickenham booster pumps change

c) 6km main, Ickenham to Hillside Road

d) Booster pump at Oxhey Woods Reservoir

e) Pressure reducing valves in DMA 6419

Measures b, c, d and e have been identified as reinforcements required to the network to allow water to be transferred to zones with deficits post sustainability reductions. These measures need to be implemented in conjunction for the network reinforcements to be effective.

Through modelling it has been identified that there will be a deficit in the supply areas directly affected by the sustainability reductions, and those indirectly affected across the Central supply region. To reduce these deficits, it is proposed to import more water to Clay Lane from the South of our network, through; upsizing Ickenham Boosters from 70 to 82 Ml/d. Increasing capacity and replacing pressure reducing valves into DMA 6419, and upsizing the trunk main (to 700mm) to accommodate additional water.

Stakeholder discussions confirmed that if the Ickenham main is upsized or twinned, there is confidence that the Hillside Road valve can take additional import and would not cause any issues in the Clay Lane zone as water would go into the Oxhey Reservoir. Having a booster from Oxhey to Bushey Reservoir, means reversing the flow direction. Normally water gravitates from Bushey to Oxhey if required.

This solution brings more water to Clay Lane to support water quality requirements, and also improves turnover in Oxhey Woods Reservoir.

f) Stonecross granular activated carbon (GAC)

Our Drinking Water Safety Plans indicate that Stonecross groundwater source in St Albans is at risk from pollution from volatile organic compounds (VOC) which is a historic pollutant in the catchment. The sum of trichloroethene (TCE) and tetrachloroethene (PCE) can exceed the current Prescribed Concentration or Value (PCV) limit of 10µg/l (set by the Drinking Water Standards), under drought conditions. We experienced TCE concentrations above the standard in 2011/2012 drought conditions at Stonecross WTW. During the low groundwater conditions of 2017 and 2018, there has been an increase in sum of TCE and PCE concentrations at the Stonecross source. In order to slow the rate of increase, there has been reduced abstraction from the source since August 2017. The peak concentration in 2017 was 6.2µg/l and the peak concentration in 2018 was 5.9µg/l.

Stonecross is located in the St Albans hydraulic demand zone and has an average deployable output of 2.05 Ml/d (2016), peak deployable output of 3.00 Ml/d (2016) and a maximum daily licence of 3.41 Ml/d. The treatment works supplies approximately 4,232 properties. On site there are two boreholes that are both part of the St Albans group licence which has an average annual licence of 22.79 Ml/d and a maximum daily licence of 30.69 Ml/d. This group licence is shared with Holywell, Mud Lane, Redbourne, and Shakespeare Road. There is greater utilisation of the group licence at Shakespeare Road due to water quality blending requirements of our source at Wheathampstead, thus increasing the criticality of keeping Stonecross in service.

Assessment of water quality at Stonecross has confirmed that no further preliminary treatment is required in addition to GAC.

PIONEER Scheme Builder has been used to generate a cost estimate for permanent GAC adsorption contactors at Stonecross WTW. The scheme includes 3 GAC contactors each with a filter area of $3.2m^2$ and media volume of $11.7m^3$. At the design flow of 3.41 Ml/d a hydraulic loading rate of 14.9m/h and an empty bed contact time of 14.8 minutes would be achieved.

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g) <u>Harefield Reservoir to Oxhey Woods Reservoir</u>

This measure looks at an alternative route for a new main described under measure c (Ickenham to Hillside Road). The proposed new route for the main would be 4.6km in length running from Harefield reservoir to Oxhey Woods reservoir. Measure b (Ickenham booster pumps change) would be replaced by a booster at Harefield resulting in a cost saving of £813,267. However, despite this large cost saving the actual trunk main route is more expensive and a number of issues present a great deal of risk to the routes implementation with two significant sections running under private land. This could result in significant delays in negotiating route agreements and compensation payments to landowners.

4.2.4 Option 7 – Implementation of measures within WRZ2 without network reconfiguration

The measures comprise:

Measure	Project name	Outcome	Cost
a	St Albans trunk main	Transfers water into the zone to replace volume lost by sustainability reduction	£7,490,208
			£7,490,208

<u>Benefits</u>

- B1. Sustainability reduction at the two sources can be implemented in the short term in line with WINEP requirements, therefore meeting customer expectations for us to leave more water in the environment
- B2. Lower Totex cost associated with option when compared to best value option.

<u>Risks</u>

- R1. No way of supporting Stonecross reservoirs without wider network reinforcements.
- R2. Option increases risks of low levels in Stonecross reservoir leading to an increase in water quality issues.
- R3. During periods of high demand, customer supply would not be maintained following implementation of sustainability reductions. Model runs show significant water deficit in WRZ2, particularly during periods of high demand. Future predictions indicate more frequent and prolonged periods of high demand.
- R4. Existing assets in WRZ2 would be pushed harder to meet demand, more failures would occur and gaining maintenance outages to maintain/repair assets would become more difficult.
- R5. Asset criticality and number of single points of failure across the Affinity Water network would increase.
- R6. Option requires the continuation of temporary GAC at Stonecross reservoir, which increases operational risk and criticality of site.

4.2.5 Option 8 – Implementation of measures within WRZ2 with network reconfiguration

The measures within this option comprise:

Measure	Project name	Outcome	Cost
a	St Albans trunk main	Transfers water into the zone to replace volume lost by sustainability reduction	£7,490,208
b	Ickenham booster pumps change	Network modifications to allow water to be transferred to zones with deficits post sustainability reduction	£1,458,090
c	6km main, Ickenham to Hillside Road		£11,335,073
d	Booster pump at Oxhey Woods reservoir		£1,043,022
e	Pressure reducing valves in DMA 6419	Pressure management post sustainability reduction	£68,216
f	Stonecross granular activated carbon treatment	Addresses site criticality post sustainability reductions to maintain supply to customers	£1,001,059
			£22,395,668

This option comprises of the measures but also includes for network reinforcements to maintain security of supply after sustainability reductions.

<u>Benefits</u>

- B1. Resilience to WRZ2 would be maintained following sustainability reductions.
- B2. Continued supply to customers achieved without water quality issues or supply interruptions.
- B3. Option meets the defined need of the business case for the lowest cost.
- B4. The proposed main from Ickenham to Hillside Road requires fewer agreements with private landowners and has a fewer number of unknowns associated with it. Leading to increased confidence in deliverability.
- B5. Feasible option for successful delivery by December 2024.
- B6. Enables successful delivery of the sustainability reductions as required in WINEP3.
- B7. Contributes towards achieving WFD objectives.
- B8. Contributes towards achieving performance commitment relating to abstraction reduction.
- B9. Addresses increased criticality of Stonecross during low groundwater conditions.

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- B10. Delivers against expectations of our customers to leave more water in the environment.
- B11. Feasible option for successful delivery by December 2024.

Risks

- R1. Will require back washing of filters, as part of routine operations at Stonecross GAC.
- R2. Power supply at Ickenham may need to be upgraded to meet requirements of new booster pumps.

4.2.6 Option 9 – Implementation of measures within WRZ2 with alternative network reconfiguration

The measures within this option comprise:

Measure	Project name	Outcome	Cost
a	St Albans trunk main	Transfers water into the zone to replace volume lost by sustainability reduction	£7,490,208
f	Stonecross granular activated carbon treatment	Addresses site criticality post sustainability reductions to maintain supply to customers	£1,001,059
g	Harefield Reservoir to Oxhey Woods Reservoir	Alternative route for transfer of water to Oxhey Woods Reservoir	£14,039,000
			£22,530,267

The option proposes an alternative arrangement in terms of network reinforcements. The Ickenham to Hillside Road main has been removed from the measures and replaced with an alternative route, Harefield reservoir to Oxhey Woods reservoir.

Benefits

- B1. Resilience to WRZ2 would be maintained following sustainability reductions.
- B2. Continued supply to customers achieved without water quality issues or supply interruptions.
- B3. Network operating costs would be reduced in comparison to option 8.

Risks

- R1. Higher CAPEX cost associated with option when compared to option 8.
- R2. Agreements from multiple landowners would be required to lay new main from Harefield reservoir to Oxhey Woods. This could lead to unknown delays and cost increases.

4.3 Cost Benefit Analysis

The nature of this investment is focussed on a number of clear drivers, the most important of these being fulfilling our regulatory commitments by undertaking the sustainability reductions and maintaining water supply to our customers. As a result of these drivers the feasible options will not provide direct monetary benefits to us following implementation. Where expenditure is needed we have focussed on maximising efficiency to ensure the best value option is selected and future operational costs are kept to a minimum.

Option 7 has been ruled out as it would result in risks to security of supply following implementation of sustainability reductions in WRZ2. The AMP7 cost for this option would be £7,490,208.

Option 8 is considered the best value option as it ensures that security of supply to WRZ2 (with approximately 187,144 customers) would be maintained following implementation of sustainability reductions. The AMP7 cost for this option is **£22,395,668**.

Option 9 is associated with a cost of £22,530,267. This option requires higher investment than the best value option. The proposed route for the new main between Harefields reservoir and Oxhey Woods reservoir was assessed during sustainability reduction workshops as being of higher risk than other options.

The EA updated the Operational Catchment Economic Appraisals for the Colne in February 2018. The bundle of measures identified to meet WFD objectives includes the proposed AMP7 sustainability reductions and morphological actions (river restoration and habitat enhancement). The EA updated their operational catchment economic appraisals in February and March 2018, using costs prepared for our dWRMP and river restoration costs for delivering our ongoing AMP6 programme of works.

The Colne Operational Catchment Economic Appraisal used costs prepared for our dWRMP. The Colne catchment includes sustainability reductions at the following sources: Amersham, Chartridge, Chesham, Holywell and Mud Lane and river restoration works on the Colne, Ver, Gade, Misbourne and Chess. This assessed costs of £421 million to deliver the recommended bundle of measures with a Benefit Cost Ratio of 1.76 (EA[2], 2018).

The monetary benefits of implementing the AMP7 sustainability reductions will be given further quantification using a Natural Capital approach. This approach is currently being developed using the data collected post AMP6 sustainability reductions as a baseline. This method will allow us to use real data linked to indicators of environmental improvements to calculate financial benefits with increased confidence.

4.4 Recommendation

[2] Environment Agency, 2018. Operational Catchment Economic Appraisal – Final Appraisal Report and Audit Trail: Colne – Version number 3. February 2018

Option 8 – Implementation of measures within WRZ2 with network reconfiguration is the recommended option to ensure all drivers for the need are achieved. This option will implement measures within WRZ2 comprising of the following:

Measure	Project name	Outcome	Cost
a	St Albans trunk main	Transfers water into the zone to replace volume lost by sustainability reduction	£7,490,208
b	Ickenham booster pumps change	Network modifications to allow water to be transferred to zones with deficits post sustainability reduction	£1,458,190
c	Ickenham to Hillside Road		£11,334,973
d	Oxhey Woods booster		£1,043,022
e	PRVs in DMA 6419	Pressure management post sustainability reduction	£68,216
f	Stonecross treatment	Addresses site criticality post sustainability reductions to maintain supply to customers	£1,001,059
			£22,395,668

This option has been selected based on cost benefit analysis (Section 4.3) and a risk-based review of the benefits and risks (Section 4.2).

5 Risks, Issues and Mitigation

The following risk and mitigation actions have been identified:

Risk/Issue	Mitigation
New proposed trunk main will not be able to operate under gravity conditions and will require investment of booster pumps to enable transfer to Stonecross reservoir.	Undertake trial to understand current capabilities for transfer and likely capabilities for new main, develop booster set into cost of project if required.
Rail freight development impacts on supply through damage to infrastructure or increased unforeseen demand.	Company to engage with council to understand proposals fully and water requirement.
Disruption to customers and the community through replacement works.	Careful planning and effective communication of planned works to minimise disruption and keep customers informed.
Getting the right people in the project team with correct skillset to deliver best value option within time and budget whilst ensuring quality.	Programme Manager to identify requirement resources early to ensure correct team in place with correct skillset for effective and efficient delivery.
Timescales for procurement of equipment and installation and other operational outages.	Detailed programme planning to ensure works are planned in advance and other planned operational outages are considered.
Sundon Conditioning Plant is not fully commissioned and operational by December 2024, limiting the areas that can be fed by Grafham derived water due to water quality concerns.	Dependency mapping and collaboration between internal delivery teams to ensure efficient and timely delivery to enable sustainability reductions to go ahead as planned.
Additional land purchase, easements and permissions/consents are required to allow construction of required assets.	Early identification of routes for new mains to minimise risk and disruption required. Any land purchase or easements required to be identified early in concept phase and supporting resource made available to progress.

6 Procurement Strategy

Affinity Water has Framework Agreements in place with Principle Contractors to deliver Above Ground Asset construction works. In addition, Framework Agreements are in place at a Tier 2 level (Pumps, MCCs, VSDs, Valves, Pipework, Security) to encourage standardisation and cost certainty. A process is ongoing to review the most cost effective way procuring projects; at a high level, the process is considering:

- Early engagement beginning in the Concept stage to drive Innovation.
- Allocation of grouping of projects to benefit from economies of scale.
- The use of incentivisation in contracts, to improve early completion of projects and lower project costs and delays.
- Some competitive tendering (where appropriate) and KPI driven allocation to improve the level of competitive tension.

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Appendices

7 Appendices

7.1 Business Requirements

7.1.1 Requirements Priority Matrix

Designation	Explanation
Must	The solution will not be accepted if a requirement that has a priority of 'Must' has not been delivered
Should	The requirement with a priority of 'Should' would provide business benefit, but the business would accept a solution where this requirement was not delivered e.g. the solution could be delivered by other projects/changes of working practice. If possible, the solution should deliver these requirements
Could	The requirement with a priority of 'Could' may provide some business benefit, but not as much as the requirements that have been prioritised as 'should' and 'must'. The business would accept a solution where this requirement was not delivered.
Won't	Won't do this now but may wish to implement in the future

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7.1.2 Functional Requirements

	Requirement Description	Rationale	Priority
1	Provide resilience to supply area and flexibility in network operation, considering future sustainability reductions and predicted reliance on 7 Ml/d import from Clay Lane, and 3.6 Ml/d import from Harpenden.	To supply wholesome drinking water in accordance with water quality standards.	Must
2	Treat imported water to acceptable WQ standards, to enable supply to St Albans without adverse effects during distribution.	To supply wholesome drinking water in accordance with water quality standards	Must
3	Provide security of supply through construction of alternative supply main – transferring water to support Stonecross reservoir.	To avoid DG2 and DG3 issues in supply area.	Must
4	The solution must remove the risk of water quality issues.	Business Plan commitment to make sure our customers have high quality water they can trust.	Must
5	The solution must ensure abstraction from non-sustainability reduction sources can be maximised (within licence)	Water available for use	Must
6	The solution should be sufficiently robust such that it does not become a limiting factor on the site.	Water available for use – site downtime reduces output capacity and leads to poor pressure or even no water within the network, and therefore customer complaints.	Should
7	Treat all water produced on Affinity water sites to acceptable standard.	To supply wholesome drinking water in accordance with water quality standards.	Must

7.1.3 Non-Functional Requirement

	Requirement Description	Rationale	Priority
1	Maintain overall security of supply and resilience of network in supply area.	To ensure customers are provided with clean drinking water, and we meet our regulatory requirements.	Must
2	Compliance with Health & Safety standards and policies, and works are conducted in the safest way possible to promote zero harm.	Health & Safety will be a project priority. Risk Assessments and Method Statements will be required for all site work.	Must

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3	Governance documents completed in line with project lifecycle	Ensure business case is valid and updated throughout lifecycle and stakeholders continued buy-in is maintained.	Must
4	Compliance with relevant Affinity Water standards and policies	Ensure high quality of work	Must
5	The solution should not impact on the operability of the rest of the process and should not increase the site's operator input on the rest of the process through adverse downstream or upstream effects.	Leaving an intelligent operating legacy – maintaining or improving existing site operability so as not to put unnecessary strain on Production staff.	Should
6	Update operational and maintenance manuals, update AMIS and tagging, update existing telemetry and SCADA software, update site drawings, update GIS information.	To ensure all site information and software is up to date.	Must

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7.2 WINEP3 – confirmed reductions as per EA letter

Source	WRZ	WINEP3 Level of certainty	WINEP3 Date	Current Licence Average	Current Licence Peak	WINEP3 Sustainability Change Average	WINEP3 Sustainability Change Peak	Proposed WINEP3 New Licence Average	Proposed WINEP3 New Licence Peak	Current 1:200 drought DO Average	Current 1:200 drought DO Peak	Proposed Sustainability Reduction Average	Proposed Sustainability Reduction Peak	Post SR 1:200 Drought Average	Post SR 1:200 Drought Peak	Comment	Comment from EA
Amersham	1	Green	22/12/2024	4.00	9.00	2	2	2.00	7.00	4.00	9.00	2.00	2.00	2.00	7.00	Replaces Chalfont SR included at PR14 WINEP3 included Chalfont daily peak licence and not Amersham. Error confirmed in email from Marta Pluta 4th April 2018	
Chartridge	1	Amber	22/12/2024	group licence	2.05	-	2.05			1.52	1.66	1.52	1.66	0	0	This source is part of a group licence and has no individual annual average licence. Assumes cessation of abstraction as per email from Marta Pluta on the 1st May 2018	
Chesham	1	Amber	22/12/2024	5.22	7.09	5.22	7.09			4.86	6.00	4.86	6.00	0	0	Error on WINEP3 relating to licence volume and hence SC. Assumes cessation of abstraction as per email from Marta Pluta on the 1st May 2018	
Holywell	2	Green	22/12/2024	-	20.46	8.84	0	5.61	11.80	11.80	11.80	6.19	0	5.61	11.80	The split between these sources has been amended due to change in DO assessment between PR14 and PR19. NB Mud Lane is Holywell BH6	Agregated licence with max daily rate from Mud Lane (11.37Ml/d). Operated almost as one source. New licence will review operations at both sites and potentially update maximum daily rate for Mud Lane to reflect operation needs. No change is proposed to total peak rate on the licence.
Mud Lane	2	Green	22/12/2024	-			0	3.78	8.66	6.60	6.60	2.82	0	3.78	6.60		
Mud Lane/Holywell					*20.46*	*8.84*		*9.39*	*20.46*	*18.40*	*18.40*	*9.01*	*0*	*9.39*	*18.40*		
Baldock Road	3	Green	22/12/2024	4.55	4.55		0		4.55	3.20	3.60					Sources to be capped to recent actual. Bowring and Fuller DO constrained by DAPWL. AMP7 scheme to included river support of c0.4Ml/d from existing licence but no impact on DO Also listed as Amber SC	
Bowring	3	Green	22/12/2024	7.96	7.96		0		7.96	3.60	3.90						
Fuller	3	Green	22/12/2024	7.96	7.96		0		7.96	3.70	4.80						
Willian Road Group			22/12/2024	*14.77*	*20.47*	*0.63*	*0*	*14.14*	*20.47*	*10.50*	*12.30*	0	0	10.5	12.3		
Digswell	3	Green	22/12/2024	11.37	11.37	9.87	2.45	1.50	8.92	7.20	8.10	5.7	0.00	1.5	8.10	No reduction in peak DO included at PR14. The s20 agreement allows peak abstraction of 8.92Ml/d which is already a reduction from the LoR of 11.37Ml/d. We believe this is an error on WINEP3	Changes reflect recent discussions with Affinity Water.
Perwinkle Lane	3	Green	22/12/2024	4.99	5.00	4.99	5.00	0.00	0.00	4.60	5.00	4.60	5.00	0	0	Assumes cessation of abstraction	
Runleywood Chalk	3	Green	22/12/2024	9.55	9.55	9.55	9.55	0.00	0.00	5.60	6.40	5.60	6.40	0	0	Assumes cessation of abstraction	
Debden Road	5	Green	22/12/2024	3.41	3.49	0.34	0	3.07	3.49	3.07	3.40	0	0	3.07	3.40	Cap to recent actual.	
Newport	5	Green	22/12/2024	1.36	2.27	0.48	0	0.88	2.27	1.30	1.70	0.42	0	0.88	1.70	Cap to recent actual. Recent pump replacement so impacts DO.	
Springwell Farm	5	Green	22/12/2024	13.68	13.64	6.77	0	11.47	13.64	0.00	0.00	0	0	0	0	Dormant source	
Uttlesford Bridge	5	Green	22/12/2024	13.68	13.64	6.77	0	11.47	13.64	6.00	6.00	0	0	6	6	Assumes no reduction in DO due to existing licence condition. AMP7 to include provision of river support of up to 5.47Ml/d from licence capped to recent actual Also listed as Amber SC	Licence volume for supply at 6 ML/d confirmed by EAN Area. Morphological change/river restoration project planned to mitigate flow support volume needed during drought conditions.
Uttlesford Group			*22/12/2024*	*15.95*	*18.18*	*0.48*	*0*	*11.47*	*18.18*								
Wenden	5	Green	22/12/2024	4.55	4.55	2.01	0	2.53	4.55	2.30	2.60	0	0	2.30	2.60	Cap to recent actual. Option to increase DO removed from EBSD	
Central Region Green/Amber Total						**44.42**	**28.14**					**33.71**	**21.06**				
Central Region Green Total	**1, 2, 3 & 5**	Green				**39.20**	**19.00**					**27.33**	**13.40**				
Central Region Amber Total	**1**	Amber				**5.22**	**9.14**					**6.38**	**7.66**			Difference between the WINEP3 SC and SR relates to Chartridge not having an individual annual average licence and an error on WINEP3 relating to Chesham licence volume and hence SC.	
Higham	8	Amber	31/03/2021	6.50	10.00	2.597	2.597			5.02	6.88	2.60	2.60	5.02	6.88	Sources subject to two group licences with daily, annual and 5 year totals. Volume of reduction uncertain. EA have indicated reduction of 15 and 20Ml/d may be required	
Shelley	8	Amber	31/03/2021	3.90	7.00					2.89	4.17			2.89	4.17		
Lattinford	8	Amber	31/03/2021	2.47	4.00					1.81	2.70			1.81	2.70		
Stoke-by-Nayland	8	Amber	31/03/2021	11.70	13.00					8.00	10.93			8.00	8.33		
East Region Amber Total	**8**					**2.597**	**2.597**					**2.60**	**2.60**				

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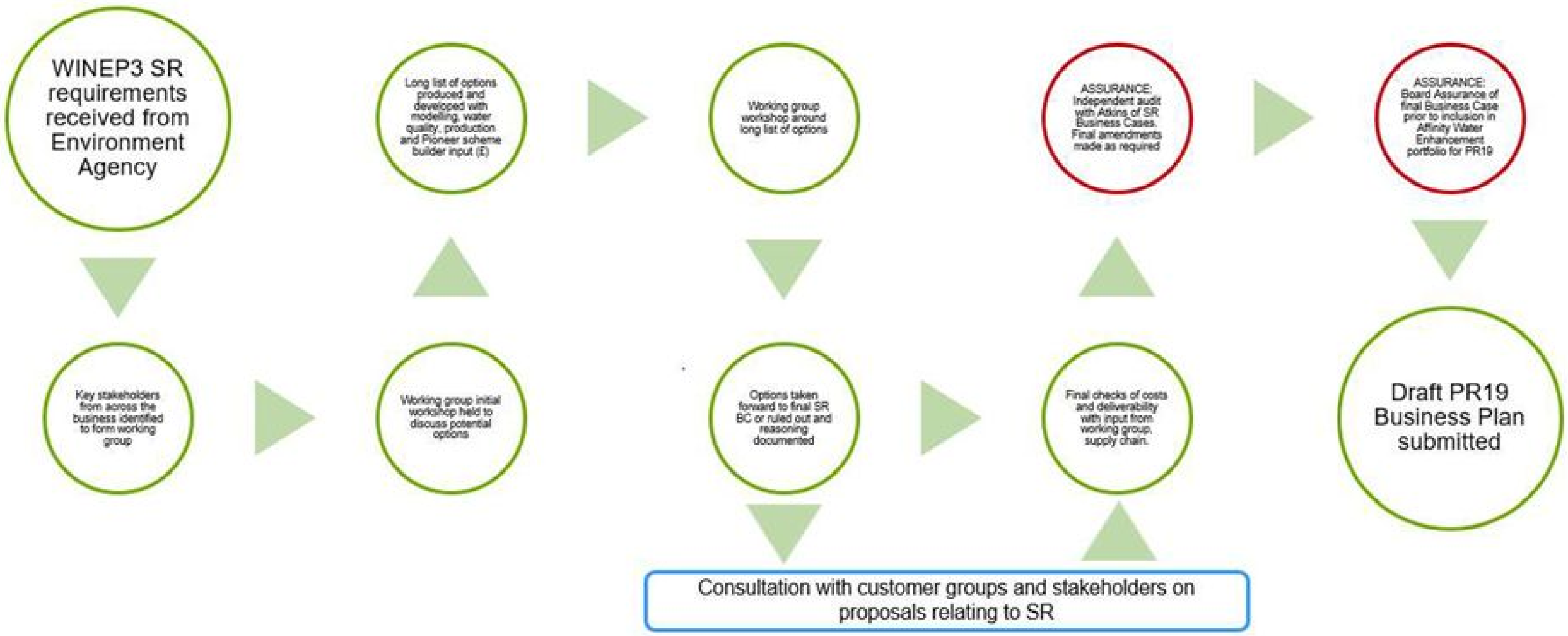
7.3 Sustainability reductions business case process



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Appendix AFW.CE.A1.10

Action ref AFW.CE.A1

Sustainability Reductions - Lee Community (WRZ3)

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Sustainability Reductions - Lee Community (WRZ3)

PR19 Business Case

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March 2019

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Asset Strategy document control sheet

Document amendment history

Version	Status	Date	Amendment to this version
1.0	Final	03/09/2018	For issue with draft business plan
2.0	Final	15/03/2019	Updated to new template for resubmission

Document approval

Document title	Sustainability Reduction WRZ3 Business Case for resubmission			
e-Document location				
	Name	**Signature**	**Title**	**Date**
Author/originator	Ellie Powers		Senior Asset Manager Asset Manager	11/03/2019
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Document Purpose

The purpose of the Project Business Case is to describe the reasons for the projects and the justification for undertaking them, based on the estimated costs of the project, the expected business benefits, savings and risks.

The Business case will also present all the options that have been assessed to deliver the project outcomes and will indicate the preferred options for each requirement out of all considered.

During the project a Business Case is a major controlled document that is referenced on a regular basis to ensure and confirm that the project remains viable. It is maintained throughout the lifecycle of the project, being reviewed by key stakeholders at key decision points, i.e. at the end of a phase.

1 Executive Summary

Our revised draft Water Resources Management Plan (rdWRMP19) includes sustainability reductions of 36.31Ml/d (average) and 23.66Ml/d (peak) for delivery by December 2024. These reductions have been identified by the Environment Agency as being required to contribute towards Water Framework Directive objectives. Investment of £58million has been included in our PR19 business plan submission to deliver green and amber sustainability reductions, in accordance with the associated regulatory guidance.

This business case covers the investment required to enable implementation of the sustainability reductions in the Lee Community (Water Resource Zone 3) and maintain supplies to customers. It includes option development, risk assessment and cost benefit assessment undertaken to identify the best value option.

Ten options were identified to enable delivery of the sustainability reduction with three options selected for detailed consideration. The completion of site specific measures, a new storage cell and network reinforcement (Option 9) was identified as the best value option at a cost of £16,791,929. These costs have been included in our business plan submission under Environmental Enhancements. This business case will be reviewed and updated at key milestones throughout the life cycle of the project.

2 Introduction

2.1 Introduction

Sustainability reductions are decreases in water company deployable output due to a sustainability change (licence change), which are identified as being required to improve river flow and ecology, to meet Water Framework Directive (WFD) objectives. Our revised draft Water Resources Management Plan (rdWRMP19) includes sustainability reductions of 36.31Ml/d (average) and 23.66Ml/d (peak) for delivery by December 2024.

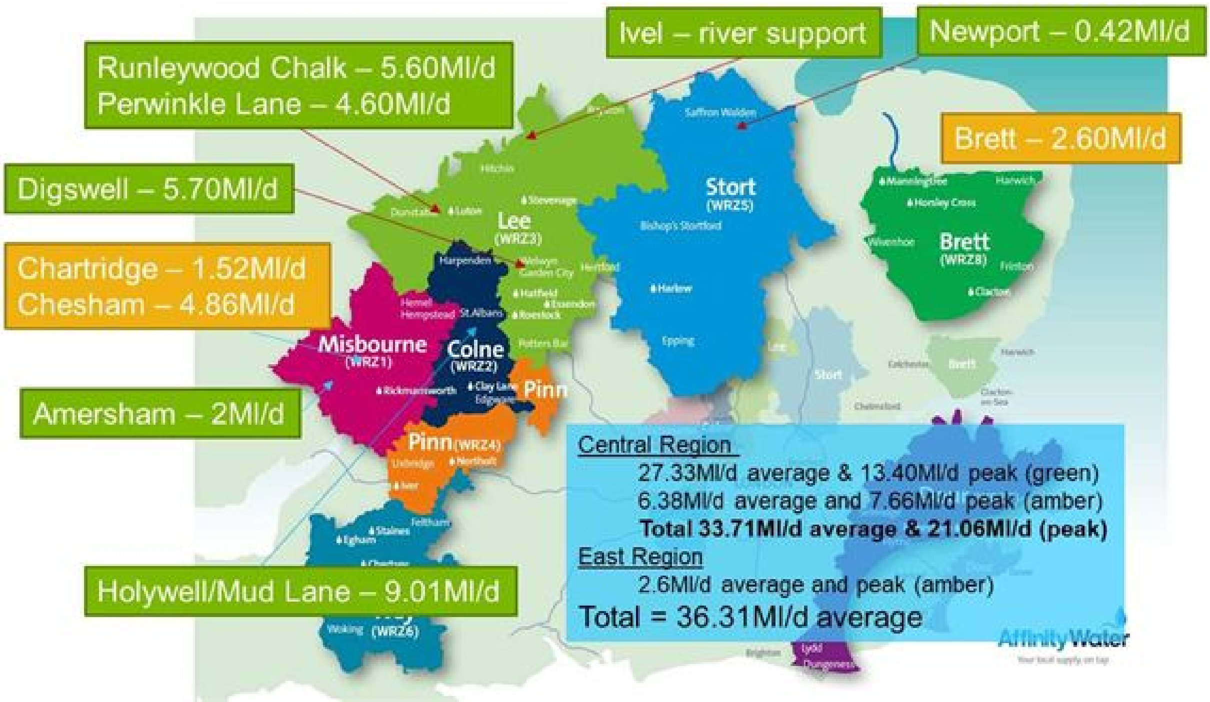

Figure 12 Location of sources subject to AMP7 sustainability reductions

The AMP7 sustainability reductions have been modelled at a water resource zone (WRZ) level using our Economic Balance of Supply and Demand (EBSD) model and transfers within and between zones have also been modelled using Miser (our bespoke model that simulates transfers between hydraulic demand zones (HDZs)). Our Miser modelling has helped identify network constraints and has been used to inform implementation requirements. This modelling work has confirmed that we cannot implement these sustainability reductions using demand management options alone and that we need to undertake works on both above and below ground assets, to ensure we can maintain supply to our customers.

In our Lee Community (WRZ3) there are six sources subject to sustainability changes. This is made up of a cessation in abstraction from two sources (Runleywood and Periwinkle Lane – WINEP ID **HNL00015** and **HNL00016**), a reduction at Digswell (WINEP ID **HNL00014**) and the implementation of a river support scheme in the Ivel catchment affecting our Willian Road Group of sources (Bowring, Fuller and Baldock Road) (WINEP ID **EAN00020**, **EAN00021** and **EAN00022**).

Across WRZ3 (Lee) a total of **seven independent measures** have been identified to ensure customer supply is maintained following the AMP7 Sustainability Reductions. For each requirement. Feasible options have been put forward and a final best value option to meet all requirements selected. Together with the best value option discounted options applicable to each of the requirements are listed with evidence as to why these have been discounted.

This business case sets out the evidence for an investment totaling £16,791,929 to meet the identified needs.

2.2 Drivers

2.2.1 Water Framework Directive & NERC Act

The Environment Agency have assigned the following Water Framework Directive (WFD) and Natural Environment and Rural Community (NERC) Act drivers to the sustainability reductions in WRZ3, within their Water Industry National Environment Programme (WINEP).

Driver Code	Description
WFD_IMP_WRFlow	Action to Improve hydrological regime to meet WFD objectives
NERC_IMP2	Changes to permits or licences, where there is evidence and it contributes towards biodiversity priorities and the NERC Act.

The EU WFD binds the UK as a whole to delivering its requirements and does not impose any legal obligations on water companies or the EA directly. The WFD is implemented in England and Wales by the Water Environment (Water Framework (England and Wales) Regulations 2017 (WFD Regs)). The WFD requires waterbodies to achieve good ecological status (GES) or potential (GEP) which may or may not be linked to increases in river flows.

Since 1990, a number of our abstraction licences have been identified by the EA to be potentially environmentally damaging. This has resulted in a series of environmental investigations and options appraisals (AMP2-6) through the Restoring Sustainable Abstraction (RSA) programme and NEP. The driver for these projects is a combination of WFD, Habitats Directive, Sites of Special Scientific Interest (SSSI) and local biodiversity drivers where there was considered to be the potential for impact on chalk streams, a biodiversity priority habitat.

2.2.2 Water Resources and Supply

The AMP7 sustainability reductions are included in our Water Resources Management Plan, which sets out how we will balance supply and demand over a 60 year planning horizon. We must ensure that we have adequate supplies to meet demand and maintain supplies to customers. In the Lee Community we supply a population of 689,500 in 302,798 properties.

2.2.3 Customer Experience

We have listened to feedback from customers and stakeholders on our draft Water Resources Management Plan and included the Water Industry National Environment Programme (WINEP3) sustainability reductions in our plans. Feedback from our engagement indicates that 78% of our customers support us investing now to ensure there is sufficient water in future. We recognise the importance of sustainable abstraction and meeting the needs of customers and the environment. This business case supports delivery of our sustainability reductions whilst maintaining supplies to customers and communities.

2.3 Best Value Option

The best value option for WRZ3 is to implement seven identified measures to ensure customer supply and network resilience is maintained following the AMP7 sustainability reductions. After assessing each requirement a best value option has been selected. Together with the best value option for each requirement discounted options applicable to each of the requirements are listed with evidence as to why these have been discounted. The best value solution has been selected to allow the implementation of sustainability reductions in WRZ3 and movement of water between WRZ3 and WRZ5, to compensate for the associated loss of source output. This solution is made up of the optimum combination of schemes identified through the options appraisal process.

The best value option for WRZ3 is to implement the following seven measures, **1. Resize borehole pumps and treatment at Digswell, 2. Installation of additional PRVs in Welwyn, 3. Run to waste facility at Nomansland, 4, New trunk main Black Fan Road to Sherrards Wood, 5. New cell at Bulls Green reservoir, 6. Beech Road reconfiguration** and **7. Letchworth to Royston reinforcemen**t.

These requirements in combination will allow the implementation of **sustainability reductions totalling 15.9Ml/d in WRZ3** to be made and customer supply maintained with no reduction in the resilience of our water supply network.

2.4 Costs Summary Table

Costings for the Best Value Option

	Y1	Y2	Y3	Y4	Y5	AMP7	20 Years
Costs (capex)	£3,538,426	£5,100,189	£5,105,191	£3,048,123	£-	£16,791,929	£16,791,929
Costs (opex)	£-	£-	£-	£-	£-	£-	£-
Risk	£353,843	£510,019	£510,519	£304,812	£-	£1,679,193	£1,679,193
Total costs (totex)	£3,538,426	£5,100,189	£5,105,191	£3,048,123	£-	£16,791,929	£16,791,929
Total revenue	£-	£-	£-	£-	£-	£-	£-
Funding requirement	£3,538,426	£5,100,189	£5,105,191	£3,048,123	£-	**£16,791,929**	£16,791,929
NPV (£k)						-£15,666,000	-£15,666,000

At this stage of option development we have detailed a 10% risk to all options for consistency but not included this figure within the options funding requirement. We will seek to manage risk at a programme level across all projects and cover any risk funding requirement through the generation of efficiencies. These efficiencies will be generated through refinement during the life cycle of the programme, ensuring mitigation is included for all risk items and value engineering considered at key milestones. This approach reduces the total funding request across the AMP7 sustainability reductions programme by £5.84million.

2.5 Customer benefits and resilience benefits

The primary purpose of this investment is to ensure we **maintain supply to customers** following the implementation of the AMP7 sustainability reductions. There are a number of other additional benefits that will be realised through implementation of this work as follows:

Supply resilience - removing turbidity restrictions at our Nomansland, one of the sources that increases in criticality following the sustainability reduction in WRZ3, allowing the site to be brought into supply in a **timely** manner and thereby reduce the risk of customer supply interruptions.

Maintain security of supply following the implementation of the sustainability reductions. Investing in the options proposed as part of this business case we are maintaining the resilience of our remaining sources that supply customers in WRZ3.

Addresses new single point of failures created through reduction or cessation in abstraction at Digswell, Periwinkle Lane and Runleywood.

Appropriate sizing of assets for peak and average demand will allow **more efficient operation**.

The importance our customers and stakeholders give to abstraction reductions is echoed in our bespoke **Performance Commitment relating to abstraction reduction** which this project will contribute towards.

Deliver regulatory expectations under the Water Industry National Environment Programme.

Contribute towards achieving **Water Framework Directive objectives**.

Improving the relationships with the local community, customers and stakeholders via **demonstrating our commitment to the environment** which we know through our consultation is important to our customers.

The investment made in WRZ3 under the Sustainability Reduction Programme is seeking only to maintain supply to customers in AMP7. We have consulted with colleagues preparing our Plan for Central region to capture links and any possible overlap. This assurance avoids double counting of options between sustainability reductions and other programmes so any **opportunities/efficiencies are realised**.

Innovation will be at the heart of delivering the preferred option as we seek to drive down costs and maximise benefits for both our customers and the environment. Associated with these reductions we are keen to ensure we continue to improve our understanding of the chalk aquifer and the relationship to river flows both pre and post reduction so future investment can be targeted in the correct areas.

We use **knowledge of our sources** and the network to identify how we can use sites differently to **support environmental objectives**, whilst giving consideration to abstraction reform and future regulatory and legislative changes to help the environment. Furthering our understating of the chalk aquifer through monitoring and groundwater modeling, working with the Environment Agency, British Geological Survey and other stakeholders to achieve this. A continuation of our groundwater level, river flow and ecological monitoring pre and post reductions will allow us to fully understand benefits and use this knowledge to **inform future decision making**.

The recommended best value option will also support achieving the target set out in the following performance commitment;

Performance Commitment Supported by this project:

Bespoke and Legacy PC	Current Performance	Base Plan J	SWR Plan L	SOP Plan K	Stakeholders / Customers	Final
Abstraction Reduction (Ml/d)	n/a	10	39	10	36	36

2.6 Methodology

The investment requirement has been identified and developed by our Asset Strategy team in collaboration with Production and Supply, Water Quality, Community Operations and Asset Delivery teams.

16. Investigating and quantifying supply risk due to sustainability reductions in WRZ3, in combination with reductions in other zones. Initial risk workshop and discussions with internal stakeholders.

17. Identifying and optioneering solutions, systematically exploring options to identify the solution with the highest cost benefit. Options developed through engagement with stakeholders from Production, Operations Centre, Network, Water Quality, Leakage, Modelling, Trunk Mains and Mains Renewals, Asset Strategy and current AMP6 sustainability reductions programme team.

18. Further liaising with internal stakeholders through workshops to review proposed solutions and identify additional risks

19. Modelling of network configurations, with data gathered from the company's systems to establish site failure rates etc. This includes: TRACE - our asset performance analysis tool (TRACE - Trackdown, Reliability, Availability, Cause & Effect), telemetry (SERCK), Asset Risk Module of Pioneer (ARM), telemetry, Asset Management Information System (AMIS), Geographic Information System (GIS) and business objects. Engaged with contractor base for asset information and assurance of costs for likely asset replacement/installation.

20. Pioneer scheme builder, Economic Balance of Supply and Demand (EBSD) model, and the unit cost model have been used for estimations of costs. With regards to trunk mains, the current PR19 mains laying summary costs were used where possible.

Options have been developed using a standardised company process through the utilisation of Scheme Builder (a module of the PIONEER software tool). Scheme Builder allows us to cost the addition or modification of assets on a project basis for delivery purposes. The optimiser uses our asset data, deterioration curves, consequences and unit costs, to determine the optimal investment to meet a defined need. Stakeholders (Water Quality, Production, Network etc.) have been engaged through workshops, and the risk analysis and cost calculations have been peer reviewed (see Appendix 7.2 for process diagram).

3 Defined Need and Dependencies

3.1 Defined need

There are six sources in WRZ3 that are subject to sustainability changes (licence changes) in WINEP3. This equates to a total reduction in deployable output (sustainability reduction) in WRZ3 of 15.9Ml/d (average) and 11.4Ml/d (peak). Three of these sources (the William Road Group) are already drought constrained and therefore these reductions do not impact drought deployable output used in our rdWRMP19 but the reduction does impact normal operation.

3.1.1 Digswell

The River Mimram is a chalk stream which has been identified, through a series of studies between AMP3 and AMP5, as suffering from low flows considered to be the result of public water supply abstraction. A reduction in groundwater abstraction from two sources in the catchment was proposed at PR14, to be implemented in two phases. We delivered the first reduction of 9.09Ml/d from our source at Fulling Mill in April 2017.

A second phase of abstraction reductions for the Mimram catchment was planned at PR14 for implementation in AMP7 from our source at Digswell. **A reduction of 5.7Ml/d (average DO)** has been included in WINEP3 for **implementation by December 2024** and reflected in our rdWRMP19 (Appendix 7.4).

Modelling has identified that following the sustainability reduction Welwyn Garden City will require at least 5Ml/d to be imported through Black Fan Road. This imported water will be Grafham derived and is therefore reliant on Sundon Conditioning Plant to ensure water quality compliance.

Bulls Green is a strategic storage site and has been identified as a critical site for movement of water through our network. The reservoir site is located at a key distribution point in our network, supplying the hydraulic demand zones in central and eastern part of Central region (WRZ3 & 5).

3.1.2 Runleywood and Periwinkle Lane

At PR14 we included the cessation of abstraction from Runleywood Chalk and Periwinkle Lane as two likely sustainability reductions in the Upper Lea for delivery in AMP7. Following a Stage 3 Water Framework Directive assessment by the Environment Agency in 2014, these sources were included in WINEP3 as a green (confirmed) reduction for a **full cessation in abstraction (reduction of 10.20Ml/d average and 11.40Ml/d peak) by December 2024**.

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Affinity Water

Digswell, Runleywood and Perwinkle Lane sustainability reductions

Source	Current Licence		WINEP3 Sustainability Change		PR19 DO (1 in 200 drought)		rdWRMP Modelled AMP7 Reduction		Resultant DO	
	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)
Digswell	11.37	11.37	9.87	2.45	7.20	8.10	5.70	0.00	1.50	8.10
Runley Wood	9.55	9.55	9.55	9.55	5.60	6.40	5.60	6.40	0.00	0.00
Periwinkle Lane	4.99	5.00	4.99	5.00	4.60	5.00	4.60	5.00	0.00	0.00

3.1.3 Willian Road Group

Our sources in the Ivel catchment (Baldock Road, Bowring and Fuller) known as the Willian Road group have been subject to an AMP6 investigation and options appraisal. This National Environment Programme (NEP) project concluded that there is an effect of abstraction from Bowring and Fuller on groundwater levels in the vicinity of the Ivel Springs but due to the modification of the channel, the effect on river flows does not transmit downstream significantly. The WFD assessment point at A507 Roadbridge Stotfold is also found to be compliant for flow and therefore any impact of abstraction is likely to be localised to the headwaters only.

The agreed way forward for the Ivel is therefore to cap the annual abstraction licence to recent actual abstracted volumes, a **sustainability change of 0.63Ml/d and implement a river support scheme** in the Ivel Springs area by **December 2024**. These sources are drought constrained by the deepest advisable pumping water level (DAPWL) and therefore there is no impact on the 1 in 200 year drought DO, but a reduction to the normal group average DO by 0.63Ml/d is still applicable to ensure no deterioration.

A provision for a river support scheme has been included in our Environment Enhancements section of PR19 business plan, along with river restoration and habitat enhancement works. Details of this are provided in the Wholesale Technical Appendices (Section 4 Environmental Enhancements).

Willian Road Group sustainability reductions

Source	Current Licence		WINEP3 Sustainability Change		PR19 DO (1 in 200 drought)		rdWRMP Modelled AMP7 Reduction		Resultant DO	
	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)
Baldock Road	4.55	4.55	0.63	0.00	3.20	3.60	0.00	0.00	3.20	3.60
Bowring	7.96	7.96		0.00	3.60	3.90	0.00	0.00	3.60	3.90
Fuller	7.96	7.96		0.00	3.70	4.80	0.00	0.00	3.70	4.80
Willian Road Group	**14.77**	**20.47**	**0.63**	**0.00**	**10.50**	**12.30**	**0.00**	**0.00**	**10.50**	**12.30**

3.1.4 Identifying the risk

Through our MISER modelling (our bespoke hydraulic demand zone model) we have identified that we cannot deliver the AMP7 sustainability reductions through the implementation of EBSD options (demand management, per capita consumption and leakage reductions) alone and that **capital works are required in WRZ3 to maintain supplies** to customers. Without undertaking this work we will not be able to maintain supplies to customers. The reduction in local source water, as a result of the sustainability reductions, will be offset by **increased import of water from Grafham** along with demand side measures included in our dWRMP. There are **distribution and storage requirements** that need to be addressed as a result of this, as well as local **source specific requirements** associated with increased criticality of sources and ensuring assets are appropriately sized for **efficient post sustainability reduction use**.

Five reservoirs were identified through model analysis and stakeholder engagement as critical for future supply scenarios post sustainability reductions. Reservoirs were investigated to understand the ease of current outage, risks surrounding valve operations, increases in pressure. These were assessed against the sustainability reductions to identify direct correlation. Where assets were identified as part of wider supply demand requirements these were considered under Supply 2040. This resulted in the following service reservoirs being considered under the AMP7 sustainability reduction programme: Bulls Green, Chaul End, Weston Hills and Wicker Hall.

3.1.5 Asset Background Information

There are two operational boreholes (borehole 5 and 6) at Digswell which are used to supply customers in the Welwyn Garden City area. Historically the area was supplied by two groundwater sources Fulling Mill and Digswell. Our groundwater sources in this area have already been subject to a 9.09Ml/d reduction as part of the AMP6 sustainability reductions programme. Abstraction from our Fulling Mill source ceased in April 2017[3]. Water for supply in the area since this reduction has been met by utilising our Nomansland and Digswell sources and supplemented at peak times via the Black Fan Road booster.

The current Digswell ultra-violet (UV) treatment is sized for 16Ml/d, and consists of four UV lamps; with the decrease in flowrate, post sustainability reduction, the velocity at which the water will travel through the asset will be too low for both dosing and mixing in the static mixer. The static mixer is designed for a minimum flow of 4Ml/d. The water will also not have enough head to travel through the treatment process post sustainability reduction with the new average deployable output of 1.5Ml/d.

With a further AMP7 reduction at Digswell (5.7Ml/d average), the criticality of the Nomansland source increases further, works are therefore required to improve its reliability and ensure its continued operation. The Nomansland source suffers from turbidity spikes related primarily to rainfall events. This issue therefore needs to be addressed to ensure reliability of Nomansland, once the reduction at Digswell comes into effect in December 2024.

[3] In response to concerns expressed by the Environment Agency over potential flood risk, an operating agreement under Section 20 of the Water Resources Act was signed between Affinity and the EA in September 2017, which permits the use of Fulling Mill under certain criteria. The agreement aggregates abstraction from Fulling Mill and Digswell to maintain the 9.09Ml/d reduction from the catchment and is considered to be a temporary arrangement whilst the EA undertake flood risk mitigation works.

Digswell is located in the Bulls Green hydraulic demand zone. There are 65,000 properties that rely on Bulls Green reservoir for their supply and following sustainability reduction at Digswell there is a need to mitigate risk of interruption to supply and the increased reliance on transfers from Grafham import.

Water abstracted from our Runleywood (chalk) and Periwinkle Lane sources are used to supply customers in the Luton and Dunstable area. The Runleywood chalk pumps to Chaul End service reservoir and Periwinkle Lane pumps to Beech Road service reservoir. Supply to the Luton area post sustainability reduction can be met by increasing utilisation of Grafham derived water. This requires the commissioning of the Sundon Conditioning Plant to ensure we meet water quality requirements; addressing taste, odour and discolouration issues from using a greater volume of Grafham derived water in a historically groundwater fed area.

Beech Road service reservoir is supplied by the Kensworth Lynch and Periwinkle Lane sources. Following the sustainability reduction at Perwinkle Lane this service reservoir under the current set up would only be fed by Kensworth Lynch. Modelling has shown that if Beech Road reservoir were to lose input from the Periwinkle Lane source (as will occur with the sustainability reduction), the level of Beech Road reservoir would drop to a critical level (20%) after approximately 2 days. Work is therefore required to maintain supply to customers and ensure no deterioration of level of service.

Following sustainability reductions across Central region, there will be an increased import of Grafham Water into our supply area. To allow this to transfer east through WRZ3 and specifically into the deficit Royston and Buntingford HDZ, investment is required to enable the flow from Grafham via Weston Hills reservoir, near Letchworth, to Wicker Hall reservoir, near Royston. MISER modelling has identified a deficits post sustainability reduction in the Royston and Buntingford zone of our Central region at average and peak demand, without mitigation works. In order to close the demand deficit the main between Weston Hills reservoir must be sufficiently sized to bring treated water into the Wickerhall reservoir and the inlet at the reservoir upsized.

3.2 Assumptions

- According to hydraulic modelling, Sherrards Wood Reservoir could last three days, supported with an import of 6Ml/d through Black Fan Road. Alongside this, it has been seen through previous trials that Black Fan Road is capable of up to 500m3/hour (12Ml/d) if required. It is therefore assumed that no pump upgrade at Black Fan Road is required as part of this programme.
- Water Quality Strategy programme has completed works on conditioning of Grafham derived water at Sundon by the time sustainability reductions come into place, enabling import of water through Black Fan Road without causing water quality issues.
- Current Section 20 operating agreement with the Environment Agency to operate Fulling Mill will have ceased. Digswell treatment will therefore be downsized according to operation after 2024 with sustainability reductions in place.
- At this point the definition cost estimate assumes AMP7 project for new trunk main will follow a similarly scaled cost schedule to the AMP6 Sacombe to Whitehall project.
- NPV cost avoidance for Nomansland run to waste based on it being out of supply for four weeks whilst disinfection, flushing, and reinstatement of the main occurred. This is based on previous experience.

- All district meter areas (DMAs) fed by Sherrards Wood Reservoir requiring a pressure reduction valve (PRV) - other than the three identified under this project - will be covered by the Leakage programme by the end of AMP7.
- Assumed unit cost of £600/m for the trunk main calculation and £450/m for the run to waste facility based on previous projects.
- The Beech Road reconfiguration assumes Periwinkle high lifts can be used to re-lift to Beech Road Reservoir, by cross-connecting from the Chaul End 12" main, then storage time would be 1.3 days. As water from Chaul End could contain a proportion of surface water the aim would be for no more than 5 days in storage.

3.3 Constraints

- Operation of Clay Lane and North Mymms will impact import ability into Welwyn Garden City.
- Gaining consents from landowners and required permissions for installation of assets.
- Where new assets are required environmental constraints relating to working within designated sites e.g. SSSI's or other protected areas need to be considered and permissions and mitigation put in place.
- Gaining outages for working on the network, commissioning and testing during times of high demand and drought conditions could lead to project delays.
- Availability of specialist supply chain designers and contractors to carry out large volume of work over a relatively tight time frame on a programme with limited free float.
- December 2024 WINEP deadline allows limited time frame for planning, design, consultation, implementation, commissioning, testing and handover of assets.

3.4 Dependencies

- Delivery of other AMP7 programmes; Water Quality Strategy programme and Water Saving Programme
- Commissioning of Sundon Conditioning Plant to allow Grafham derived water to be supplied to areas previously receiving chalk groundwater.
- Bovingdon to Boxted pump upgrade is successful - enabling more water to be in the correct area to support these reductions
- Current estimated costings for projects are based on either Pioneer scheme builder, or trunk mains team estimation of unit cost per metre (engaged with teams to get accurate estimations)

There is an inter-dependency with River Ver sustainability reductions in St Albans (as covered in WRZ2 business case). This is due to more water being required from Clay Lane to support the St Albans area, thereby resulting in a need to pump water south from Bulls Green to Brookmans Park via the trunk main. This requirement is also linked to Sundon Conditioning Plant to address water quality issues by bringing more Grafham derived water into groundwater fed zones.

4 Options Appraisal

4.1 Approach

The best value solution has been identified through taking a holistic approach to the sustainability reductions programme. We have utilised output from our EBSD modelling for the WRMP, with more detailed MISER and InfoWorks hydraulic demand zone modelling. This in combination with stakeholder engagement has enabled us to identify the best value solution, taking in to account combination effects of the sustainability reductions and the identification of efficiencies.

In order to gain a common understanding between stakeholders on the importance of delivery requirements under sustainability reductions programme, the **MoSCoW** (Must have, Should have, Could have ad Won't have) method was used to evaluate functional and non-functional requirements (see Appendix 7.3).

4.2 Options

Costings for the feasible options

	Option 8	Option 9	Option 10
Year 1	£3,092,518	£3,538,426	£3,598,367
Risk	£309,252	£353,843	£359,837
Year 2	£3,683,095	£5,100,189	£5,143,942
Risk	£368,310	£510,019	£514,394
Year 3	£3,688,097	£5,105,191	£5,148,944
Risk	£368,810	£510,519	£514,894
Year 4	£1,631,029	£3,048,123	£3,091,876
Risk	£163,103	£304,812	£309,188
Year 5	£-	£-	£-
Risk	£-	£-	£-
Total ex Risk	**£12,094,739**	**£16,791,929**	**£16,983,131**

Options 1, 2, 3, 4, 5, 6 and 7 were not costed as the more detailed assessment concluded that these options would not address implementing the sustainability reductions whilst maintaining security of supply.

Final option cost does not include risk, see section 2.4.

4.2.1 Unconstrained Options

An initial un-constrained list of 15 measures were identified to enable delivery of the WRZ3 sustainability reductions and maintain supplies to customers. These were grouped into alternative options and then assessed to find the optimum solution.

4.2.1.1 Rejected Options

1. **Do nothing** – rejected as not carrying out the sustainability reductions would mean not fulfilling our regulatory requirement to comply with WINEP objectives, which have a combination of drivers including WFD, and local biodiversity drivers. This would also mean not achieving our bespoke performance commitment relating to abstraction reduction. Thirdly this option would go against listening to our customer base who we know support the implementation of works seeking to sustain and enhance the local environment.

2. **Make licence changes at sustainability reduction sources, with no investment** in wider network – this option was rejected as this would result in an increased risk of failures and have the potential to impact supply to customers. This would also mean not achieving our common performance commitment relating to unplanned outages.

3. Measure to supply WRZ3 post sustainability reductions – **Construction of a new trunk main from North Mymms and Black Fan Road boosters**. This option was rejected as it would utilise the same water from Brookmans Park and not replace the water lost by the sustainability reduction.

4. Measure to supply WRZ3 post sustainability reductions – including **alternative measure for addressing criticality of Nomansland** (standby generator and new borehole). This option was rejected as current power supply to site is assessed as reliable and standby arrangement of mobile generators adequate. Boreholes on site already operating duty standby pumps for current licence. Nomansland third borehole due to be commissioned in AMP6 to provide duty-standby/ duty-assist operation.

5. Measures to supply WRZ3 post sustainability reductions – **alternative pressure management and level control options**. This option involved installation of additional pressure reducing valves (PRV) and level management at Sherrards Wood reservoir. This option was rejected as it does not provide any replacement water and therefore does not address supply needs.

6. **Implementation of measures within WRZ3 without site reconfiguration** – rejected as this would impact supply to customers – increased risk of asset failure in WRZ3, asset criticality and number of single points of failure would increase.

7. **Implementation of site specific measures in WRZ3 only** – rejected as this would impact supply to customers, as it would not allow for the import and distribution of replacement water to address volume lost by the sustainability reductions.

4.2.2 Feasible Options

Four feasible options (option 8, 9 and 10) were brought forward and considered for further analysis. These were modelled and discussed at the SR technical workshops. Scheme costs were built up as described in methodology section.

8. **Implementation of measures within WRZ3 with site specific and network reinforcement measures but no new storage**. Measures comprise of Digswell treatment and pumps, Welwyn PRVs, Nomansland washout, trunk main from Black Fan Road to Sherrards Wood, Beech Road reconfiguration and Letchworth to Royston reinforcement.

9. **Implementation of measures within WRZ3 with site specific measures, network reinforcement and storage**: Digswell treatment and pumps, Welwyn pressure reducing

valves, Nomansland washout, trunk main from Black Fan Road to Sherrards Wood, Beech Road reconfiguration, new cell at Bulls Green and Letchworth to Royston reinforcement.

10. **Implementation of measures within WRZ3 with site specific measures, alternative network reinforcement and storage**: Digswell treatment and pumps, Welwyn PRVs, Nomansland washout, trunk main from Black Fan Road to Sherrards Wood, Beech Road reconfiguration, new cell at Bulls Green and alternative Letchworth to Royston reinforcement.

The measures included in the options above are described as follows:

a) **Resize borehole pumps and drives, UV treatment and hypochlorite dosing pumps at Digswell -** This will allow abstraction at post sustainability reduction flow rates and maintain water quality regulatory requirements. Two new borehole pumps each capable of delivering 5Ml/d, working on a duty standby basis at average and duty assist at peak. New variable speed drives (changing from 160kW to 75kW) to maintain continuous site production. Resize the UV plant and the static mixer to 250mm pipework, so that it is able to handle 8Ml/d peak, with 0.5m head loss. Replacement of neat hypochlorite dosing with an OSEC unit and associated dosing pumps. Cost £240,543

b) **New washout facility at Nomansland** – This is required to allow pumping to waste during short term turbidity spikes and avoid the need for site outage. The option addresses the requirement for improved reliability of Nomansland in direct response to its increased criticality in maintaining supply to Welwyn Garden City area following the reduction at Digswell. This requires a new dedicated pump to waste main to be laid from the site to the River Lea (3300m of 250mm diameter pipe) through largely rural area. Cost £2,101,279

c) **Beech Road reconfiguration** - This option required a new cross-connection from the 12" main to the Periwinkle High Lifts within the existing pump-house, connecting into the existing supply manifold to the High Lifts' Suction Tank. The new connection will allow the Periwinkle high lifts to draw from Chaul End service reservoir and feed Beech Road service reservoir. This will allow the reservoir to turn over, meeting water quality requirements and providing adequate supply post reduction at Perwinkle Lane. Variable speed drives (VSD) are also required as the Periwinkle high lifts are direct on line and could cause surge issues. The VSDs will eliminate a surge of water back towards Chaul End, preventing pressure issues and bursts. This solution allows the operation of the network to remain as is, in the Beech Road Reservoir zone. Cost £9,940

d) **New trunk main between Black Fan Road boosters and Sherrardswood Reservoir** – A new 400mm trunk main 3750m long providing a direct feed of water into Sherrards Wood reservoir from Black Fan Road boosters. This will allow water from the strategic main into the Welwyn zone to replace loss of output from Digswell, post sustainability reduction. Cost £3,511,035

e) **Three additional pressure reducing valves (PRVs)** - Three additional PRVs in Welwyn in DMA 2536 Sherrards Park South (1 No.) and 2554 Factories (2 No.). This option comprises of installing three additional pressure reducing valves in Welwyn. This is required to control pressure in the distribution system within two district meter areas (DMAs) that have been identified as being at increased risk of failure (bursts) following the network changes required to implement the sustainability reductions. These will be installed in DMAs 2536 Sherrards Park South (1 x PRV) and 2554 Factories (2 x PRV). Cost £90,000

f) **Letchworth to Royston reinforcement** - This measure requires the twinning of the existing Slip End to Wicker Hall main and associated works to mitigate increased velocities from higher post sustainability reduction transfer rate. 1) The installation of a new 200mm main running parallel to the existing 300mm main from Slip End to Wicker Hall Reservoir - 9.23km in length. This is required as the current 300mm main could not operationally carry enough water without significantly increasing velocity. 2) An additional booster at Slip End to enable the original booster to remain on, rather than current operation in which it has to be turned off. The operational parameters of this booster being indicated from the modelling as flow of 417.6 m3/hr, and pressure of 107m. 3) Upsizing the 9" inlet to 450mm, spanning approximately 45m in length from the connection point of the 180mm main to the reservoir inlet. This is required to mitigate increased velocities at the reservoir inlet. Cost £6,141,942

g) **New 8Ml cell at Bulls Green -** Construct and commission a new 8Ml cell at Bulls Green service reservoir providing 12 hours storage, plus a new PRV. Bulls Green has been identified as a critical site for movement of water throughout our network - this criticality increases with the larger volumes of daily imported water from Grafham to meet demand post sustainability reductions and the loss of local sources of water at Digswell. There are 65,000 properties that rely on Bulls Green reservoir for their supply and following sustainability reduction at Digswell there is a need to mitigate risk of interruption to supply and the increased reliance on transfers from Grafham import. Cost £4,697,190

h) **Letchworth to Royston reinforcement alternative** - Construction of new main 400mm new main from Slip End source to Wicker Hall Reservoir, replacing the existing 300mm. This would place a greater reliance on the Slip End source to transfer water from Weston Hills to meet demand in Royston. Cost £6,333,144

4.2.3 Option 8 - RZ3 site specific measures, network reinforcement, no new storage

Implementation of measures within WRZ3 with network reinforcement but no new storage. Measures comprise of the following:

Measure	Project name	Outcome	Cost
a	Digswell pumps and treatment	Maintain water quality compliance post sustainability reduction	£240,543
b	Nomansland run to waste	Addresses increased site criticality post sustainability reduction	£2,101,279
c	Beech Road reconfiguration	Maintains water quality and reservoir levels post sustainability reduction	£9,940
d	Black Fan to Sherrards Wood trunk main	Transfers water into the zone to replace volume lost by sustainability reduction	£3,511,035
e	Welwyn PRVs	Pressure management following sustainability reduction	£90,000
f	Letchworth to Royston	Network modification to transfer water post reductions	£6,141,942
			£12,094,739

Benefits

- B1. New Digswell pumps and drives will meet new flow rate requirements of 1.5Ml/d (average) and 8.1Ml/d (peak). (Current minimum flow rates are 3.4Ml/d (borehole 5) and 3.18Ml/d (borehole 6)).
- B2. New Digswell UV treatment will ensure the decreased flowrate, post sustainability reduction maintain required drinking water quality standards. Through doing this we avoid the UV lamps overheating and size the equipment appropriately, ensuring sufficient treatment.
- B3. New Digswell hypochlorite dosing pumps will meet required dosing levels and water quality standards. Additional environmental, health and safety benefit of removing need for bulk hypochlorite delivery to site.
- B4. Improves reliability of Nomansland site by allowing borehole turbidity to be flushed to waste without need for prolonged outage of site and decommissioning/recommissioning of the current treated water main.
- B5. Addresses flooding issues associated with existing Nomansland run to waste arrangement.
- B6. Maintains water levels and water quality in Beech Road service reservoir post Periwinkle Lane reduction.

- B7. Will manage pressure in the Welwyn distribution system following sustainability reductions, reducing risk of bursts and maintaining supply to customers.
- B8. Maintains supply to the Welwyn supply zone post Digswell reduction.
- B9. Provides direct transfer of water to Sherrards Wood service reservoir and utliise existing network from Sherrards Wood for onward distribution to customers.
- B10. Takes account of the interdependencies with other sustainability reductions (St Albans) and operational changes to transfers.
- B11. Increases transfer capability from WRZ3 to WRZ5 to deliver required volume of water (Grafham import) post sustainability reduction.
- B12. Maintains required velocities in the main from Letchworth to Royston, enabling optimum utilisation of Weston Hills and Wicker Hall reservoirs.
- B13. Twinning the Slip End to Wicker Hall main, has an additional benefit of increasing supply resilience in the event of a failure of either the existing 300mm or new 200mm main.
- B14. Delivers sustainability reductions in line with WINEP3 requirements.
- B15. Contributes towards meeting WFD objectives.
- B16. Leaves more water in the environment and contributes towards delivery of performance commitment.

Risks

- R1. This option is dependent on Sundon Conditioning Plant being delivered by 2024, to allow replacement water to be brought into the currently groundwater fed zone.
- R2. Does not address increased number of properties reliant on Bulls Green service reservoir following Digswell reduction.
- R3. Bulls Green service reservoir increased criticality not addressed post sustainability reductions.
- R4. Black Fan boosters may not be sufficiently sized to address import of replacement water.
- R5. Works associated with this option will result in some disruption to the local community which will need to be mitigated.
- R6. AMP7 leakage programme does not address other pressure reduction requirements in the district meter area fed by Sherrards Wood reservoir.
- R7. Insufficient storage capacity for number of properties (65,000) dependent on Bulls Green.
- R8. Does not address future maintenance challenge for inspections and works at Bulls Green due to increased criticality of site post sustainability reduction. Limits ability for site outages due to associated supply risk.

4.2.4 Option 9 – WRZ3 measures with storage and network reinforcement

Implementation of measures within WRZ3 including storage and network reinforcement. Measures comprise of the following:

Measure	Project name	Outcome	Cost
a	Digswell pumps and treatment	Maintain water quality compliance post sustainability reduction	£240,543
b	Nomansland run to waste	Addresses increased site criticality post sustainability reduction	£2,101,279
c	Beech Road reconfiguration	Maintains water quality and reservoir levels post sustainability reduction	£9,940
d	Black Fan to Sherrards Wood trunk main	Transfers water into the zone to replace volume lost by sustainability reduction	£3,511,035
e	Welwyn PRVs	Pressure management following sustainability reduction	£90,000
f	Letchworth to Royston	Network modification to transfer water post reductions	£6,141,942
g	Bulls Green	New storage cell to address increase number of properties reliant on storage site post sustainability reduction	£4,697,190
			£16,791,929

Benefits

- B1 to B16. As Option 8 plus additional benefits described below.
- B17. Addresses increased criticality issue at Bulls Green with additional number of properties reliant on it post WRZ3 sustainability reductions.
- B18. Provides an additional 12 hours storage at Bulls Green, safeguarding against failure of the strategic main and the greater reliance on Grafham import following loss of local sources post sustainability reduction.

Risks

- R1. This option is dependent on Sundon Conditioning Plant being delivered by 2024, to allow replacement water to be brought into the currently groundwater fed zone.
- R2. Works associated with this option will result in some disruption to the local community which will need to be mitigated.
- R3. Black Fan boosters may not be sufficiently sized to address import of replacement water.

4.2.5 Option 10 – WRZ3 measures with storage and alternative network reinforcement

Implementation of measures within WRZ3 including storage and alternative network reinforcement. Measures comprise of the following:

Measure	Project name	Outcome	Cost
a	Digswell pumps and treatment	Maintain water quality compliance post sustainability reduction	£240,543
b	Nomansland run to waste	Addresses increased site criticality post sustainability reduction	£2,101,279
c	Beech Road reconfiguration	Maintains water quality and reservoir levels post sustainability reduction	£9,940
d	Black Fan to Sherrards Wood trunk main	Transfers water into the zone to replace volume lost by sustainability reduction	£3,511,035
e	Welwyn PRVs	Pressure management following sustainability reduction	£90,000
g	Bulls Green	New storage cell to address increase number of properties reliant on storage site post sustainability reduction	£4,697,190
h	Letchworth to Royston (alternative route)	Network modification to transfer water post reductions	£6,333,144
			£16,983,131

Benefits

- B1 to B18. As Option 9.

Risks

- R1. This option is dependent on Sundon Conditioning Plant being delivered by 2024, to allow replacement water to be brought into the currently groundwater fed zone.

- R2. This option would result in a much greater reliance on the Slip End source, to transfer water from Weston Hills to meet the demand in Royston. The Slip End source is drought constrained and may not provide required volume of water.

- R3. Constructing a new main would create a new single point of failure risk.

- R4. Works associated with this option will result in some disruption to the local community which will need to be mitigated.

4.3 Cost Benefit Analysis

The nature of this investment is focussed on a number of clear drivers, the most important of these being fulfilling our regulatory commitments by undertaking the sustainability reductions and maintaining water supply to our customers. As a result of these drivers none of feasible options will provide direct monetary benefits to us following implementation. Where expenditure is needed we have focussed on maximising efficiency to ensure the best value option is selected and future operational costs are kept to a minimum.

Option 8: The AMP7 cost for this option is £12,094,739. This option has been ruled out as it does not mitigate against the identified risks following implementation of the WRZ3 sustainability reductions and drivers for the programme would not be met.

Option 9 is the best value option as it ensures that security of supply in WRZ3 would be maintained following the sustainability reductions at Digswell, Runleywood and Periwinkle Lane. The AMP7 costs for this option are **£16,791,929**.

Option 10: The AMP7 cost for this option is £16,983,131. This option requires the largest investment and has a greater level of risk.

The EA updated the WFD Operational Catchment Economic Appraisals for the Upper Lee in February 2018. The Upper Lee operational catchment includes sustainability reductions at Runleywood, Periwinkle Lane and Digswell.

The bundle of measures identified to meet WFD objectives includes the proposed AMP7 sustainability reductions along with other measures; morphological actions and catchment management. The EA updated their operational catchment economic appraisals using costs prepared for our dWRMP and river restoration costs for delivering our ongoing AMP6 programme of works.

The Upper Lee Operational Catchment Economic Appraisal included a cost of £140 million with a **Benefit Cost Ratio of 1.29** for the recommended bundle of measures (EA, 2018[4]).

The monetary benefits of implementing the AMP7 sustainability reductions will be given further quantification using a Natural Capital approach. This approach is currently being developed using the data collected post AMP6 sustainability reductions as a baseline. This method will allow us to use real data linked to indicators of environmental improvements to calculate financial benefits with increased confidence.

[4] Environment Agency. 2018. Operational Catchment Economic Appraisal – Final Appraisal Report and Audit Trail: Upper Lee – Version number 3. February 2018

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4.4 Recommendation

The recommended best value option is Option 9 which includes the following measures:

Measure	Project name	Outcome	Cost
a	Digswell pumps and treatment	Maintain water quality compliance post sustainability reduction	£240,543
b	Nomansland run to waste	Addresses increased site criticality post sustainability reduction	£2,101,279
c	Beech Road reconfiguration	Maintains water quality and reservoir levels post sustainability reduction	£9,940
d	Black Fan to Sherrards Wood trunk main	Transfers water into the zone to replace volume lost by sustainability reduction	£3,511,035
e	Welwyn PRVs	Pressure management following sustainability reduction	£90,000
f	Letchworth to Royston	Network modification to transfer water post reductions	£6,141,942
g	Bulls Green	New storage cell to address increase number of properties reliant on storage site post sustainability reduction	£4,697,190
			£16,791,929

This option has been selected based on cost benefit analysis (section 4.3) and a risk-based review (section 0).

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5 Risks, Issues and Mitigation

The following risk and mitigation actions have been identified:

Risk/Issue	Mitigation
Disruption to local community whilst trunk main and other construction works are on-going.	Careful planning of works to minimize disruption. Stakeholder engagement. Good communication with customers and communities and to keep informed of works and manage situation.
Sundon Conditioning Plant is not fully commissioned and operational by December 2024, limiting the areas that can be fed by Grafham derived water due to water quality concerns.	Dependency mapping and collaboration between internal delivery teams to ensure efficient and timely delivery to enable sustainability reductions to go ahead as planned.
Black Fan boosters may not be sufficiently sized to address import of replacement water.	Further hydraulic modelling and network trials early in AMP7 replicating sustainability reductions to confirm current boosters are sufficient to meet local demand under different conditions.
Getting the right people in the project team with correct skillset to deliver best value option within time and budget whilst ensuring quality.	Programme Manager to identify required resources early to ensure correct team in place with correct skillset for effective and efficient delivery.
Additional land purchase, easements and permissions/consents are required to allow construction of required assets.	Early identification of routes for new mains to minimise risk and disruption required. Any land purchase or easements required to be identified early in concept phase and supporting resource made available to progress.
Timescales for procurement of equipment and installation and other operational outages.	Detailed programme planning to ensure works are planned in advance and other planned operational outages are considered.
Power requirements for new/modified assets not met and require upgrading, as found to be insufficient during project definition phase.	Early designer/contractor involvement to ensure requirements are understood as early as possible. Potential to look at alternative/renewable energy options where appropriate.

6 Procurement Strategy

Affinity Water has Framework Agreements in place with Principle Contractors to deliver Above Ground Asset construction works. In addition, Framework Agreements are in place at a Tier 2 level (Pumps, MCCs, VSDs, Valves, Pipework, Security) to encourage standardisation and cost certainty. A process is ongoing to review the most cost effective way procuring projects; at a high level, the process is considering:

- Early engagement beginning in the Concept stage to drive Innovation
- Allocation of grouping of projects to benefit from economies of scale
- The use of incentivisation in contracts, to improve early completion of projects and lower project costs

Some competitive tendering (where appropriate) and KPI driven allocation to improve the level of competitive tension

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Appendices

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7 Appendices

7.2 Methodology

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7.3 Business Requirements

7.3.5 Requirements Priority Matrix

Designation	Explanation
Must	The solution will not be accepted if a requirement that has a priority of 'Must' has not been delivered
Should	The requirement with a priority of 'Should' would provide business benefit, but the business would accept a solution where this requirement was not delivered e.g. the solution could be delivered by other projects/changes of working practice. If possible, the solution should deliver these requirements
Could	The requirement with a priority of 'Could' may provide some business benefit, but not as much as the requirements that have been prioritised as 'should' and 'must'. The business would accept a solution where this requirement was not delivered.
Won't	Won't do this now but may wish to implement in the future

7.3.6 Functional Requirements

	Requirement Description	Rationale	Priority
1	The solution must remove the risk of turbidity at Nomansland.	Business Plan commitment to make sure our customers have high quality water they can trust.	Must
2	The solution must ensure abstraction from the source can be maximised (within licence)	Water available for use	Must
3	The solution should be sufficiently robust such that it does not become a limiting factor on the site.	Water available for use – site downtime reduces output capacity and leads to poor pressure or even no water within the network, and therefore customer complaints.	Should
4	Provide resilience to supply area and flexibility in network operation, considering future sustainability reductions and predicted reliance on various imports to the supply region.	To supply wholesome drinking water in accordance with water quality standards.	Must
5	Provide security of supply	To avoid DG2 and DG3 issues in supply area.	Must
6	Treat all water produced on Affinity water sites to acceptable standard.	To supply wholesome drinking water in accordance with water quality standards.	Must
7	The solution must address increased criticality of strategic storage post sustainability	Water available for use	Must

	reductions to maintain levels of service		

7.3.7 Non-Functional Requirements

	Requirement Description	Rationale	Priority
1	The solution should not impact on the operability of the rest of the process, and should not increase the site's operator input on the rest of the process through adverse downstream or upstream effects.	Leaving an intelligent operating legacy – maintaining or improving existing site operability so as not to put unnecessary strain on Production staff.	Should
2	Compliance with relevant Affinity Water standards and policies.	Ensure high quality of work.	Must
3	Governance documentation completed in line with project lifecycle	Ensure business case is valid and all stakeholders retain buy-in throughout project.	Must
4	Health and Safety will be a project priority. Risk Assessments and Method Statements will be required for all site work. Hazard identification and assessment will be completed through the project lifecycle. Additionally, hazards for on-going maintenance will be reviewed through the design phase. The project will comply with CDM regulations.	Ensure all works are risk assessed and conducted in the safest way possible to promote zero harm.	Must
5	Update operational and maintenance manuals, update AMIS and tagging, update existing telemetry and SCADA software, update site drawings, update GIS information.	To ensure all site information and software is up to date.	Must
6	Improve overall security of supply and resilience of network in supply area.	To ensure customers are provided with clean drinking water, and we meet our regulatory requirements.	Should

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7.4 WINEP3 – confirmed reductions as per EA letter

Source	WRZ	WINEP3 Level of certainty	WINEP3 Date	Current Licence Average	Current Licence Peak	WINEP3 Sustainability Change Average	WINEP3 Sustainability Change Peak	Proposed WINEP3 New Licence Average	Proposed WINEP3 New Licence Peak	Current 1:200 drought DO Average	Current 1:200 drought DO Peak	Proposed Sustainability Reduction Average	Proposed Sustainability Reduction Peak	Post SR 1:200 Drought Average	Post SR 1:200 Drought Peak	Comment	Comment from EA
Amersham	1	Green	22/12/2024	4.00	9.00	2	2	2.00	7.00	4.00	9.00	2.00	2.00	2.00	7.00	Replaces Chalfont SR included at PR14 WINEP3 included Chalfont daily peak licence and not Amersham. Error confirmed in email from Marta Pluta 4th April 2018	
Chartridge	1	Amber	22/12/2024	group licence	2.05	-	2.05			1.52	1.66	1.52	1.66	0	0	This source is part of a group licence and has no individual annual average licence. Assumes cessation of abstraction as per email from Marta Pluta on the 1st May 2018	
Chesham	1	Amber	22/12/2024	5.22	7.09	5.22	7.09			4.86	6.00	4.86	6.00	0	0	Error on WINEP3 relating to licence volume and hence SC. Assumes cessation of abstraction as per email from Marta Pluta on the 1st May 2018	
Holywell	2	Green	22/12/2024	-	20.46	8.84	0	5.61	11.80	11.80	11.80	6.19	0	5.61	11.80	The split between these sources has been amended due to change in DO assessment between PR14 and PR19. NB Mud Lane is Holywell BH6	Agregated licence with max daily rate from Mud Lane (11.37Ml/d). Operated almost as one source. New licence will review operations at both sites and potentially update maximum daily rate for Mud Lane to reflect operation needs. No change is proposed to total peak rate on the licence.
Mud Lane	2	Green	22/12/2024	-			0	3.78	8.66	6.60	6.60	2.82	0	3.78	6.60		
Mud Lane/Holywell					*20.46*	*8.84*		*9.39*	*20.46*	*18.40*	*18.40*	*9.01*	*0*	*9.39*	*18.40*		
Baldock Road	3	Green	22/12/2024	4.55	4.55		0		4.55	3.20	3.60					Sources to be capped to recent actual. Bowring and Fuller DO constrained by DAPWL. AMP7 scheme to included river support of c0.4Ml/d from existing licence but no impact on DO Also listed as Amber SC	
Bowring	3	Green	22/12/2024	7.96	7.96		0		7.96	3.60	3.90						
Fuller	3	Green	22/12/2024	7.96	7.96		0		7.96	3.70	4.80						
Willian Road Group			22/12/2024	*14.77*	*20.47*	*0.63*	*0*	*14.14*	*20.47*	*10.50*	*12.30*	0	0	10.5	12.3		
Digswell	3	Green	22/12/2024	11.37	11.37	9.87	2.45	1.50	8.92	7.20	8.10	5.7	0.00	1.5	8.10	No reduction in peak DO included at PR14. The s20 agreement allows peak abstraction of 8.92Ml/d which is already a reduction from the LoR of 11.37Ml/d. We believe this is an error on WINEP3	Changes reflect recent discussions with Affinity Water.
Perwinkle Lane	3	Green	22/12/2024	4.99	5.00	4.99	5.00	0.00	0.00	4.60	5.00	4.60	5.00	0	0	Assumes cessation of abstraction	
Runleywood Chalk	3	Green	22/12/2024	9.55	9.55	9.55	9.55	0.00	0.00	5.60	6.40	5.60	6.40	0	0	Assumes cessation of abstraction	
Debden Road	5	Green	22/12/2024	3.41	3.49	0.34	0	3.07	3.49	3.07	3.40	0	0	3.07	3.40	Cap to recent actual.	
Newport	5	Green	22/12/2024	1.36	2.27	0.48	0	0.88	2.27	1.30	1.70	0.42	0	0.88	1.70	Cap to recent actual. Recent pump replacement so impacts DO.	
Springwell Farm	5	Green	22/12/2024	13.68	13.64	6.77	0	11.47	13.64	0.00	0.00	0	0	0	0	Dormant source	
Uttlesford Bridge	5	Green	22/12/2024	13.68	13.64	6.77	0	11.47	13.64	6.00	6.00	0	0	6	6	Assumes no reduction in DO due to existing licence condition. AMP7 to include provision of river support of up to 5.47Ml/d from licence capped to recent actual Also listed as Amber SC	Licence volume for supply at 6 ML/d confirmed by EAN Area. Morphological change/river restoration project planned to mitigate flow support volume needed during drought conditions.
Uttlesford Group			*22/12/2024*	*15.95*	*18.18*	*0.48*	*0*	*11.47*	*18.18*								
Wenden	5	Green	22/12/2024	4.55	4.55	2.01	0	2.53	4.55	2.30	2.60	0	0	2.30	2.60	Cap to recent actual. Option to increase DO removed from EBSD	
Central Region Green/Amber Total						**44.42**	**28.14**					**33.71**	**21.06**				
Central Region Green Total	**1, 2, 3 & 5**	Green				**39.20**	**19.00**					**27.33**	**13.40**				
Central Region Amber Total	**1**	Amber				**5.22**	**9.14**					**6.38**	**7.66**			Difference between the WINEP3 SC and SR relates to Chartridge not having an individual annual average licence and an error on WINEP3 relating to Chesham licence volume and hence SC.	
Higham	8	Amber	31/03/2021	6.50	10.00	2.597	2.597			5.02	6.88	2.60	2.60	5.02	6.88	Sources subject to two group licences with daily, annual and 5 year totals. Volume of reduction uncertain. EA have indicated reduction of 15 and 20Ml/d may be required	
Shelley	8	Amber	31/03/2021	3.90	7.00					2.89	4.17			2.89	4.17		
Lattinford	8	Amber	31/03/2021	2.47	4.00					1.81	2.70			1.81	2.70		
Stoke-by-Nayland	8	Amber	31/03/2021	11.70	13.00					8.00	10.93			8.00	8.33		
East Region Amber Total	**8**					**2.597**	**2.597**					**2.60**	**2.60**				

Appendix AFW.CE.A1.11

Action ref AFW.CE.A1

Sustainability Reduction – Stort Community (WRZ5)

Sustainability Reductions - Stort Community (WRZ5)

PR19 Business Case

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March 2019

Security Notice

This Document is classified as official sensitive in accordance with the Security and Emergency Measures Directive as it includes specific location details of public water supply sources. This document is only reviewed by designated persons and must not be disclosed or published to third parties or placed on a website. A redacted version of this document is available for publication.

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Asset Strategy document control sheet

Document amendment history

Version	Status	Date	Amendment to this version
1.0	Final	03/09/2018	For issue with draft business plan
2.0	Final	15/03/2019	Updated to new template for resubmission

Document approval

Document title	Sustainability Reduction WRZ5 Business Case			
e-Document location				
	Name	**Signature**	**Title**	**Date**
Author/originator	Ellie Powers		Senior Asset Manager Asset Manager	11/03/2019
Technical Reviewer 1	Jahed Ahmed		Asset Engineer	12/03/2019
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Document Purpose

The purpose of the Project Business Case is to describe the reasons for the project and the justification for undertaking it, based on the estimated costs of the project, the expected business benefits, savings and risks.

The Business case will also present all the options that have been assessed to deliver the project outcome and will indicate the preferred option out of all considered.

During the project a Business Case is a major controlled document that is referenced on a regular basis to ensure and confirm that the project remains viable. It is maintained throughout the lifecycle of the project, being reviewed by key stakeholders at key decision points, i.e. at the end of a phase.

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1 Executive Summary

Our revised draft Water Resources Management Plan (rdWRMP19) includes sustainability reductions of 36.31Ml/d (average) and 23.66Ml/d (peak) for delivery by December 2024. These reductions have been identified by the Environment Agency as being required to contribute towards Water Framework Directive objectives. Investment of £58million has been included in our PR19 business plan submission to deliver green and amber sustainability reductions, in accordance with the associated regulatory guidance.

This business case covers the investment required to enable implementation of the sustainability reductions in the Stort Community (Water Resource Zone 5) and maintain supplies to customers. It includes option development, risk assessment and cost benefit assessment undertaken to identify the best value option.

Seven options were identified to enable delivery of the sustainability reduction with two options selected for detailed consideration. The installation of Amazon filters, pump and drive upgrades (Option 7) was identified as the best value option at a cost of £668,173. These costs have been included in our business plan submission under Environmental Enhancements. This business case will be reviewed and updated at key milestones throughout the life cycle of the project.

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22 Introduction

2.1 Background

Sustainability reductions are decreases in water company deployable output due to a sustainability change (licence change), which are identified as being required to improve river flow and ecology, to meet Water Framework Directive (WFD) objectives. Our revised draft Water Resources Management Plan (rdWRMP19) includes sustainability reductions of 36.31Ml/d (average) and 23.66Ml/d (peak) for delivery by December 2024.

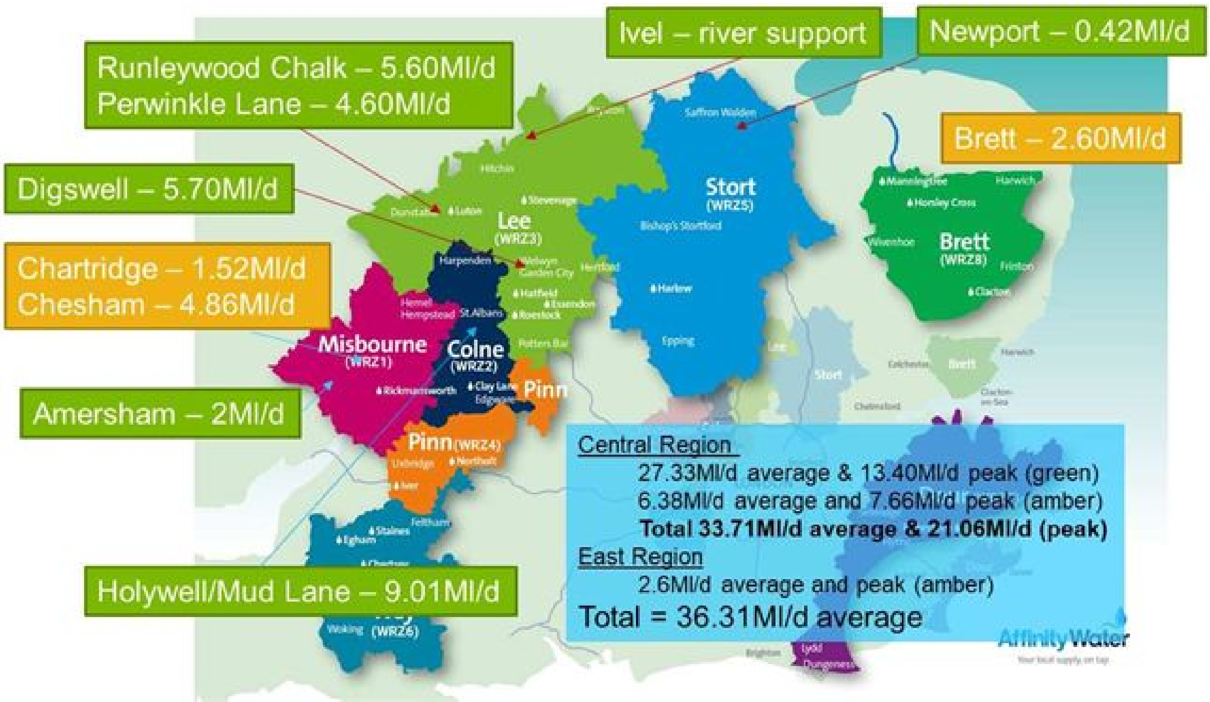

Figure 13 Location of sources subject to AMP7 sustainability reductions

The AMP7 sustainability reductions have been modelled at a water resource zone (WRZ) level using our Economic Balance of Supply and Demand (EBSD) model and transfers within and between zones have also been modelled using Miser (our bespoke model that simulates transfers between hydraulic demand zones (HDZs)). Our Miser modelling has helped identify network constraints and has been used to inform implementation requirements. This modelling work has confirmed that we cannot implement these sustainability reductions using demand management options alone and that we need to undertake works on both above and below ground assets, to ensure we can maintain supply to our customers.

In our Stort Community (WRZ5) there are three components to the sustainability reductions; 0.42Ml/d reduction in deployable output (**WINEP ID EAN00013,35,36**) a capping of licences to recent actual abstraction (**EAN00011,19,23,25,26,27,29,37**) and a revision to the river support trigger at Great Chesterford gauging station (**EAN02412**, **EAN2413**) (Appendix 0 for details). This revised trigger will increase the frequency and duration of support from our Uttlesford Bridge source. The increased duration of river support will result in a longer period of time when water is required to support river flows rather than available for public supply.

2.2 Drivers

2.2.1 Water Framework Directive

The Environment Agency have assigned the following Water Framework Directive (WFD) drivers to sustainability reductions in WRZ5, within their Water Industry National Environment Programme (WINEP).

Driver Code	Description
WFD_ND_WRFlow	Action to prevent deterioration of ecological status from flow pressures
WFD_IMP_WRFlow	Action to Improve hydrological regime to meet WFD objectives

The EU WFD binds the UK as a whole to delivering its requirements and does not impose any legal obligations on water companies or the EA directly. The WFD is implemented in England and Wales by the Water Environment (Water Framework (England and Wales) Regulations 2017 (WFD Regs)). The WFD requires waterbodies to achieve good ecological status (GES) or potential (GEP).

Since 1990, a number of our abstraction licences have been identified by the EA to be potentially environmentally damaging. This has resulted in a series of environmental investigations and options appraisals (AMP2-6) through the Restoring Sustainable Abstraction (RSA) programme and NEP. The driver for these projects is a combination of WFD, Habitats Directive, Sites of Special Scientific Interest (SSSI) and local biodiversity drivers where there was considered to be the potential for impact on chalk streams, a biodiversity priority habitat.

2.2.2 Water Resources and Supply

Abstraction licences are issued by the Environment Agency (EA) and the capability of sources to yield water is undertaken through an assessment of deployable output (DO). The methodology for assessing DO has changed for PR19, reflecting a more robust stochastic view of historic drought. Using this methodology, we have adopted a 1 in 200 year drought for the calculation of our baseline DO in our revised draft Water Resources Management Plan 2019 (rdWRMP19).

The AMP7 sustainability reductions are included in our Water Resources Management Plan, which sets out how we will balance supply and demand over a 60 year planning horizon. We must ensure that we have adequate supplies to meet demand and maintain supplies to customers. The Stort Community (WRZ5) includes a population of 285,000 and 133,310 properties. We need to complete above and below ground works to ensure that this happens.

2.2.3 Customer Experience

We have listened to feedback from customers and stakeholders on our draft Water Resources Management Plan and included the Water Industry National Environment Programme (WINEP3) sustainability reductions in our plans. Feedback from our engagement indicates that 78% of our customers support us investing now to ensure there is sufficient water in future. We recognise the importance of sustainable abstraction and meeting the needs of customers and the environment. This business case supports delivery of our sustainability reductions whilst maintaining supplies to customers and communities.

2.3 Best Value Option

Option 5 – turbidity treatment and upgrade pumps

The best value option is to install **turbidity treatment (Amazon filters) and upgrade pumps** at Uttlesford Bridge pumping station. The sources in the Upper Cam catchment including Uttlesford Bridge are subject to sustainability change under the AMP7 sustainability reductions programme. Optimising source performance at Uttlesford Bridge with the proposed new licence and improving its reliability of the source is key to implementing the wider sustainability reduction programme.

This option has been developed through engagement with internal stakeholders including Asset Strategy, Water Quality, Production and Supply. This option will require the installation of 44 Amazon filters to enable the revised post sustainability change full licence of 11.47Ml/d (average) and 13.64Ml/d (peak) to be utilised under non-drought conditions.

2.4 Costs Summary Table

Cost Summary for Best Value Option

	Y1	Y2	Y3	Y4	Y5	AMP7	20 Years
Costs (capex)	£346,586	£321,587	£-	£-	£-	£668,173	£668,173
Costs (opex)	£-	£-	£-	£-	£-	£-	£-
Risk	£34,659	£32,159	£-	£-	£-	£66,817	£66,817
Total costs (totex)	£346,586	£321,587	£-	£-	£-	£668,173	£668,173
Total revenue	£-	£-	£-	£-	£-	£-	£-
Funding requirement	£346,586	£321,587	£-	£-	£-	**£668,173**	£668,173
NPV (£k)						-£641,000	-£641,000

At this stage of option development we have detailed a 10% risk to all options for consistency but not included this figure within the options total funding required. We will seek to manage risk at a programme level across all projects and cover any risk funding requirement through the generation of efficiencies. These efficiencies will be generated through refinement during the life cycle of the programme, ensuring mitigation is included for all risk items and value engineering considered at key milestones. This approach reduces the total funding request across the AMP7 sustainability reductions programme by £5.84million.

2.5 Customer benefits and resilience benefits

The primary purpose of this investment is to ensure we **maintain supply to customers** following the implementation of the AMP7 sustainability reductions. There are a number of other additional benefits that will be realised through implementation of this work as follows:

Supply resilience - removing pump and turbidity restrictions at this source will maintain our 'operational headroom,' and reduce the risk of customer supply interruptions.

Reduced water quality risk – raw water turbidity will be addressed and allow efficient utilization of the source.

Maintain security of supply following the implementation of the sustainability reductions. Investing in the options proposed as part of this business case we are maintaining the resilience of our Uttlesford Bridge source to increase security of supply for our customers.

Deliver regulatory expectations under the Water Industry National Environment Programme.

Contribute towards achieving **Water Framework Directive objectives**.

Improving the relationships with the local community, customers and stakeholders via **demonstrating our commitment to the environment** which we know through our consultation is important to our customers.

The importance our customers and stakeholders give to abstraction reductions is echoed in our bespoke **Performance Commitment relating to abstraction reduction** through implementation of the sustainability reduction which we know through our consultation is important to our customers.

The solution **maintains supply resilience** and mitigating against operational incidents such as site failure and water quality. It will reduce the likelihood, duration and frequency of site shutdown due to turbidity, maintaining output to support the zone where other source reductions are to be made.

The importance our customers and stakeholders give to abstraction reductions is echoed in our bespoke **Performance Commitment relating to abstraction reduction** which this project will contribute towards.

The best value option **maintains supply resilience** and mitigates against operational incidents such as water quality. Through investment we are maintaining resilience of water supply to our customers, whilst considering future growth of local developments which put pressure on our network and capacity.

The investment made in WRZ5 under the Sustainability Reduction Programme is seeking only to **maintain supply to customers** in AMP7. We have consulted with colleagues preparing our Plan for Central region to capture links and any possible overlap. This assurance avoids double counting of options between sustainability reductions and other programmes so any opportunities/efficiencies are realised.

Innovation will be at the heart of delivering the preferred option as we seek to drive down costs and maximise benefits for both our customers and the environment. Associated with these reductions we are keen to ensure we continue to **improve our understanding of the chalk aquifer** and the relationship to river flows both pre and post reduction so future investment can be targeted in the correct areas. Furthering our understating of the chalk aquifer through monitoring and groundwater modeling, working with the Environment Agency, British Geological Survey and other stakeholders to achieve this. A continuation of our groundwater level, river flow and ecological monitoring pre and post reductions will allow us to fully understand benefits and use this knowledge to **inform future decision making**.

The Sustainability Reduction Programme drivers encourage us to think about how we can use our groundwater sources differently and to work with the new abstraction reform protocols to ensure the water we supply to customers is from more **sustainable** sources with **lower impacts upon the environment**.

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The recommended best value option will also support achieving the target set out in the following performance commitments;

Performance Commitments Supported by this project

Bespoke and Legacy PC	Current Performance	Base Plan J	SWR Plan L	SOP Plan K	Stakeholders / Customers	Final
Abstraction Reduction (Ml/d)	n/a	10	39	10	36	36

2.6 Methodology

The investment requirement has been identified and developed by our Asset Strategy team in collaboration with Production and Supply, Water Quality, Community Operations and Asset Delivery teams.

21. Investigating and quantifying supply risk due to sustainability reductions in WRZ5, in combination with reductions in other zones. Initial risk workshop and discussions with internal stakeholders.

22. Identifying and optioneering solutions, systematically exploring options to identify the option with the highest cost benefit. Options developed through engagement with stakeholders from Production, Operations Centre, Network, Water Quality, Leakage, Modelling, Trunk Mains and Mains Renewals, Asset Strategy and current AMP6 sustainability reductions programme team.

23. Further liaising with internal stakeholders through workshops to review proposed solutions and identify additional risks

24. Modelling of network configurations, with data gathered from the company's systems to establish site failure rates etc. This includes: TRACE - our asset performance analysis tool (TRACE - Trackdown, Reliability, Availability, Cause & Effect), telemetry (SERCK), Asset Risk Module of PIONEER (ARM), Asset Management Information System (AMIS), our corporate Geographic Information System (GIS) and business objects reporting. Engaged with contractor base for asset information and validation of costs for likely asset replacement/installation.

25. PIONEER scheme builder, Economic Balance of Supply and Demand (EBSD), and the unit cost model have been used for estimations of costs. With regards to trunk mains, the current PR19 mains laying summary costs were used where possible.

Options have been developed using a standardised company process through the utilisation of Scheme Builder (a module of the PIONEER software tool). Scheme Builder allows us to cost the addition or modification of assets on a project basis for delivery purposes. The optimiser uses our asset data, deterioration curves, consequences and unit costs, to determine the optimal investment to meet a defined need. Stakeholders (Water Quality, Production, Network etc.) have been engaged through workshops, and the risk analysis and cost calculations have been peer reviewed (see Appendix 0 for process diagram).

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23 Defined Need and Dependencies

3.1 Defined need

Our groundwater abstractions at Newport, Wenden, Debden Road, Uttlesford Bridge and Springwell Farm in the Upper Cam catchment have been assessed under our AMP6 NEP. This has resulted in a proposal by the EA to cap our abstraction licences to the recent actual annual abstraction volumes, to prevent deterioration of WFD waterbody status. The EA have also identified a change to the river support trigger at Great Chesterford gauging station, affecting the frequency of use of support from Uttlesford Bridge but not the volume of water available for supply. These proposed changes result in a sustainability reduction of 0.42Ml/d from Newport, as the deployable output from the other sources in the catchment is already drought constrained. The criticality of the remaining available sources therefore increases with these changes to our sources.

Cam Sustainability Reductions

Source	Current Licence		WINEP3 Sustainability Change		PR19 DO (1 in 200 drought)		rdWRMP Modelled AMP7 Reduction		Resultant DO	
	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)	Ave (Ml/d	Peak (Ml/d)	Ave (Ml/d)	Peak (Ml/d)
Uttlesford Bridge	13.68	13.64	6.77	0.00	6.00	6.00	0.00	0.00	6.00	6.00
Springwell Farm	13.68	13.64	6.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Uttlesford Group	**15.95**	**18.18**	**0.48**	**0.00**	**6.00**	**6.00**	**0.00**	**0.00**	**6.00**	**6.00**
Debden Road	3.41	3.49	0.34	0.00	3.07	3.40	0.00	0.00	3.07	3.40
Newport	1.36	2.27	0.48	0.00	1.30	1.70	0.42	0.00	0.88	1.70
Wenden	4.55	4.55	2.01	0.00	2.30	2.60	0.00	0.00	2.30	2.60
Total	**25.27**	**28.49**	**3.31**	**0.00**	**12.67**	**13.70**	**0.42**	**0.00**	**12.25**	**13.70**

The loss of 0.42Ml/d abstraction from the catchment and the capping of licence to recent actual use, in combination with the other sustainability reductions in the Central region increases the criticality of the remaining sources. This includes Uttlesford Bridge which has been identified as suffering from turbidity issues caused by the chalk from the aquifer being drawn up out of the borehole.

3.1.1 Identifying the risk

The imposition of a sustainability reduction in the catchment at Newport and the new trigger on the river support affecting abstraction from Uttlesford Bridge increases site criticality and requires a solution to ensure we can maintain supply to customers. Without a solution Uttlesford Bridge's availability for public supply will be reduced.

3.1.2 Asset Background Information

Raw water is treated on site at Uttlesford Bridge and used to meet demand in the local area (Saffron Walden). Turbidity mobilised from the water abstracted from the chalk can be above our operational triggers. There is no particle removal stage and therefore the increase in turbidity causes the treatment works to shut down. Our evidence for this is in the UV strainer, deposition in instruments and the site shut down on turbidity levels. There is already a facility to pump to the river at Uttlesford Bridge to meet the licence requirements for river support and therefore no additional investment is needed to deliver this aspect of the WINEP3 sustainability change requirements.

River flow data from Great Chesterford gauging station was analysed for the AMP6 NEP Upper Cam project. This identified that with the revised trigger of **15.64Ml/d** required to mitigate the impact of our abstraction and protect flows in the River Cam there will be an increased frequency of river support from Uttlesford Bridge. Based on data from January 1997 to December 2017, under the existing trigger of 12.7Ml/day flow dropped below this for a total period of 238 days (3.3% of the time). With the new revised trigger of 15.64Ml/day, over the same time period river flow drop below this level for a period of **909 days (12.7% of the time),** meaning that we would have had to support the river with a larger volume and for a longer period of time. This would therefore reduce the volume available for supply.

3.1.3 Impact

Turbidity levels of greater than 1 NTU result in the site shutting down. The site then needs to be left to rest to allow turbidity to reduce before bringing back into supply, thus reducing its availability to supply customers. The criticality of this site increases with other sustainability reductions in Central region (including within the catchment) and therefore the turbidity issue needs to be addressed, in order not to impact customers. For prolonged periods of outage from the site due to turbidity we would need import more water from Grafham. This would reduce the volume of Grafham water available for use in other locations in Central region, following the AMP7 sustainability reductions.

3.2 Assumptions

- The incoming power supply is sufficient to meet requirements of the larger pumps and drives.
- Filters can be housed in existing building.
- Work can be completed with a short duration outage.
- Work on site will require an environmental permit, as within 9m of main river.
- Giant Hogweed (an invasive non-native species) treatment currently on going on the site, is effective.

3.3 Constraints

- The Uttlesford Bridge site is relatively small in size. This means that there is limited space available to accommodate additional assets on site. Vehicular access onto the site and movements within the compound during construction will also be limited.
- The site is located on the banks of the River Cam and therefore environmental constraints need to be considered.
- Gaining consents from landowners and required permissions for installation of required assets where we are not the landowner.
- Where new assets are required Environmental constraints relating to working within SSSI's and other protected areas need to be considered and permissions and mitigation put in place.
- Failure to achieve network outages for construction, commissioning and testing during times of high demand and drought conditions could lead to project delays.

- Availability of specialist supply chain designers and contractors to carry out large volume of work over a relatively tight time frame on a programme with limited free float.
- December 2024 WINEP deadline allows limited time frame for planning, design, consultation, implementation, commissioning, testing and handover of assets.

3.4 Dependencies

- The scheme is dependent on delivery of the demand management and leakage options in the rdWRMP, in order to balance future supply and demand in Central region.
- This project is dependent on availability of resource from Production & Asset Strategy staff to facilitate the project's progress.
- This project's timeline is dependent on any other CAPEX schemes occurring at the treatment works in question.
- This project is dependent on availability of resource from Production & Asset Strategy staff to facilitate the project's progress.
- Delivery of other AMP 7 programmes; Water Quality Strategy programme and Sundon treatment works.
- Hydraulic modelling outputs (frequent engagement with modellers, discussed output with other relevant stakeholders).
- Regular stakeholder meetings (meeting required personnel each week to discuss options and best way to progress).
- Alterations to flows and supply needs in areas dependant on MISER and Water Resource Management Plan output (frequent engagement with colleagues running these programmes, speak with senior managers to check latest plans and estimations).

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24 Options Appraisal

4.1 Approach

In order to gain a common understanding between stakeholders on the importance of delivery requirements under sustainability reductions programme, the **MoSCoW** (Must have, Should have, Could have ad Won't have) method was used to evaluate functional and non-functional requirements (see Appendix 0).

The best value solution to address this need is to add Amazon filters in the process that allows backwash to clean the filter through a 1mm mechanical screen. Backwash from the filters can be put into the river (subject to environment permitting) and will require a smaller pump to enable backwash. The benefits of installing a filter are that it can be added to the existing operational configuration on site and does not require a complete change of treatment process.

The installation of filters will also require a re-sizing of the borehole pumps. This is required to cope with the additional head losses created by installing the filters, which in turn requires larger drives to be installed.

4.2 Options

Costings for the Feasible Options

	Option 5 Tank	Option 7 Amazon Filters
Year 1	£582,591	£346,586
Risk	£58,259	£34,659
Year 2	£815,628	£321,587
Risk	£81,563	£32,159
Year 3	£932,146	-
Risk	£93,215	-
Year 4	-	-
Risk	-	-
Year 5	-	-
Risk	-	-
Total ex. risk	**£2,330,365**	**£668,173**

Final option cost excludes risk, see section 2.4.

Options 1, 2, 3, 4 and 6 were not costed as the more detailed assessment concluded that these options would not fully address the implementation requirements for the sustainability reductions and maintain security of supply.

4.2.1 Unconstrained Options

An initial un-constrained list of six options was developed to enable delivery of the sustainability reductions and maintain supplies to customers. Options 1, 2, 3, 4 and 6 were rejected for the following reasons:

Rejected options:

18. Do nothing – rejected as this would result in an increased risk of failures and have the potential to impact supply to customers.

19. Make licence reductions at sustainability reduction sources, with no investment in wider network – this option was rejected as this would result in an increased risk of failures and have the potential to impact supply to customers.

20. Manage turbidity induced outages with additional call out of operation staff and pumping to waste.

4. Installation of Amazon filters and backwash pump without upgrading borehole pumps – rejected as this would reduce output as existing pumps would not be able to deliver required volume due to head loss through the filters.

6. Installation of BOLL filters and upgrade pumps – rejected as these filters are not currently on the Water Supply (Water Quality) Regulations, Regulation 31 approved products list.

4.2.2 Feasible Options

Two potential options were brought forward for more detailed examination:

5. Utilise the old contact tank as a sedimentation tank and reconfigure the treatment plant. Install new borehole pumps to lift water to the tank and additional booster pumps to lift from the sedimentation tank to the booster. Install new control panels to accompany the new pumps.

7. Install Amazon filters (turbidity treatment) including backwash pumps and upgrade borehole pumps to address head loss across filters.

4.2.3 Option 5 – Sedimentation tank, reconfigure treatment and install new pumps

The first feasible option assessed at Uttlesford Bridge was to utilise the old contact tank on site as a sedimentation tank and reconfigure the treatment plant. This would require new borehole pumps to lift water to the tank and additional booster pumps to lift from the sedimentation tank to the booster. Further to this, new control panels to accompany the new pumps would need to be installed. This would require periodic scheduled maintenance to remove sediment from the tank and maintain turbidity settlement capacity.

Option	Project name	Outcome	Cost
5	Sedimentation tank	Addresses turbidity and reliability post sustainability reductions	£2,330,365

Benefits

- B1. Makes use of a redundant asset on site (former contact tank).
- B2. Allows turbidity in raw water to settle out.
- B3. Supports delivery of the AMP7 sustainability reductions through increased reliability of source output.
- B4. Delivers against the programme drivers (section 0).

Risks

- R1. There would be additional operational costs associated with maintenance and removal of chalk sediment in the settlement tank.
- R2. Removal of sediment from the tank would require a source outage, reducing availability for supply.
- R3. This option requires two sets of new pumps.
- R4. It would require the reconfiguration of treatment works, requiring additional space which is limited on site.
- R5. Work required within 9m of main river and may require environmental permit.
- R6. Giant hogweed known to be present on site. Currently undergoing treatment.

4.2.4 Option 7 – Amazon filters and pump upgrades

This option comprises of installing a series of Amazon filters and upgrading the borehole pumps to address head loss through the filters. Based on the abstraction volumes and flow requirements it has been calculated that 44 filters would be required. These would be installed to intercept turbidity in the raw water before passing through the rest of the treatment process. This option makes use of the existing UV treatment on site.

Option	Project name	Outcome	Cost
7	Amazon filters and pumps	Addresses turbidity and reliability post sustainability reductions	£668,173

Benefits

- B1. This will address the raw water turbidity issues that are currently affecting source output.
- B2. This will improve output of the site under different groundwater levels conditions.
- B3. Reduces the need to rest the site for period of time following turbidity spikes and therefore maintain output.
- B4. Supports delivery of the AMP7 sustainability reductions through increased reliability of source output.
- B5. Delivers against the programme drivers (Section 0).
- B6. Can utilise existing washout facility for filter backwash water, subject to appropriate environmental permitting.

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Risks

- R1. Will require back washing of filters, as part of routine operations.
- R2. Frequency of filter replacement will be dependent on turbidity levels and grain size.
- R3. Work required within 9m of main river and may require environmental permit.
- R4. Giant hogweed known to be present on site. Currently undergoing treatment.

4.3 Cost Benefit Analysis

The nature of this investment is focussed on a number of clear drivers, the most important of these being fulfilling our regulatory commitments by undertaking the sustainability reductions and maintaining water supply to our customers. As a result of these drivers the feasible options will not provide direct monetary benefits to us following implementation. Where expenditure is needed we have focussed on maximising efficiency to ensure the best value option is selected and future operational costs are kept to a minimum.

Option 7 is the best value as it ensures that the security of supply to WRZ5 (a population of approximately 285,000) would be maintained following the Upper Cam sustainability reductions. The AMP7 costs for this option is £668,173.

Option 5: The AMP7 costs for this option are £2.33m. This option requires a larger level of investment and there was deemed to be insufficient evidence to justify the cost.

The monetary benefits of implementing the AMP7 sustainability reductions will be given further quantification using a Natural Capital approach. This approach is currently being developed using the data collected post AMP6 sustainability reductions as a baseline. This method will allow us to use real data linked to indicators of environmental improvements to calculate financial benefits with increased confidence.

4.4 Recommendation

The recommended best value option is Option 7 to install Amazon filters, upgrade the two borehole pumps and variable speed drives.

Option	Project name	Outcome	Cost
7	Amazon filters and pumps	Addresses turbidity and reliability post sustainability reductions	£668,173
			£668,173

This option has been selected based on cost benefit analysis (section 0) and a risk-based review of the benefits and risks (section 0).

25 Risks, Issues and Mitigation

The following risk and mitigation actions have been identified:

Risk/Issue	Mitigation
Backwashing of filters will be required.	Scheduling of maintenance to be identified in detailed design and tested during commissioning. Early discussion with EA regarding environmental permitting requirements.
Frequency of filter replacement will be dependent on turbidity levels and grain size.	Sampling of turbidity and downhole CCTV inspection to be carried out as part of design phase to identify grain size.
The Uttlesford site is relatively small in size and adjacent to the River Cam.	Careful planning and design of works to ensure efficient use of space on site.
Site located on bank of main river (River Cam)	Environmental mitigation to be identified to protect river habitat. Relevant environmental permitting to be obtained in consultation with Environment Agency.
Timescales for procurement of equipment and installation and other operational outages	Detailed programme planning to ensure works are planned in advance and other planned operational outage are considered.
Giant hogweed known to be present on site.	Continued treatment of this invasive non-native species to eradicate presence and remove risk. Ensure appropriate mitigation during construction to ensure it is not spread off site.

26 Procurement Strategy

Affinity Water has framework agreements in place with principle contractors to deliver Above Ground Asset construction works. In addition, framework agreements are in place at a Tier 2 level (Pumps, MCCs, VSDs, Valves, Pipework, Security) to encourage standardisation and cost certainty. A process is ongoing to review the most cost-effective way procuring projects; at a high level, the process is considering:

- Early engagement beginning in the Concept stage to drive Innovation
- Allocation of grouping of projects to benefit from economies of scale
- The use of incentivisation in contracts, to improve early completion of projects and lower project costs
- Some competitive tendering (where appropriate) and KPI driven allocation to improve the level of competitive tension.

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Appendices

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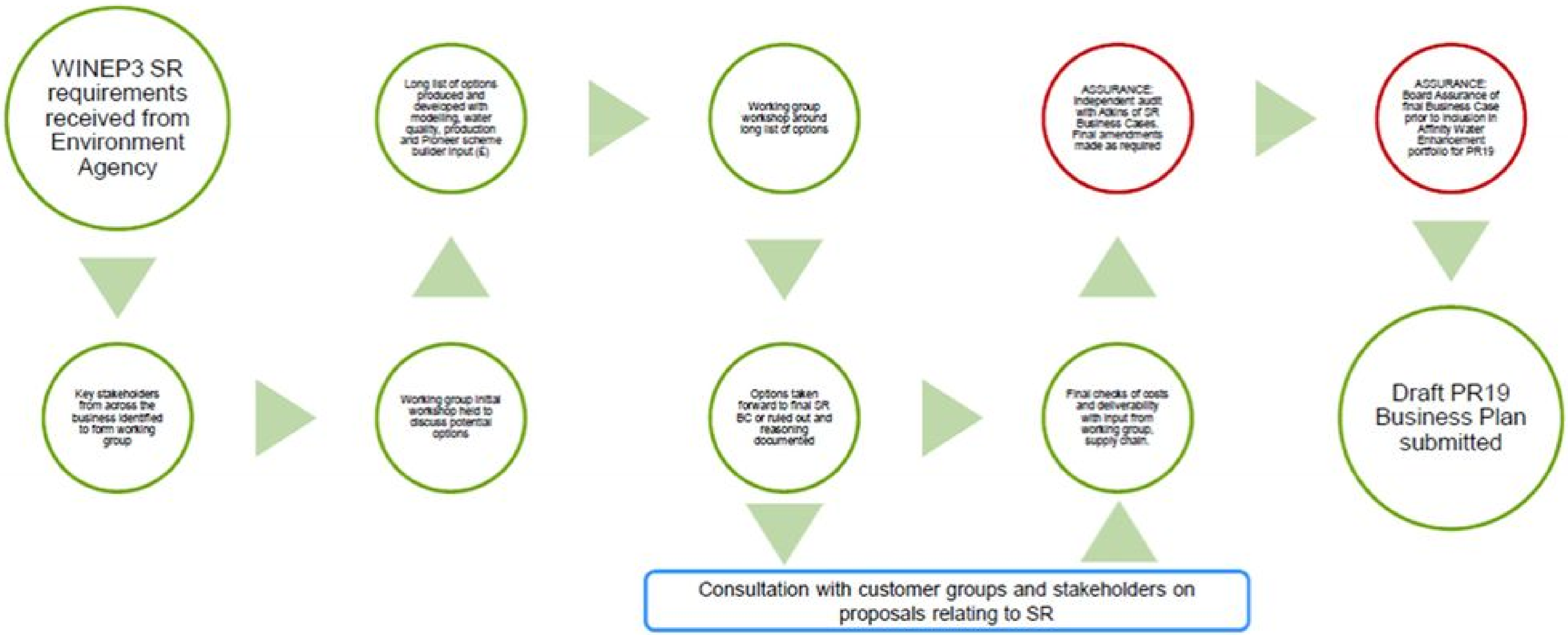
27 Appendices

Methodology

AMP7 Sustainability Reductions Business Case process

From WINEP3 requirements to submitted PR19 Business Case



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WINEP3 – confirmed reductions as per EA letter

Source	WRZ	WINEP3 Level of certainty	WINEP3 Date	Current Licence Average	Current Licence Peak	WINEP3 Sustainability Change Average	WINEP3 Sustainability Change Peak	Proposed WINEP3 New Licence Average	Proposed WINEP3 New Licence Peak	Current 1:200 drought DO Average	Current 1:200 drought DO Peak	Proposed Sustainability Reduction Average	Proposed Sustainability Reduction Peak	Post SR 1:200 Drought Average	Post SR 1:200 Drought Peak	Comment	Comment from EA
Amersham	1	Green	22/12/2024	4.00	9.00	2	2	2.00	7.00	4.00	9.00	2.00	2.00	2.00	7.00	Replaces Chalfont SR included at PR14 WINEP3 included Chalfont daily peak licence and not Amersham. Error confirmed in email from Marta Pluta 4th April 2018	
Chartridge	1	Amber	22/12/2024	group licence	2.05	-	2.05			1.52	1.66	1.52	1.66	0	0	This source is part of a group licence and has no individual annual average licence. Assumes cessation of abstraction as per email from Marta Pluta on the 1st May 2018	
Chesham	1	Amber	22/12/2024	5.22	7.09	5.22	7.09			4.86	6.00	4.86	6.00	0	0	Error on WINEP3 relating to licence volume and hence SC. Assumes cessation of abstraction as per email from Marta Pluta on the 1st May 2018	
Holywell	2	Green	22/12/2024	-	20.46	8.84	0	5.61	11.80	11.80	11.80	6.19	0	5.61	11.80	The split between these sources has been amended due to change in DO assessment between PR14 and PR19. NB Mud Lane is Holywell BH6	Agregated licence with max daily rate from Mud Lane (11.37Ml/d). Operated almost as one source. New licence will review operations at both sites and potentially update maximum daily rate for Mud Lane to reflect operation needs. No change is proposed to total peak rate on the licence.
Mud Lane	2	Green	22/12/2024	-			0	3.78	8.66	6.60	6.60	2.82	0	3.78	6.60		
Mud Lane/Holywell					*20.46*	*8.84*		*9.39*	*20.46*	*18.40*	*18.40*	*9.01*	*0*	*9.39*	*18.40*		
Baldock Road	3	Green	22/12/2024	4.55	4.55		0		4.55	3.20	3.60					Sources to be capped to recent actual. Bowring and Fuller DO constrained by DAPWL. AMP7 scheme to included river support of c0.4Ml/d from existing licence but no impact on DO Also listed as Amber SC	
Bowring	3	Green	22/12/2024	7.96	7.96		0		7.96	3.60	3.90						
Fuller	3	Green	22/12/2024	7.96	7.96		0		7.96	3.70	4.80						
Willian Road Group			22/12/2024	*14.77*	*20.47*	*0.63*	*0*	*14.14*	*20.47*	*10.50*	*12.30*	0	0	10.5	12.3		
Digswell	3	Green	22/12/2024	11.37	11.37	9.87	2.45	1.50	8.92	7.20	8.10	5.7	0.00	1.5	8.10	No reduction in peak DO included at PR14. The s20 agreement allows peak abstraction of 8.92Ml/d which is already a reduction from the LoR of 11.37Ml/d. We believe this is an error on WINEP3	Changes reflect recent discussions with Affinity Water.
Perwinkle Lane	3	Green	22/12/2024	4.99	5.00	4.99	5.00	0.00	0.00	4.60	5.00	4.60	5.00	0	0	Assumes cessation of abstraction	
Runleywood Chalk	3	Green	22/12/2024	9.55	9.55	9.55	9.55	0.00	0.00	5.60	6.40	5.60	6.40	0	0	Assumes cessation of abstraction	
Debden Road	5	Green	22/12/2024	3.41	3.49	0.34	0	3.07	3.49	3.07	3.40	0	0	3.07	3.40	Cap to recent actual.	
Newport	5	Green	22/12/2024	1.36	2.27	0.48	0	0.88	2.27	1.30	1.70	0.42	0	0.88	1.70	Cap to recent actual. Recent pump replacement so impacts DO.	
Springwell Farm	5	Green	22/12/2024	13.68	13.64	6.77	0	11.47	13.64	0.00	0.00	0	0	0	0	Dormant source	
Uttlesford Bridge	5	Green	22/12/2024	13.68	13.64	6.77	0	11.47	13.64	6.00	6.00	0	0	6	6	Assumes no reduction in DO due to existing licence condition. AMP7 to include provision of river support of up to 5.47Ml/d from licence capped to recent actual Also listed as Amber SC	Licence volume for supply at 6 ML/d confirmed by EAN Area. Morphological change/river restoration project planned to mitigate flow support volume needed during drought conditions.
Uttlesford Group			*22/12/2024*	*15.95*	*18.18*	*0.48*	*0*	*11.47*	*18.18*								
Wenden	5	Green	22/12/2024	4.55	4.55	2.01	0	2.53	4.55	2.30	2.60	0	0	2.30	2.60	Cap to recent actual. Option to increase DO removed from EBSD	
Central Region Green/Amber Total						**44.42**	**28.14**					**33.71**	**21.06**				
Central Region Green Total	**1, 2, 3 & 5**	Green				**39.20**	**19.00**					**27.33**	**13.40**				
Central Region Amber Total	**1**	Amber				**5.22**	**9.14**					**6.38**	**7.66**			Difference between the WINEP3 SC and SR relates to Chartridge not having an individual annual average licence and an error on WINEP3 relating to Chesham licence volume and hence SC.	
Higham	8	Amber	31/03/2021	6.50	10.00	2.597	2.597			5.02	6.88	2.60	2.60	5.02	6.88	Sources subject to two group licences with daily, annual and 5 year totals. Volume of reduction uncertain. EA have indicated reduction of 15 and 20Ml/d may be required	
Shelley	8	Amber	31/03/2021	3.90	7.00					2.89	4.17			2.89	4.17		
Lattinford	8	Amber	31/03/2021	2.47	4.00					1.81	2.70			1.81	2.70		
Stoke-by-Nayland	8	Amber	31/03/2021	11.70	13.00					8.00	10.93			8.00	8.33		
East Region Amber Total	**8**					**2.597**	**2.597**					**2.60**	**2.60**				

Business Requirements

Requirements Priority Matrix

Designation	Explanation
Must	The solution will not be accepted if a requirement that has a priority of 'Must' has not been delivered
Should	The requirement with a priority of 'Should' would provide business benefit, but the business would accept a solution where this requirement was not delivered e.g. the solution could be delivered by other projects/changes of working practice. If possible the solution should deliver these requirements
Could	The requirement with a priority of 'Could' may provide some business benefit, but not as much as the requirements that have been prioritised as 'should' and 'must'. The business would accept a solution where this requirement was not delivered.
Won’t	Won't do this now but may wish to implement in the future

Functional Requirements

	Requirement Description	Rationale	Priority
1	The solution must remove the risk of turbidity.	Business Plan commitment to make sure our customers have high quality water they can trust.	Must
2	The solution must ensure abstraction from the source can be maximised (within licence)	Water available for use	Must
3	The solution should be sufficiently robust such that it does not become a limiting factor on the site.	Water available for use – site downtime reduces output capacity and leads to poor pressure or even no water within the network, and therefore customer complaints.	Should
4	Provide resilience to supply area and flexibility in network operation, considering future sustainability reductions and predicted reliance on various imports to the supply region.	To supply wholesome drinking water in accordance with water quality standards.	Must

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5	Provide security of supply	To avoid DG2 and DG3 issues in supply area.	Must
6	Treat all water produced on Affinity water sites to acceptable standard.	To supply wholesome drinking water in accordance with water quality standards.	Must

Non-Functional Requirements

	Requirement Description	Rationale	Priority
1	The solution should not impact on the operability of the rest of the process, and should not increase the site's operator input on the rest of the process through adverse downstream or upstream effects.	Leaving an intelligent operating legacy – maintaining or improving existing site operability so as not to put unnecessary strain on Production staff.	Should
2	Compliance with relevant Affinity Water standards and policies.	Ensure high quality of work.	Must
3	Governance documentation completed in line with project lifecycle	Ensure business case is valid and all stakeholders retain buy-in throughout project.	Must
4	Health and Safety will be a project priority. Risk Assessments and Method Statements will be required for all site work. HAZOP, HAZID and HAZCOM will be completed through the project lifecycle. Additionally, hazards for on-going maintenance will be reviewed through the design phase. The project will comply with CDM regulations.	Ensure all works are risk assessed and conducted in the safest way possible to promote zero harm.	Must
5	Update operational and maintenance manuals, update AMIS and tagging, update existing telemetry and SCADA software, update site drawings, update GIS information.	To ensure all site information and software is up to date.	Must
6	Improve overall security of supply and maintain resilience of network in supply area.	To ensure customers are provided with clean drinking water, and we meet our regulatory requirements.	Should

Appendix AFW.CE.A1.12

Action ref AFW.CE.A1

AFW PR19 Technical Assurance Report – Final Investment Case Supplement

ATKINS

AMP6 Technical Assurance

PR19 Assurance Report Investment Case Supplement

Affinity Water

15 March 2019

Contains *sensitive* information

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This document has 14 pages including the cover.

Document history

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Revision	**Purpose description**	**Originated**	**Checked**	**Reviewed**	**Authorised**	**Date**
Rev 1.0	Draft report	JPA	JJ	BA	JPA	06/03/19
Rev 2.0	Final report	JPA	JJ	BA	JPA	15/03/19

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Table of contents

Executive Summary

Atkins has been engaged by Affinity Water to provide technical assurance on its PR19 Business Plan submission to Ofwat. In the Assurance Report dated 17th August 2018 for the Business Plan submission on 3rd September 2018, Atkins provided technical assurance on the Investment Programme amongst other areas. Atkins reported its findings to the Audit Committee on 16th August 2018 and the Board on 28th August 2018.

The technical assurance of the Investment Programme reported findings on 19 investment areas, summarised below.

Classification	**Investment Areas by Classification**	**Totex Value of Investment Areas by Classification**
Green	12	£362.5m
Amber	7	£367.4m
Red	-	-

Ofwat released in January 2019 its initial assessment of Affinity Water's Business Plan. As part of its assessment, Ofwat assessed Affinity Water's Board assurance statement as being partially compliant because it *"does not confirm that the large investment proposals are robust."*. Ofwat requires Affinity Water to provide in 1st April 2019 submission *"a restated and compliant Board assurance statement."*

Affinity Water sought assurance in respect of these matters to be provided in a further technical assurance report to be presented to the Board and published alongside Affinity Water's new submission to Ofwat. This review was undertaken in February and March 2019 and was designed to revisit the seven large investment areas classified as 'Amber' and review the Supply 2040 Scheme in order to support the Board in its assessment. The review considered:

- adherence to Ofwat's PR19 Business Plan methodology and regulatory guidance from the EA and DWI
- the reliability and transparency of the processes used to develop the proposals
- their technical suitability
- robustness of the challenge and decision-making process
- consistency of investment proposals with proposed Performance Commitments
- that uncertainties either in relation to the quantum of activities or the costs are not material

To address the above, we considered each of the Investment Cases and assessed the progress made on addressing uncertainties raised in the August 2018 Assurance Report. Unit costs were broadly unchanged and the assurance of costing was not revisited in detail during these audits.

After discussion of the underlying reasons for the original assessment, it became apparent that the focus of the supplementary audits would be on the extent to which the Investment Cases demonstrated that the proposals were well founded. That is, the need was well defined, all reasonable solution options had been considered and the means of implementation of the selected option and the associated risks were understood. The same approach was adopted for the Supply 2040 Scheme.

Based upon a combination of both documented evidence and verbal explanation, we formed the opinion that the concerns raised in the original audits had been addressed to the extent that the Amber statuses could be removed from each of the seven Investment Cases and that the Supply 2040 scheme should be assigned 'Green' status.

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Background

In the Assurance Report dated 17th August 2018 for the Business Plan submission on 3rd September 2018, Atkins provided technical assurance on the Investment Programme amongst other areas. Atkins reported its findings to the Audit Committee on 16th August 2018 and the Board on 28th August 2018. The technical assurance of the Investment Programme reported findings on 19 investment areas, summarised below.

Classification	Investment Areas by Classification	Totex Value of Investment Areas by Classification
Green	12	£362.5m
Amber	7	£367.4m
Red	-	-

The following definitions underpinned the RAG classification for each investment area:

Green: Clear drivers, optioneering and costs that are underpinned by an appropriate evidence base

Amber: Reasonable clarity over drivers and evidence of reasonable optioneering, but there are notable uncertainties either in relation to the quantum of activities or the costs that have been applied, or there are inconsistencies between the investment proposals and the Performance Commitments within the Business Plan

Red: Areas of investment where we have significant concerns over the derivation of the investment activities or the costs associated with those activities, and those concerns relate to either a defined regulatory issue or cost errors in the programme that are likely to exceed 1% of totex. All 'red' level concerns were satisfactorily addressed by Affinity Water prior to the submission.

Ofwat released in January 2019 its initial assessment of Affinity Water's Business Plan. As part of its assessment, Ofwat assessed Affinity Water's Board assurance statement as being partially compliant because it *"does not confirm that the large investment proposals are robust."*. Ofwat requires Affinity Water to provide in 1st April 2019 submission *"a restated and compliant Board assurance statement."*

Scope of Work

To support the Board in providing the required statement, Affinity Water requires further assurance of its AMP7 investment programme to demonstrate in respect of its large investment proposals classified 'Amber' in the Atkins PR19 Assurance Report and the Supply 2040 scheme:

- adherence to Ofwat's PR19 Business Plan methodology and regulatory guidance from the EA and DWI
- the reliability and transparency of the processes used to develop the proposals
- their technical suitability
- robustness of the challenge and decision-making process
- consistency of investment proposals with proposed Performance Commitments
- that uncertainties either in relation to the quantum of activities or the costs are not material

Affinity Water sought assurance in respect of these matters to be provided in a further technical assurance report to be presented to the Board and published alongside Affinity Water's further submission to Ofwat.

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Summary of Amber Classifications

Table 3-1 below summarises our findings at August 2018 for each of the investment areas assigned ‘Amber’ status that we reviewed as part of the technical audits.

Our analysis at that time considered the technical adequacy of the proposals including both a review of the calculations and methods used to support the Business Cases, as well as a comparison against the equivalent AMP6 expenditure where appropriate.
Where there had been clear stepped changes from AMP6 investment we commented on this within the table.
Only those key issues or concerns that we considered needing to be brought to the attention of the Audit Committee and Board were highlighted in the table. We also identified lesser issues that were either addressed prior to the report or were not considered material enough to warrant inclusion within the report. They were included in the individual audit summary reports that we provide to Affinity Water following each audit, and were tracked through an ‘Issues Log’.

There were seven areas of investment where an Amber classification was applied, meaning there were uncertainties beyond those that would normally be expected in an investment programme. Of those, four categories of investment (infrastructure capital maintenance, management of supply interruptions, leakage and the WRMP demand management activities) had direct potential implications on the achievement of PC targets and hence could translate into ODI penalties.

• **Table 3-1 Summary of Technical Assurance Findings by Investment Area (August 2018)**

Investment Area	Summary of any Key Issues or Concerns	AMP7 totex (£m)	RAG classification
Schemes to manage sustainability reductions	All major challenges satisfactorily addressed, although we note that £20m relates to strategic transfers to allow the transfer of water out of the Wey Water Resource Zone. Following our audit challenges, we can confirm that this has clear drivers associated with the Water Resources Management Plan but there is a relatively high level of cost uncertainty. The Sundon scheme is listed separately below.	78.7	Amber – relatively high cost uncertainty
Infrastructure: Distribution mains, trunk mains and communication pipes – Bursts	The modelling of renewals costs was generally well evidenced and carried out, although we note that the AMP7 mains renewals costs have dropped significantly from AMP6 (£64m in AMP6 to £38m for AMP7). Much of this reduction in costs is associated with apparent modelling ‘artefacts’ in the Pioneer model, which are not well linked to actual delivery efficiencies, and reduce the short-term cost of interventions (mains renewals) to below the longer term sustainable rate. The implications of this reduction in expenditure on burst rates within a single AMP are relatively small (less than 20 bursts/annum likely impact by the end of the AMP). In addition to this, proposed renewals lengths were dropped on a pre-efficiency basis from the 280km in the model down to 210km, which theoretically increases burst rates by a further 30 per annum by the end of the AMP. The ‘central’ estimate of burst rates by the end of the AMP is therefore theoretically around the 3,050 level (compared with 3,000 current), so still below the target of 3,100 *[note, in terms that are equivalent to the PC, this relates to a risk of +3 bursts/1000km/annum versus the target of 186 bursts/1000km/annum]*. However, there is a large amount of volatility in the burst figure, so Affinity Water is increasing its risk of ODI penalties as a result of the proposed mains renewals investment.	38	Amber – the combination of model uncertainty and reduction in scope means that the risks associated with meeting the bursts target will be higher in AMP7 than they have been in AMP6.

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Infrastructure: Operational costs for leakage reduction	Costs for leakage reduction have been assessed through both a 'bottom up' analysis of costs, and through the use of the SALT model to derive Active Leakage Control (ALC) cost curves. We found that the SALT model costs are highly uncertain due to the model's sensitivity to cost allocations between DMAs, but that there is some confidence gained by use of the 'bottom up' engineering analysis of activities and costs, which supports the overall figure. Leakage costs were also evaluated through the WRMP process, which used a combination of the SALT model curves for distribution leakage and 'bottom up' costs for customer side leakage improvements. Overall these indicate a range of totex in the order of £48m to £52m, but there is considerable uncertainty in these costs. Because the majority of the costs are opex rather than capex, leakage control has then been subject to an effective efficiency reduction of 28%. The risk of under-funding for the leakage Performance Commitment (PC) is therefore relatively high.	35.5	Amber – significant uncertainties plus high levels of 'top down' efficiency represent a risk to the leakage PC.

Wholesale operations costs: management of supply interruptions	The achievement of the interruptions to supply PC comprises a trunk mains maintenance programme covering valves, critical crossings, etc (circa £7.5m pre-efficiency), plus two tranches of largely operationally based activities to reduce interruptions from their current levels down to the 3 minute target. The first, larger tranche of activities, to achieve a reduction down to 6 minutes, which is based on an extension of the current operational initiative has been reasonably well costed. The second, smaller tranche of activities, to reduce from 6 to 3 minutes is highly uncertain and requires activities that Affinity Water has limited experience of (e.g. overland temporary connections and tankering). We have assigned this an 'amber' risk as the initial costs that were presented to us totalled £45.8m (£7.5m trunk mains maintenance and £38.3m interruptions response investment), compared with the £33m in the final programme, so not only are the requirements very uncertain but there have also been large levels of efficiency challenge applied to the initiative. A 'red' risk has not been assigned as this has been mitigated by the use of penalty collar 'deadbands' for the PC.	33.0	Amber – high levels of uncertainty for circa 1/3 of the costs, plus very high levels of efficiency applied to this uncertain programme, mitigated by the use of 'deadbands' for the PC
Water Resource Management Plan: meters and water savings	The costs for the continuation of the metering programme (£75m) are straightforward and based on the current programme. They contain some efficiency, but still outturn at a realistic £220 per meter installed. The remainder of the water saving programme is highly uncertain and contains at least £28m of schemes with a very low benefit to cost ratio, which have been selected by the WRMP model as there were no other options to achieve the PCC target. Other options such as fast logging have increased from £7m to £12m following initial audits. As there are no 'top down' efficiency assumptions that have been imposed on water efficiency targets it appears that this part of the programme is well funded, although the costs and benefits of the activities remain inherently uncertain by their very nature, as Affinity Water is effectively pushing the boundary of demand management in the measures that it is proposing to implement in AMP7.	140.2	Amber – very uncertain costs, but this is unavoidable to a large extent and the programme appears to be well funded, so we have not applied a 'red' classification.

Water Resources Management Plan: Strategic Water Resource costs	Costs associated with up-front planning of longer term strategic water resource options, including Abingdon reservoir, plus Water Resources in the South East (WRSE) contributions and an allowance for feasibility studies for strategic investment needs post AMP7. The Abingdon reservoir development costs and WRSE are well evidenced, but £10m of the expenditure (on the Abingdon reservoir public inquiry and future strategic needs) are nominal figures. We checked and confirmed that the public inquiry costs have not been double counted with the Abingdon reservoir costs. Although the Abingdon costs are based on a reasonable apportionment, the exact level of need and timing is very uncertain at this stage, given the very long lead times before the scheme is constructed, and the high level of scrutiny and resistance it is likely to attract.	30	Amber – uncertainty over the timing of Abingdon reservoir expenditure and large uncertainties over the strategic scheme and public inquiry cost elements
IT enhancement strategy	Because there is no linkage between capital costs and operational savings within the programme, the £12m here effectively represents a 'budget' allowance, and the return on investment associated with the enhanced IT spend does not appear to inform the approval process. We note that this amount is much less than the 'minimum case' spend initially put forward by IT (£31m), so it is likely that all of the expenditure contained within this £12m will be cost beneficial.	12	Amber (main issue is the lack of linkage with operational savings, as discussed above)

Findings

After discussion on the underlying reasons why the August 2018 Assurance Report had assigned an 'Amber' status to the seven Investment Areas, it became apparent that the focus of the supplementary audits would be on the extent to which the Investment Case documentation demonstrated that the proposals were well founded. That is, the need was well defined, all reasonable solution options had been considered and the means of implementation of the selected option was and the associated risks were understood. Unit costs were broadly unchanged and the assurance of costing was not revisited in detail.
In addition, we reviewed the Supply 2040 scheme. This scheme is an overarching set of projects to manage supply deficits, provide operational resilience and provide operating cost benefits. It is considered separately to the Sustainability Reduction schemes and the Strategic Water resource schemes so as to avoid ambiguity and the potential for either double counting or missing a critical scheme. It has been done in this way to avoid the risk of overlap in the schemes originally tabled for Technical Assurance.

Table 4-2 below summarises our findings from the reviews undertaken in February and March 2019 for each of the investment areas that we revisited and the one new area reviewed.

• **Table 4-2 Summary of Technical Assurance Findings by Investment Area (February-March 2019)**

Investment Area	**Summary of any Key Issues or Concerns**	**Documents Reviewed**	**RAG classification**

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Schemes to manage sustainability reductions	Our assessment of an Amber status for the sustainability investment case was based upon the need for further detailed explanation of the component parts of the investment. Four separate Investment Cases have been produced. The delivery of sustainability reductions as listed in the WINEP3 spreadsheet covered by the 4 Investment Cases requires work to be carried out to ensure security of supply. This involves works (pipes, storage, pumps, treatment plant expansions etc) to convey water from other sources to replace the sustainability reductions. In each of the investment cases, alternative means of replacing or supplementing existing supply arrangements are considered and costed. The costing is based upon unit rates for much used asset types. These costs were considered in the original technical assurance audits.	• Summary Pack: Holywell and Mud Lane sources in St Albans area of supply • Summary Pack: Digswell Sustainability Reduction • Summary Pack: Amber Sustainability Reduction sites • Summary Pack: Green Sustainability Reduction sites	On the basis that further detailed explanation of the components and costs of the investment was provided, we believe the Investment Cases for Sustainability Reductions should be a Green status.
Infrastructure: Distribution mains, trunk mains and communication pipes – Bursts	We noted in our previous audit that the modelling of renewals costs was generally well evidenced and carried out. The rate of mains renewal in AMP4 and AMP5 was c.1%, in AMP6 c.0.5% and AMP7 c.0.3%. The Company provided analysis of the rate of rise of bursts and it is apparent that a 0.3% replacement rate may not be sustainable in the long term. The reduction of the renewals length from 280km to 210km results in 40 extra bursts across the AMP7 period. Assuming an "average/typical" year the burst levels will remain below the existing target of 3100 bursts. The Company is not challenging itself to reducing the level of bursts but is allowing the headroom with which it can absorb the effects of weather events to reduce. The rate at which burst rates will increase for the proposed level of renewal appears to be understood. The positive impact of mains stressed less due to network calming and falling demand is not yet understood; and emerging technologies may further improve the targeting of mains renewal. There is a large amount of volatility in the burst figure, so Affinity Water is increasing its risk of ODI penalties as a result of the proposed mains renewals investment	• Summary Pack (Infrastructure: distribution mains, trunk mains and communication pipes - Bursts) • Bursts analysis: summer 2018 report (January 2019)	The change in risk is small and is clear in the Investment Case. On this basis, we change the Investment Case to Green status.
Infrastructure: Operational costs for leakage reduction	The Company has prepared a Leakage Taskforce report which provides detail on how Affinity Water will achieve its stretching leakage targets for AMP7. Five key areas are considered: Organisation; ALC Policy; Data and Reporting; Skills and Competencies; and Performance, Benefits Tracking and Change Control. Findings in each area are both industry wide and company specific and the lessons learned are to be applied in the proposed changes for each of the areas. The document shows ambition and has detail of the actions required, including for the remainder of AMP6 in order that the AMP6 closing leakage levels are at or better than the AMP6 target.	• Summary Pack (Infrastructure: distribution mains, trunk mains and communication pipes - Leakage) • Affinity Water Leak Survey Benefits Assessment • Leakage Taskforce (Initial Review, Assessment and	The Leakage Taskforce document provides detail and its application including the organisational changes to ensure the agility to respond to evolving performance and technologies should give comfort that the risk is being managed. On

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	The proposal to reduce leakage by 18.5% across AMP7 will inevitably move the Company into areas of cost uncertainty. The Company is assuming that the marginal cost of high or low levels of active leakage control are a third higher or lower than the unit costs experienced at current leakage levels. The detailed considerations in the Leakage Taskforce document mitigate much of the associated risk. Experience gained in the closing years of AMP6 will be reflected on continuing improvement in AMP7. The downwards pressure on leakage from Ofwat, in response to customer preference, is leading to an industrywide rethink of leakage management. The cross fertilisation of ideas between companies and from experienced contractors with a broad client base is allowing a vision of future good practice to take shape. As with other PCs, there will always remain the inherent risks associated with extreme client events. We understand that the costs within the Investment Case are those that were reviewed previously, and the uncertainty in costs referred to in the original Amber status was a reflection of the lack of clarity in how the leakage effort was going to achieve the targets.	Proposed Changes to Current Leakage Strategy) - Confidential	this basis, we assign this Investment Case a Green status.
Wholesale operations costs: management of supply interruptions	This is an industry wide performance measure that will be subject to cross company comparison and target setting. There is limited scope to make allowance for exceptions when reporting, and the measure will always be vulnerable to extreme weather events. There are limits to the extent to which burst events can be reduced with an affordable level of mains renewal. Network calming and pressure reduction are part of the consideration of the bursts measure. The effective and efficient handling of each interruption is the critical success factor for CML performance. Performance at the annual return 2018 was 33 minutes and the current figure is approximately 10 minutes. The investment case for the interruptions to supply PC comprises a trunk mains maintenance programme plus two tranches of largely operationally based activities to reduce interruptions from their current levels down to the 3-minute target. The first, larger tranche of activities, to achieve a reduction down to 6 minutes, was based on an extension of current operational initiatives. Our earlier Amber assessment was on the basis that the second, smaller tranche of activities, to reduce from 6 to 3 minutes was highly uncertain and required activities of which Affinity Water has limited experience. We have reviewed the Investment Case and the component breakdown of the measures with which it is proposed to reduce the performance level to 3 minutes. None of the proposals are different from the approaches that are have been or will be adopted by the wider water industry.	• Summary Pack (Infrastructure: distribution mains, trunk mains and communication pipes)	The combination of company and industry learning alleviates some of the concerns we raised previously. There will be a lag before new responses to interruption incidents are fully understood and practiced, but the shift to the more customer centric approaches is already leading to improved performance and we believe the cost risk is being managed and have given our assessment that the Investment Case should have a Green status.

Water Resource Management Plan: meters and water savings	Our view in the August 2018 Assurance Report was that the costs for the continuation of the metering programme were straightforward, realistic and based on the current programme; the remainder of the water saving programme was seen as highly uncertain, which had been selected by the WRMP model as there were no other options to achieve the PCC target. The costs and benefits of the activities remained inherently uncertain, as Affinity Water was effectively pushing the boundary of demand management in the measures that it is proposing to implement in AMP7. Subsequently, considerable new work has been carried out on the revised WRMP and these activities have been subject to further audit. The updated results have fed into the Investment Case for Water Savings. The schemes are now considered for each Water Resource Zone and were subject to internal and independent challenge in the development of the revised draft WRMP.	• Audit Note: Water Savings Programme Costs and Benefit	We believe that the further detailed consideration of the water savings and new information detailing the Water Savings Programme Costs and Benefits have added certainty to the proposals and that the Investment case should now be given a Green status.
Water Resources Management Plan: Strategic Water Resource costs	The original Technical Assurance audits considered costs associated with up-front planning of longer-term strategic water resource options, including Abingdon Reservoir, plus Water Resources in the South East (WRSE) contributions and an allowance for feasibility studies for strategic investment needs post AMP7. The Abingdon Reservoir development costs and WRSE are well evidenced, but expenditure on the potential Abingdon Reservoir Public Inquiry and future strategic needs were nominal figures. We observed that although the Abingdon costs were based on a reasonable apportionment, the exact level of need and timing was very uncertain, given the very long lead times before the scheme is constructed, and the high level of scrutiny and resistance it is likely to attract. This Investment Case has been overtaken by Ofwat's rejection of the component costs and allocation of £70.9m as part of a national strategy. The Company explained the strategic options available including the construction of Abingdon Reservoir (and the stages in its development and shared financing), a Grand Union canal transfer, regional transfer in the River Thames to Iver WTW and the Grafham to Affinity transfer. It was the Company position that the £70.9m was adequate to cover any likely costs.	• None	The need for the initial Amber status is therefore removed and the replacement Investment Case which is in preparation can be assigned Green status.

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IT enhancement strategy	In preparing our August 2018 Assurance Report, we formed the view that the business case was strong. Though we identified some weaknesses and areas for improvement, overall we thought the expenditure was well-justified and supported the case for the £21.52m enhanced investment across Wholesale and Retail proposed. This was later capped at £12m by the business. Our challenge, which we took up with the team at the time, was that it appeared that the return on investment (ROI) was not taken into account in the approval process – i.e. IT enabled efficiencies across the business, 'spend to save', etc. We identified the risk that the business may not have sight of the benefits and efficiencies that the IT investment would deliver. We considered that the net cost with ROI from IT enhancement may lead to expenditure in most operational areas that could be materially lower. The £12m effectively represents a 'budget' allowance, and the return on investment associated with the enhanced IT is implicit within the £12m rather than identified across the business in areas that benefit directly or indirectly from the IT enhancements. The approach allows the flexibility and agility to plan as a business to become a "fast follower". The Investment Case includes consideration of the basis by which the originally requested investment can achieve the lower allocated figure. Therefore, we believe the Investment Case which included AMP7 Capex of £12m to be justified and supported; indeed, we saw a robust case for the higher figures at our 2018 audits.	• IT Investment Plan Version 2.0 24/07/2018 • Summary Pack (IT)	We were not challenging the costs in August 2018 and are comfortable with a Green status being assigned to this investment area, on the basis that the ROI from IT enhancement investment is understood.
Supply 2040	The Supply 2040 scheme is an overarching set of projects to manage supply deficits, while providing incidental operational resilience and operating cost benefits. AMP7 expenditure is associated with moving 17Ml/d out of WRZ6. Non-drought resilience is incidental and not the primary driver for the investment. The Investment Case supports the use of water envisaged in the WRMP as well as providing operational flexibility, network resilience, reduced risk of drought restrictions, accommodating growth and fitting in with future strategic resources. We were taken through the proposals and were able to confirm that the proposals had considered and avoided the potential for stranded assets caused by the uncertainty associated with the final detail of the strategic water resources schemes. During our audits, we challenged the inclusion of generic power costs and risk contingency in the costings and these were removed.	• Summary Pack (Supply 2040) • Affinity Water Regions Map • Supply 2040 – Egham Surplus 5 schemes • Summary Supply 2040 • Various supporting documents and appendices	Though not part of the original scope of this audit, we formed the opinion that the Supply 2040 proposals were based upon detailed assessment and calculation, taking a strategic perspective of the system enhancements needed to reach 2040, while avoiding any contradictions of the sustainability reduction schemes or strategic resource schemes.

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Conclusions

Based upon a combination of both documented evidence and verbal explanation, we formed the opinion that the concerns raised in the original audits had been addressed to the extent that the Amber statuses could be removed from each of the seven Investment Cases.

Appendix – Meeting and Audit Schedule

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Meeting or Audit	Atkins	Affinity Water	Date
Start-up meeting by teleconf	Jonathan Archer, Julian Jacobs	Tim Monod, Lauren Schogger, Nicola Fomes, Affie Panayiotou, Jen Kirby, Gerald Doocey	12th February 2019
Discussion on scope by teleconf	Jonathan Archer, Julian Jacobs	Marie Whaley, Doug Hunt	18th February 2019
Progress meeting	Jonathan Archer, Julian Jacobs	Tim Monod, Marie Whaley, Chris Offer, David Beesley, Alan Shaw	25th February 2019
IT enhancement strategy	Julian Jacobs	David Clifton	25th February 2019
Infrastructure: Operational costs for leakage reduction	Jonathan Archer	Patrick Campbell, Anton Gazzard	25th February 2019
Wholesale operations costs: management of supply interruptions	Jonathan Archer	Patrick Campbell, Anton Gazzard	25th February 2019
Schemes to manage sustainability reductions	Jonathan Archer	David Watts, Ellie Powers	26th February and 1st March 2019
Water Resource Management Plan: meters and water savings	Jonathan Archer	Doug Hunt	26th February 2019
Supply 2040	Jonathan Archer	Sarah Sayer, Teddy Belrain	26th February and 1st March 2019
Water Resources Management Plan: Strategic Water Resource costs	Jonathan Archer	Doug Hunt	1st March 2019
Infrastructure: Distribution mains, trunk mains and communication pipes – Bursts	Jonathan Archer	Patrick Campbell	1st March 2019
EMT Pre-Board meeting to discuss draft report	Jonathan Archer	EMT members	19th March 2019
Presentation of findings from assurance activities at Board meeting	Jonathan Archer	Board members	21st March 2019
EMT meeting to discuss final audit report	Jonathan Archer	EMT members	25th March 2019
Board meeting to discuss final audit report	Jonathan Archer	Board members	27th March 2019

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Appendix AFW.CE.A1.13

Action ref AFW.CE.A1

Regional Wages Study

Response to Ofwat's Approach to Controlling for Regional Labour Differences at IAP

Prepared for Affinity Water

27 March 2019

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Executive Summary

NERA Economic Consulting (NERA) has been commissioned by Affinity Water (Affinity) to review Ofwat's treatment of regional wage variation in its Initial Assessment of Plans (IAP), published in the course of the PR19 price control review. The IAP contains Ofwat's initial view of companies' efficient AMP7 costs, based in part on a comparative econometric benchmarking exercise.[1]

Some companies operate in regions with higher wages than others. Where the cost of living is higher (e.g. London and its immediate surroundings in the South East), employees will require a higher wage than their counterparts working in regions with a lower cost of living. For the most part, a water company cannot locate its workforce in a lower-cost region than where its network is located. Therefore, a company operating in a high-wage region will generally face higher costs than those operating in low-wage regions, through factors unrelated to the company's efficiency.

For this reason, UK regulators have typically controlled for regional variation in wages when performing comparative benchmarking to inform price control decisions. In contrast to this wide body of precedent, Ofwat's IAP proposes not to control for regional variation in wages.

Ofwat puts forward a number of arguments to support its approach, which we have examined in this report. We find they do not justify its decision not to control for regional wage variation in assessing companies' business plans and setting AMP7 allowances:

- In its work to develop PR19 benchmarking models, Ofwat's consultants (CEPA) found that the inclusion of a regional wage variable as a cost driver did not yield statistically-significant coefficients. Ofwat repeats this line of argument in its IAP, suggesting regional wage variation has low predictive power, and that the modelled relationship with density controls implicitly for regional wage variation. However, this argument is flawed for a number of important reasons:
  - The particular measure of regional wages used by Ofwat in its models does not correspond closely to the regions served by water companies. This has been recognised previously by the CMA at PR14, for example. As such, any modelled relationship between costs and wages will be biased and understated.
  - The statistical procedure CEPA used to determine whether it is appropriate to add explanatory variables to the benchmarking models, a minimum increase of one percentage point in the R-squared parameter, is an arbitrary standard and a highly misleading test of whether a relationship exists between regional wages and costs:
    - An improvement in model fit achieved using an "off model" adjustment for variation in companies' regional labour costs could actually reduce R-squared, as this parameter is not designed to compare models with different explanatory variables (i.e. water companies' expenditure with and without a labour cost adjustment applied).
    - Ofwat has estimated aggregate cost models (rather than unit cost models), so the absolute value of the R-squared parameter is extremely high because the models need to control for differences in companies' scale, the major determinant of

[1] Ofwat (January 2019), PR19 Initial Assessment of Plans: Overview of company categorisation, p.40.

variation in cost across companies. Hence, achieving a further one percentage point change in R-squared is an extremely demanding standard.

- Ofwat's explanation that density controls implicitly for variation in regional wages relies on the existence of a close relationship, in the form of a strong positive correlation, between density and wages. In practice, only a weak correlation exists between wages and density, and this relationship is especially weak outside of central London. As such, companies like Affinity Water with relatively high wages compared to other companies with comparable density will receive allowances from Ofwat's models that understate their efficient costs.

In Ofwat's review of Affinity Water's special factor claim in relation to regional wage variation, Ofwat also suggests that regional wage variation is within management control, and that regional Affinity fails to recognise supposed "off-setting benefits of urban density on salaries". Neither of these claims provide a reasonable basis for ignoring the effect of regional wage variation on Affinity Water's costs.

- Water companies, like companies in all sectors of the economy, face the prevailing market wage for the types of labour they require in the locations where they operate. Companies may take different decisions depending on prevailing wages, such as by making different trade-offs between labour and capital depending on the wages they face, but companies operating in high wage regions will still tend to face higher overall costs as a result.
- Any effect of density on salaries will be reflected in the published measures of regional wage variation which are typically used by UK regulators to control for regional variation in labour costs.
- Differences in individual companies' effectiveness at managing regional wage variation will be reflected in their performance in comparative benchmarking.

For the reasons set out above, Ofwat's explanation of why it proposes not to control for regional wage variation, either within its econometric modelling or through allowing special factor claims, is flawed. Its proposal rests on an arbitrary interpretation of statistics, and an unsupported assertion that the correlation between density and wages is sufficient to control for this factor. Ofwat's suggestion that regional wage variation is within management control is also irrelevant, as companies' efficiency in managing the cost pressures they face is addressed through its comparative efficiency modelling.

We therefore recommend that Ofwat addresses this flaw, either by incorporating regional wages into its econometric modelling as a driver or an off-model adjustment, or by applying special factor adjustments. As explained in more detail in this report, we have estimated that Ofwat's IAP modelling understates Affinity's AMP7 allowances by around **£14.6 million** over five years by failing to control for regional variation in wages.

1. Introduction

In January 2019, Ofwat released its Initial Assessment of Plans (IAP) for water and wastewater companies in England and Wales, as part of the ongoing PR19 review process to set revenue caps during the Seventh Asset Management Period (AMP7), from April 2020 to March 2025. The IAP contains Ofwat's initial view of companies' efficient AMP7 costs, based in part on a comparative econometric benchmarking exercise, which it may amend in draft and final determinations due later in 2019.[2]

In carrying out a comparative econometric benchmarking exercise, Ofwat made a series of decisions on whether to include or exclude certain cost drivers from the econometric models. It sought to include drivers representing operating conditions that were out of control of the companies, while excluding other potential drivers that do not materially influence companies' costs or capture choices made by the company.

In its IAP benchmarking, contrary to its approach at previous price reviews and used by other regulators in similar circumstances, Ofwat decided not to control for regional differences in wages, citing two reasons: (1) it found the variable's predictive power in modelling to be poor; and (2) it argued that the effect of regional wages would be partially controlled for by the inclusion of density variables, which it claims are correlated with regional wages.[3]

We have been commissioned by Affinity Water (Affinity) to review the treatment of regional wage variation in Ofwat's current methodology, and appraise whether it provides AMP7 cost allowances that reflect variation in companies' costs caused by regional wage variation.

This report is structured as follows:

- Chapter 2 briefly describes Ofwat's proposed approach to calculating AMP7 cost allowances;
- Chapter 3 reviews regulatory precedent in controlling for regional wage variation; and
- Chapter 4 evaluates the merits of Ofwat's proposal not to control for regional labour factors in its cost assessment; and
- Chapter 5 quantifies a cost adjustment claim to be applied to Affinity's AMP7 cost allowances related to the relatively high regional wages in the region it serves as compared to lower wages in other parts of the country.

[2] Ofwat (January 2019), PR19 Initial Assessment of Plans: Overview of company categorisation, p.40.

[3] Ofwat (January 2019), Supplementary technical appendix: Econometric Approachp.15-16

2. Overview of Cost Assessment and Econometric Modelling

2.1. General Econometric Approach

As set out in the IAP, Ofwat's view of companies' efficient Base Total Expenditure (Botex) – i.e. opex plus capital maintenance expenditure, and excluding capital enhancement expenditure – derives from a comparative econometric benchmarking exercise. Ofwat estimates five econometric models, estimating the relationship between companies' historical costs (from 2011-12 to 2017-18) and a set of cost drivers. As described below, Ofwat combines "fitted" or "modelled" values from the econometric models from the final five years (2013-14 to 2017-18) to form a combined view of modelled costs.

The five models are as follows:

- Two econometric models estimate Water Resources Plus costs (WRP) (i.e. all wholesale water costs excluding Treated Water Distribution) as a function of the number of properties served, water treatment complexity (the two models differ only in the approach to measuring water treatment complexity), and density of the network region (both as a linear and a square term). Ofwat places 50 per cent weight on each of these models to form a combined view of modelled Water Resources Plus botex.
- One econometric model estimates Treated Water Distribution (TWD) costs as a function of the lengths of main, boosters per length, and density of the network region (both as a linear and a square term). Ofwat adds companies' modelled Treated Water Distribution costs with modelled WRP costs to form a combined "bottom-up" view of modelled Wholesale Water (WW) botex.
- Two econometric models estimate total WW botex as a function of the number of properties served, water treatment complexity, boosters per length, and density of the network region (both as a linear and a square term). Ofwat places a 50 per cent weight on each of these models to form a combined "top-down" view of modelled WW botex.

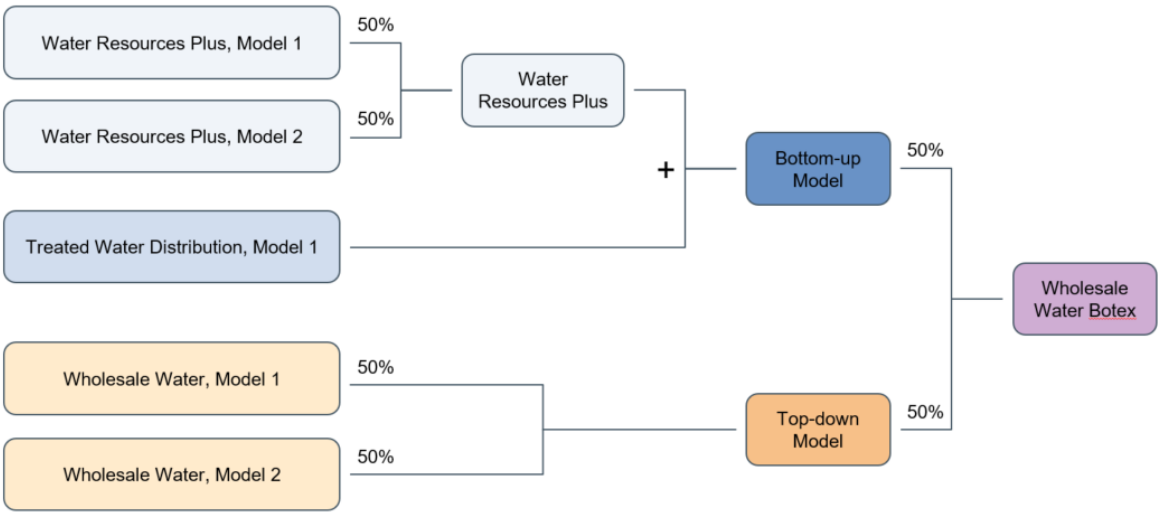
Ofwat then places 50 per cent weight on its bottom-up and top-down estimates to form its final view of modelled WW botex between 2013-14 and 2017-18. Table 2.1 lists the variables included in each model and the associated coefficients, while Figure 2.1 sets out Ofwat's process for combining each model into its view of efficient botex in the historical period.

Table 2.1: Ofwat Econometric Model Specification

Model name	WRP1	WRP2	TWD1	WW1	WW2
Connected properties (log)	1.014***	1.014***		0.993***	0.984***
Lengths of main (log)			1.013***		
Water treated at works of complexity levels 3 to 6 (%)	0.008***			0.003***	
Weighted average treatment complexity (log)		0.443***			0.371***
Number of booster pumping stations per lengths of main (log)			0.465***	0.515***	0.517***
Weighted average density (log)	-1.360**	-0.701	-3.068***	-1.711***	-1.473***
Squared term of log of weighted average density	0.083**	0.036	0.245***	0.126***	0.109***
Constant term	-5.316***	-7.605***	5.777***	-1.273	-2.267**
Overall R-Squared	0.934	0.921	0.968	0.978	0.979

Source: Ofwat[4]

Figure 2.1: Weighting of Econometric Models into Final Botex



Ofwat then calculates each company's efficiency score, the ratio of each company's actual botex in the modelling period to its modelled botex. It then ranks companies' efficiency score and selects the upper quartile value (95.2 per cent, set by South West Water) to be used as the efficiency challenge during AMP7.

Ofwat then multiplies modelled AMP7 botex by (1) the efficiency challenge of 95.2 per cent; and (2) an ongoing productivity or frontier shift of 1.5 per cent cost reduction per annum. This calculation produces Ofwat's view of efficient modelled WW botex.

4 Ofwat (January 2019), Supplementary technical appendix: Econometric approach, p.9.

Finally, Ofwat adds any company-specific factors which are not adequately controlled for by the econometric models (known as “cost adjustment claims”) as well as efficient unmodelled botex to arrive at a final view of efficient botex.

2.2. Ofwat’s IAP Treatment of Regional Labour Factors

Some companies operate in regions with higher wages than others. Where the cost of living is higher (e.g. London and its immediate surroundings in the South East), employees will require a higher wage than their counterparts working in regions with a lower cost of living. For the most part, a water company cannot locate its labour force in a lower-cost region than its network region, though this may be possible for some administrative and overhead functions. Therefore, a company operating in a high-wage region will generally face higher labour costs than those operating in low-wage regions, through factors unrelated to the company’s efficiency.

As discussed in greater detail in Section 3.3, cost assessment analyses at past price control reviews have typically controlled for regional wage variation through one of two approaches:

- Including a measure of regional wages as a cost driver in the econometric models, thereby allowing the models to estimate econometrically the extent to which total costs are driven by regional wage pressures; or
- Performing an “off-model” adjustment, which rescales a portion of companies’ costs deemed (usually subjectively) to be driven by regional wage pressures, and then estimating the econometric models on these “normalised” costs.

Ofwat’s consultants, CEPA, considered both of these approaches as robustness checks in developing the PR19 econometric models in March 2018, but ultimately decided to adopt neither into its core models.

- With respect to the first approach, CEPA found that the estimated coefficient on the variable was never both “statistically significant at more than a 10% level and […] of a sensible sign and magnitude” when added to its preferred models.[5]
- With respect to the second approach, it found that “pre-modelling regional wage adjustments did not significantly improve the predictive power of the models (i.e. increase in adjusted R-squared **by more than one percentage point**”.[6]

In the IAP, Ofwat confirmed CEPA’s view and rejected the inclusion of the wage variable in its models, citing the following reasons:[7]

- **The variable is not a robust cost driver.** “In many specification [sic] the variable has very low predictive power, and sometimes it showed a counter-intuitive negative sign (albeit statistically insignificant)”.

[5] CEPA (March 2018), Cost Assessment – PR19 Econometric Benchmarking Models, p.121.

[6] CEPA (March 2018), Cost Assessment – PR19 Econometric Benchmarking Models, p.60, 61, 68, 71, 75, 81, 87, 91, 95, 100, 104, 109, 113. Emphasis added.

[7] Ofwat (January 2019), Supplementary technical appendix: Econometric Approachp.15-16.

- **The variable is partially under management control.** “We recognise that variation in labour cost can have an impact on costs although companies can exercise control to mitigate this impact”.
- **Regional wages are correlated with density, which is included in the models.** “We consider also that the inclusion of a density variable, and a square of density, in our models, capture the effect of regional wage as the two are correlated”.

Under the assumption that Ofwat would not explicitly account for regional wages in the cost assessment process, Affinity submitted a cost adjustment claim of £12.5 million over AMP7, based on a 7 per cent premium relative to industry average that Ofwat’s own data shows Affinity faces on its labour costs.[8]

Ofwat rejected Affinity’s claim for three reasons:

- **Affinity fails to quantify offsetting cost savings due to urban density**. Ofwat argues that, while urban density drives higher cost of living and therefore higher wages, it also lowers labour costs due to “better match between skills and needs, and greater flexibility to hire and fire and to fill in part-time jobs”.[9]
- **The current models capture regional wage premia through controlling for density**.
- **Labour costs are partially under management control**. Ofwat finds that Affinity has taken reasonable steps to control the costs, but that three companies have reduced labour costs to a greater extent than Affinity over the five-year period to 2016/17.[10]

8 Affinity Water (3 September 2018), PR19 Table Commentaries, p.156.

9 Ofwat (January 2019), Affinity Water Cost Adjustment Claims Feeder Model, Tab “AFW-WN602001”, Cell D38.

10 Ofwat (January 2019), Affinity Water Cost Adjustment Claims Feeder Model, Tab “AFW-WN602001”, Cell D39.

3. Regulatory Precedent in Controlling for Regional Wages

In this chapter, we survey the approaches used by other regulators in similar price control benchmarking exercises to control for regional wage differences. As we show below, it is common for regulators to control for regional differences in wages, as this particular cost pressure is outside of the control of the network.

In particular, we review the treatment of regional wages at PR14 (by both Ofwat and the CMA) and RIIO-ED1, the most recent Ofgem price control review. We also review the approaches with which Ofwat and its consultants CEPA have experimented to control for regional wage differences at PR19. In describing and evaluating each approach, we consider three steps in the process of adjusting for regional wage variation:

- How “relevant” wages in a region are measured, which itself comprises several methodological choices;
- How the regulator determines the share of costs which are reasonably affected by these wage pressures; and
- How the regulator combines the two steps above to apply an adjustment to control for regional labour factors.

3.1. Measuring a Regional Labour Factor

The first step in controlling for regional wage differences is to identify an appropriate measure of regional wage variation.

Across all recent regulatory decisions in the UK which have required a regional wage adjustment, regulators have relied on data from the Annual Survey of Hours and Earnings (ASHE), collected by the Office for National Statistics (ONS). The ASHE dataset collects wages for different occupations (categorised by Standard Occupational Classification codes, or SOC codes) and in each of the 11 statistical regions of Great Britain.

However, within the ASHE dataset, a number of methodological choices are required to construct a single figure which represents the variation in wage pressures faced by companies’ in different regions. For example, the average person working in the financial sector in London earns considerably more than their counterparts in other parts of the country, but network companies do not typically employ investment bankers. Hence, London-based companies would be unfairly advantaged if Ofwat controlled for wages using a measure of regional wages in all sectors of the economy, as it would be distorted by the high-wages earned in London’s financial sector. By contrast, a measure of variation in the regional wages earned by engineers in the construction or utility sectors would not be distorted in this way.

In using the ASHE dataset to control for regional wage variation, the following methodological choices are required, as we discuss further below:

- Whether average wages are measured on an hourly or weekly basis;
- Whether average wages are measured as a mean or median wage;
- Whether average wages include or exclude overtime pay;

- Whether average wages include wages of part-time employees or are restricted to full-time employees;
- Which occupational categories are relevant, and with what weight; and
- How many regions are explicitly accounted for in the calculation.

3.1.1. Wage measurement (hourly vs weekly, including vs excluding overtime pay, mean vs median, all vs full-time employees)

In applying the ASHE dataset, a first step is to choose whether to compare hourly or weekly wages. All recent decisions we have reviewed, as well as the regional wage variable included in Ofwat's PR19 dataset, have used hourly wages because a measure based on weekly pay would "potentially capture differences in company policies and in efficiency (e.g. if employees in one company work 40 hours a week while employees in another company work 35 hours a week, doing the same job".[11]

The second choice is whether to include or exclude overtime pay from the comparison of wages. There is no regulatory consensus on this point. The regional wage measure in Ofwat's dataset uses a measure of wage that excludes overtime pay, on the basis that "workers who are on salaries, rather than paid hourly, may not receive any compensation for overtime work. It is difficult to know exactly how important overtime is for a typical company and we considered that the reasons for why the mix of overtime could differ across water and wastewater are most likely to be within company control – for instance, company policies on overtime pay". [12] By contrast, at RIIO-ED1 Ofgem relied on gross pay, including overtime.[13]

Another choice is whether to compare mean or median wages. A mean comparison will reflect the full distribution of wages and may therefore be more appropriate where the company hires from across the distribution, but may also be distorted if the occupational category includes job types which are not relevant to network companies. Ofwat's current approach relies on mean versus median wages "as it better captures the distribution of earnings within the occupation category", and all other approaches we have reviewed follow the same approach.[14]

A final choice in how to measure wages is between wages for all employees, or just of full-time employees. In the decisions we have reviewed, as well as in the measure of wages in Ofwat's PR19 dataset, regulators have exclusively used wages for full time employees. In its PR19 methodology, Ofwat argues that it is probably "the case that companies employ a mixture of fulltime and part time staff".[15]

[11] (1) CEPA (March 2018), Cost Assessment – PR19 Econometric Benchmarking Models, p.119; (2) Frontier Economics (April 2013), Total cost benchmarking at RIIO-ED1 –Phase 2 report –Volume 1, p.32; (3) CEPA (20 March 2014), Cost assessment – advanced econometric models, p.6.

[12] CEPA (March 2018), Cost Assessment – PR19 Econometric Benchmarking Models, p. 119

[13] Frontier Economics (April 2013), Total cost benchmarking at RIIO-ED1 –Phase 2 report –Volume 1, p.32

[14] (1) CEPA (March 2018), Cost Assessment – PR19 Econometric Benchmarking Models, p.118; (2) Frontier Economics (April 2013), Total cost benchmarking at RIIO-ED1 – Phase 2 report – Volume 1, p.33; (3) CEPA (20 March 2014), Cost Assessment – Advanced Econometric Models, p.56.

[15] CEPA (March 2018), Cost Assessment – PR19 Econometric Benchmarking Models, p.120

3.1.2. SOC code granularity and weighting

The ONS classifies types of workers in the ASHE dataset using an index of SOC codes, which identify a range of occupational classifications, with an increasing level of granularity as the number of "digits" in the SOC code increases. For instance:

- The 1-digit SOC codes group workers by the level of responsibility and skill, ranging from SOC Code 1 "Managers and Senior Officials" to SOC Code 9 "Elementary Occupations", with no differentiation by industrial sector;
- Adding digits to the SOC code makes the classification (and hence the associated estimates of average wages) progressively more specific to a particular type of worker. For example:
  - The "2-digit" SOC Code 31 corresponds with "Science, engineering and technology associate professionals", and is a subset of the "1-digit" SOC Code 3, "Associate professional and technical occupations";
  - The "3-digit" SOC Code 311 (a subset of the "2-digit" SOC Code 31) corresponds with "Science, engineering and production technicians"; and
  - The "4-digit" SOC Code 3114 (a sub-set of the "3-digit" SOC Code 311) corresponds with "Building and civil engineering technicians".

In the regulatory decisions we have reviewed, regulators selected SOC codes which they deemed relevant to the industry and companies in question, but this still requires several subjective choices:

- The most granular 4-digit SOC codes can be selected to be highly specific to the relevant industry, but the wage data for such granular categories of worker may be volatile due to small sample sizes. Hence, companies' resulting allowances would be driven in part by statistical variation in ASHE survey responses rather than true regional differences in wage. Furthermore, where employees of a regulated company represent a sizeable proportion of total employees within a SOC code, companies' allowances could be driven by their own pay decisions, potentially distorting their incentives to minimize long-term wage costs.
- By contrast, if a regulator chooses to use less granular codes, the measures of wage may become less relevant to the industry in question, and may be susceptible to "composition bias", where apparent differences in wage represent regional differences in the types of jobs included in the SOC code, rather than wage premia on the same job description.

Amongst the decisions we have reviewed for this report, regulators have used a 2-digit SOC code approach, but we note that there has been substantial debate around this issue. For example, in its 2014 price re-determination for Northern Ireland Electricity (NIE), the Competition Commission (CC) used 3- and 4-digit SOC codes.[16] Moreover, in 2015, Northern Powergrid (NPg) appealed Ofgem's RIIO-ED1 decision, in part on the grounds that its 2-digit SOC code approach unfairly advantaged companies in London and the South East

[16] Competition Commission (26 March 2014), Northern Ireland Electricity Limited price determination, para. 8.220.

for differences in the composition of labour in those regions (this ground of appeal was rejected).[17]

We present Ofwat's PR19 labour weightings by SOC code in Table 3.1 below. We have not reviewed the basis on which it determined these weights, but the approach is more granular than at PR14, when Ofwat placed 40 per cent weight on SOC code 21 and 60 per cent on SOC code 53.[18] We do not discuss Ofgem's RIIO-ED1 weights as these are specific to the electricity industry.

Table 3.1: Ofwat's PR19 Proposed SOC Codes

SOC code	Description	Weighting
11	Corporate managers and directors	5%
12	Other Managers and proprietors	5%
21	Science, research, engineering and technology professionals	14%
24	Business, media and public service professionals	4%
31	Science, engineering and technology associate professionals	20%
35	Business and public service associate professionals	5%
41	Administrative occupations	12%
52	Skilled metal, electrical and electronic trades	5%
53	Skilled construction and building trades	5%
72	Customer service occupations	5%
81	Process, plant and machine operatives	10%

Source: Ofwat's CEPA cost assessment report

3.1.3. Definition of separate labour markets

The ASHE dataset divides Great Britain into 11 regions, of which 10 are in England and Wales. At PR14, and for the wage index included in the PR19 dataset, Ofwat and the CMA calculated separate wage premia for all 10 regions in England and Wales. However, in RIIO-ED1, Ofgem only accounted for differences in wages in London and the South East, arguing that there is not "sufficient and compelling new evidence to support applying regional wage differentials for each region of GB given the mobility in the labour market".[19]

Because companies' network regions generally do not align perfectly with ONS's statistical regions, regulators will then map regional wage estimates onto network regions, generally weighted by the number of customers served in each region.

For the PR19 dataset, Ofwat combines the average wage for each of the occupations listed in Table 3.1 into a single composite average measure of the wages faced by companies' operating in each, either in £ per hour or as an index measuring deviation from the national average wage (see Section 3.3).

17 Competition and Markets Authority (29 September 2015), Northern Powergrid (Northeast) Limited and Northern Powergrid (Yorkshire) plc v the Gas and Electricity Markets Authority, Para. 6.10.

18 CEPA (20 March 2014), Cost Assessment – Advanced Econometric Models, p.57.

19 Ofgem (28 November 2014), RIIO-ED1 Final Determinations – Expenditure Assessment, para. 4.16

3.2. Applying the Regional Labour Adjustment to Water Companies' Costs

After estimating the difference in comparable wages between different regions (and different companies), the regulator may then need to decide the share of a company's total costs to adjust. In principle, a company will only face regional wage pressures on costs which relate to labour (rather than materials), and, within its labour force, only for employees which are necessarily co-located with the network. Therefore, in this section, we discuss approaches adopted by regulators to estimate these two factors.

However, incorporating a regional labour factor as a cost driver rather than an off-model adjustment (as discussed in Section 3.3), then the econometric models will determine the appropriate weight to place on the regional labour factor, and it will not be necessary to estimate the proportion of costs affected by regional wage variation.

3.2.1. Labour Share of Costs

Regional labour factors only affect a company's labour costs, and so any approach to control for regional labour factors should only do so on company's labour costs. However, this is not always straightforward, both in theory and in practice.

First, a regulator must decide whether it will apply an adjustment to the company's own labour share of costs, or to a "notional" labour share across the industry. The former approach more accurately controls for the pressures companies face, but links allowances to companies' actual costs so may weaken incentives to minimise costs. For this reason, Ofgem used notional weightings at RIIO-ED1, to "ensure we do not reward a potentially inefficient company".[20]

While Ofwat has not performed an adjustment so far for PR19, its consultants CEPA did experiment with the inclusion of regional labour factors as an off-model adjustment, which required it to estimate a labour share of costs. It "applied these indices to the labour component of company expenditure which was split out in companies' data submissions to Ofwat".[21] This text suggests that it applied the adjustment to companies' *own* labour share rather than to that of a notional company.

As discussed above, Ofwat's approach at PR14 did not require it to calculate this share, as it instead allowed the econometric models to identify the appropriate weights.

3.2.2. Local Share of Labour

Additionally, some labour may be located outside of the network region and is therefore effectively sourced from a national labour market. In principle, such staff (e.g. staff concerning call centres or overhead functions) could be located anywhere in the country (or even abroad).

[20] Ofgem (28 November 2014), RIIO-ED1 Final Determinations – Expenditure Assessment, para. 4.19

[21] CEPA (March 2018), Cost Assessment – PR19 Econometric Benchmarking Models, p.120.

At RIIO-ED1, Ofgem accounted for "the proportion of work that is done in these areas and elsewhere".[22] It assumed that 100 per cent of business support labour costs, 60 per cent of indirect labour costs, and 12 per cent of all other labour costs could be located outside of the network region and would therefore not be subject to an adjustment.[23]

In the model selection work that it carried out for Ofwat at PR19, CEPA acknowledged that "competitive pressure should therefore eliminate price differentials across regions" for some proportion of labour costs. Accordingly, it tested two alternatives to account for the share of labour that could be sourced anywhere: In the first, it assumed that 100 per cent of labour is sourced locally; in the second, it assumed that 70 per cent of labour is sourced locally.[24] It is not clear how it derived these shares.

3.3. Econometric Approach

After determining the extent to which a company faces higher efficient costs due to regional labour factors, the final step is to incorporate the calculated differences into benchmarking and cost assessment methodologies. In the regulatory decisions we have reviewed, this has taken two forms: regulators have either made an off-model adjustment to companies' costs or they have included regional wages as an explanatory variable in their econometric models.

Under the first approach, regulators scale up or down companies' submitted costs before conducting cost benchmarking in order to improve the comparability across companies. For example, if a company's regional wages were 105 per cent of the country average, the share of the company's costs that the regulator assumes is labour that needs to be sourced locally would be scaled down by the ratio of 1.0/1.05 before model estimation. This approach requires that this adjustment be reversed after the model estimation, scaling up that company's modelled efficient costs by 5 per cent. Ofgem adopted this approach at RIIO-ED1, as well as in several other decisions we do not discuss in detail in this report.[25] In its PR14 re-determination for Bristol Water, the CMA also calculated a special cost factor for Bristol Water's local labour costs, which is similar to this first approach but applied only to Bristol Water.

A second approach is to include regional wages as a cost driver in the econometric models, and then allow the model to determine the weight applied to regional wages. The process for setting cost allowances then happens automatically: companies' allowed costs are simply based on the wage in its region(s) multiplied by the estimated coefficient. Ofwat adopted this approach at PR14, and CEPA experimented with it in developing initial PR19 econometric models (see Section 2.2).

[22] Ofgem (28 November 2014), RIIO-ED1 Final Determinations – Expenditure Assessment, para. 4.12

[23] RIIO-ED1 modelling files

[24] CEPA (March 2018), Cost Assessment – PR19 Econometric Benchmarking Models, p. 121

[25] Ofgem (28 November 2014), RIIO-ED1 Final determinations for the slow-track electricity distribution companies - Business plan expenditure assessment, para. 4.1. Other decisions which have followed this approach are Ofgem's 2012 RIIO-GD1 decision, the Utility Regulator of Northern Ireland's 2014 PC15 decision for NI Water, and the CMA in its 2014 decision for Northern Ireland Electricity.

4. Appraisal of Ofwat's Decision not to Control for Regional Labour Factors

In this chapter, we appraise the arguments Ofwat and CEPA used to support the proposal not to control for variation in regional labour costs in the cost assessment process, and not to allow Affinity's cost adjustment claim for high regional labour costs in London and the South East. Specifically, we appraise the following arguments from Ofwat/CEPA that were used in the IAP to support the proposal not to control for regional wage variation when estimating efficient costs for Affinity Water (and the industry as a whole):

- That including regional wages as an econometric cost driver is not statistically robust;
- That performing an off-model adjustment does not adequately improve model fit to justify its use;
- That regional labour factors are adequately controlled for by the inclusion of density variables in Ofwat's models, as wages are correlated with density;
- That companies in high-density regions also benefit from wage *savings,* and that Affinity's cost adjustment claim does not account for these benefits; and
- That labour costs are partially within management control and should therefore not be included in the cost assessment process.

4.1. The Robustness of Including a Regional Wage Driver

In the robustness checks of its preferred models, CEPA found that the inclusion of a regional wage variable as a cost driver did not yield statistically-significant coefficients, and Ofwat's IAP repeated CEPA's line of argument, and rejected the inclusion of the wage variable in its models, citing the following reasons:[26]

- **The variable is not a robust cost driver.** "In many specification [sic] the variable has very low predictive power, and sometimes it showed a counter-intuitive negative sign (albeit statistically insignificant)".
- **The variable is partially under management control.** "We recognise that variation in labour cost can have an impact on costs although companies can exercise control to mitigate this impact".
- **Regional wages are correlated with density, which is included in the models.** "We consider also that the inclusion of a density variable, and a square of density, in our models, capture the effect of regional wage as the two are correlated".

We have tested model specifications which include the regional wage variable as a cost driver, using the measure of regional wages (excluding overtime) in £/hour as a proportion of the national average (i.e. the per company regional wage divided by the national average). We also tested model specifications using this same variable, but in natural logarithms.

Our analysis shows that these variables are not significant at a 10% level, which is in line with Ofwat's results. Therefore we come to a similar conclusion, that the inclusion of

[26] Ofwat (January 2019), Supplementary technical appendix: Econometric Approachp.15-16.

regional wage variables in Ofwat's current models does not improve their statistical robustness.

However, Ofwat is wrong to suggest that this evidence shows that regional wage variation is not an important driver of water companies' efficient costs and/or the inclusion of the density variable is sufficient to control for this effect. Rather, it is just as likely that the regional wage variable CEPA developed, and Ofwat considered including in its models, does not accurately measure the wages faced by water companies

In particular, while the ONS measures wages across 10 statistical regions of England and Wales, wages are not constant within each of these regions. For example, wages in Bristol are generally higher than the average in the South West, while wages in Leicester are lower than the average in the East Midlands.[27] In fact, in its re-determination of PR14 allowances for Bristol Water, the CMA allowed for a cost adjustment claim on the basis of "likely differences in wages between Bristol Water's area of appointment and the South West region as a whole".[28]

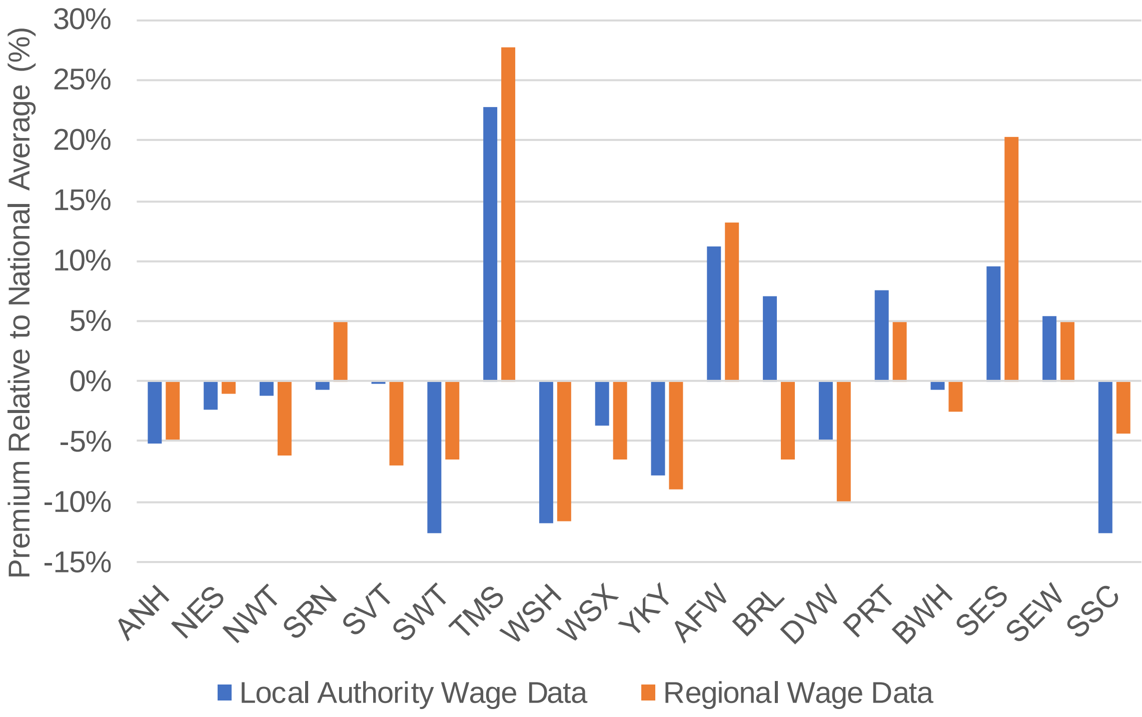
All statistical regions are served by more than one water company, and most water companies operate within more than one statistical region. Due to this mismatch, any approach to calculating regional wage variation that is based on a weighted average of the 10 statistical regions in England and Wales will necessarily be measured with error, because wages in the specific localities where a company operates may differ from the average across the whole statistical region.

We demonstrate this effect in Figure 4.1 below. We use ONS data on average wage by Local Authority District (LAD) and calculate the average wage in each company's network region (weighted by LAD population). We compare against the alternative approach of calculating a regional wage index using the same data, but with the same weighted-average approach across regions that CEPA used to construct its regional wage index. The LAD data does not differentiate between occupations, so we compare to the economy-wide average wage in each region. The figure presents wages as a percentage difference from the national average.

27 According to ONS wage data at the local authority level.

28 Competition and Markets Authority (6 October 2015), Bristol water plc: A reference under section 12(3)(a) of the Water Industry Act 1991, appendix 4.3, para 186.

Figure 4.1: Wage Premia Based on Local Authorities vs Weighted Statistical Regions



As the figure shows, the two measures regional wage provide substantially different estimates of wage premia, particularly for companies which operate in only a small subset of one or more statistical regions. For example, Bristol Water (BRL) serves 23 per cent of the population of the South West (and nowhere else), while Sutton and East Surrey Water (SES) serves 4 per cent of the population of London and 4 per cent of the population of the South East (and nowhere else). For these companies especially, the specific localities served are not representative of the regions as a whole: SES's "London" localities are all of Sutton and parts of Croydon and Merton, which may not be representative of London in terms of wage pressures.

Ofwat's variable therefore measures companies' true regional wage pressure with some error. When an explanatory variable in an econometric model is measured with error (like regional wages in CEPA's robustness tests), the magnitude of the coefficient will tend to be understated through a process known as "attenuation bias".[29] As a result, the estimated coefficients are less likely to be statistically significant, even if companies do indeed face additional wage pressures beyond those captured by density variables. Therefore, the absence of statistically significant evidence that regional wage variation affects costs in Ofwat's models does not necessarily mean that regional wage pressures do not exist.

[29] Attenuation bias: When an explanatory variable is measured with "classical error" (i.e. the expected value of the error is zero and it is uncorrelated with the "true" values of the explanatory or dependent variables), the coefficient defining the modelled impact of this explanatory variable (here, regional wage pressures) on the dependent variable (here, botex) is biased towards zero. Source: Madalla, G.S. (2001), Introduction to Econometrics, Third Edition, p.438-439.

4.2. CEPA's Arbitrary Standard for Making an Off-model Adjustment

4.2.1. The standard of achieving a one percentage point improvement in adjusted R-squared is arbitrary and unachievable

In its March 2018 report developing the PR19 econometric models, CEPA performed a series of robustness checks of its preferred models. One robustness check whether the inclusion of an off-model regional wage adjustment changed the "adjusted R-squared" by at least one percentage point.

The "R-squared" is a standard statistical measure of a model's explanatory power, where a value of 1.00 (or 100 per cent) indicates that 100 per cent of the variation in costs is explained by variation in cost drivers. The "adjusted R-squared" effectively applies a "penalty" on the R-squared for each additional variable included, so that adding explanatory variables that only marginally improve model fit do not increase the adjusted R-squared. CEPA found that the off-model adjustment did not increase the adjusted R-squared by at least one percentage point in any of its models.

This "one percentage point" standard is arbitrary. Econometrics literature does not define what constitutes a "high R-squared" or a "low R-squared". As such, there is no objective basis for CEPA's chosen threshold for identifying a significant change in R-squared.

In any case, a "one percentage point" change in R-squared is also unlikely to be achievable in Ofwat's models, given the high explanatory power already of the econometric models.[30] As shown in Table 2.1, the R-squared of each of Ofwat's five models ranges between 92.1 per cent and 97.9 per cent. In order for the off-model adjustment to improve model fit by one percentage point, between 13 and 49 per cent of unexplained variation in Ofwat's models would need to disappear.[31] Given that labour costs are only around 35 per cent of total costs, and the variation in wages between companies is small relative to the total wage bill, it is not reasonable to expect the off-model adjustment to explain such a large proportion of each model's remaining unexplained variation. [32]

In Table 4.1 below, we compare the R-squared from Ofwat's five preferred models to those we obtain from running the same models, but with an off-model adjustment to control for regional variation in labour costs. To implement the off-model adjustment, we assume that 35 per cent of botex is labour (as estimated by Europe Economics in its report on productivity), and that either 70 per cent or 100 per cent of labour must be co-located with the network, in line with CEPA's assumptions.

[30] Because Ofwat's models use expenditure as dependent variables (as opposed to unit costs) and control for scale drivers like length of network and number of customers, the vast majority of variation in the dependent variables is explained by these factors capturing variation in scale across companies. Hence, Ofwat's models have a very high R-squared.

[31] i.e. 1%/ (1 - 92.1%) or 1%/ (1 - 97.9%)

[32] Note: Companies report labour as a share of total expenditure rather than botex. We assume that the labour share of botex is the same as the labour share of total expenditure, though it is likely to be somewhat higher in reality because capital enhancement is likely more capital-intensive. Source: Europe Economics (2 January 2018), Real Price Effects and Frontier Shift, p. 20

Table 4.1: R-squared Comparison from Performing an Off-model Adjustment

Model	Ofwat R-squared	35% Labour Share Adjustment	Difference	70%*35% Labour Share Adjustment	Difference
Model 1 WRP	93.42%	93.36%	-0.06%	93.38%	-0.04%
Model 2 WRP	92.11%	92.04%	-0.07%	92.07%	-0.04%
Model 3 TWD	96.76%	96.98%	0.22%	96.98%	0.21%
Model 4 WW	97.78%	97.79%	0.01%	97.79%	0.01%
Model 5 WW	97.94%	97.94%	0.00%	97.94%	0.00%

Source: NERA analysis

4.2.2. Comparisons of R-squared between models with different dependent variables is misleading

As the table shows, an off-model adjustment improves the R-squared in the TWD model by around 0.2 percentage points, which is around 7 per cent of the remaining unexplained variation in Ofwat's preferred TWD model.[33] The R-squared improves in the WW models as well, albeit minimally.

However, the R-squared statistic is intended as a guide to which combinations of potential explanatory variables best explain variation in a particular explanatory variable. By contrast, the R-squared parameter is not a suitable for comparing the fit of models with different dependent variables, as Ofwat has done by comparing the models with and without the off-model adjustment for regional wage variation that rescales the cost variable.

Comparisons of the R-squared parameter across models with different dependent variables are not meaningful, and a model which reduces variation in the dependent variable (e.g. by removing variations due to regional labour factors) will tend to have a lower R-squared:

- In this case, the R-squared is calculated by dividing the sum of squared variation in costs explained by the model (Explained Sum of Squares, ESS) relative to the overall squared variation in costs (Total Sum of Squares, TSS).
- An off-model adjustment that controls for wage differences across companies will also reduce total variation in costs across companies. Hence, the denominator in the R-squared calculation will fall, even though the adjustment has the effect of better explaining variation in companies' costs.

Therefore, CEPA's standard for determining whether an off-model adjustment for regional wage variation is required is arbitrary and misleading.

[33] CEPA's threshold is based on an "adjusted R-squared", while we compare the "overall R-squared", as reported by Ofwat's models. Because our comparison does not add any cost drivers, the change in the adjusted R-squared is equivalent.

4.3. Correlation Between Density and Regional Wages

In both its decision to not include regional wage variables in the econometric models and to reject Affinity's regional cost adjustment claim for high regional wages, Ofwat cites that its models includes density (in both linear and squared terms), which it claims is correlated with regional wages.

In Table 4.2 below, we demonstrate that there is some correlation between these variables as included in Ofwat's modelling files, with a correlation coefficients of around 0.60.[34]

Table 4.2: Correlation Between a Company's Regional Wage and Density

	Density	Density squared	Regional wage
Density	1		
Density squared	0.9976	1	
Regional wage	0.5808	0.6048	1

Source: NERA analysis

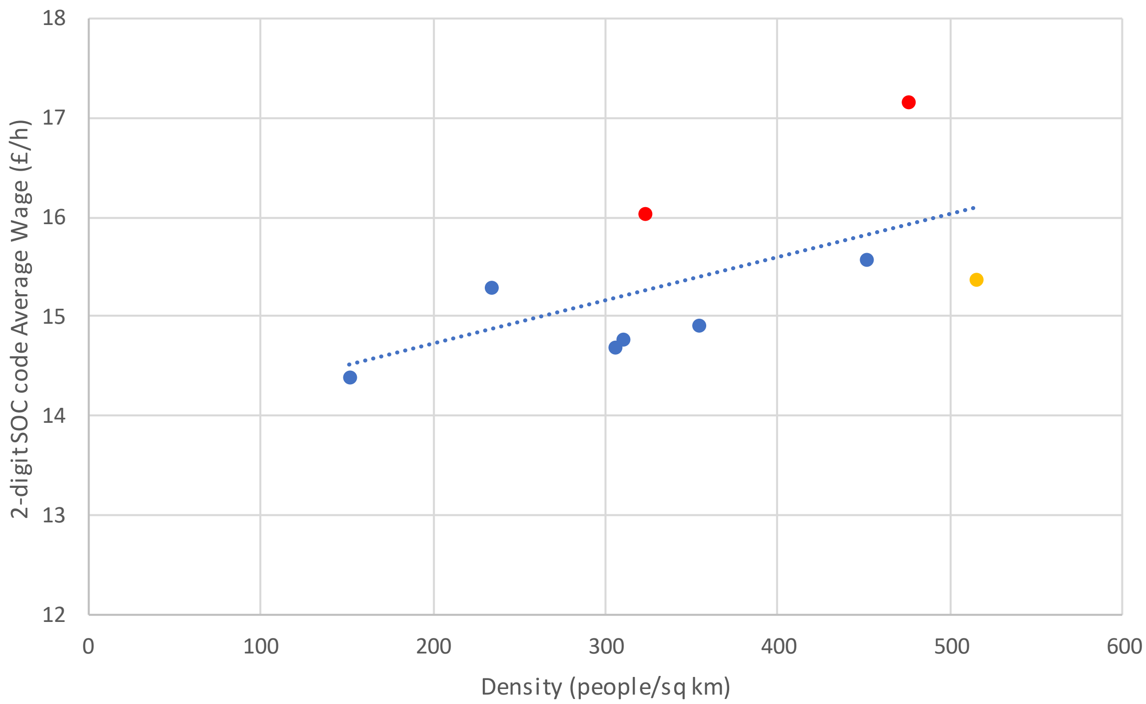
This positive correlation between density and wages reflects a number economic effects. For instance, city centres (e.g. London) high wages in city centres may attract people to live nearby, increasing density. Similarly, a scarcity of land caused by density may result in higher living costs and necessitating higher wages.

However, there are other drivers of wage levels that are unrelated to density. For example, a region with high demand for or low supply of a particular type of labour will tend to see employees in that labour type paid more. Moreover, there are many dense urban areas, such as in former industrial areas, where wages are low despite high density.

We demonstrate this positive, but weak, relationship at a regional level in Figure 4.2 below, which compares the statistical regions of England and Wales in terms of wage and density. We exclude London because it is an outlier in terms of wage and (especially) density.

[34] A correlation coefficient measures the extent to which the variation in one variable is correlated with the variation in another variable.

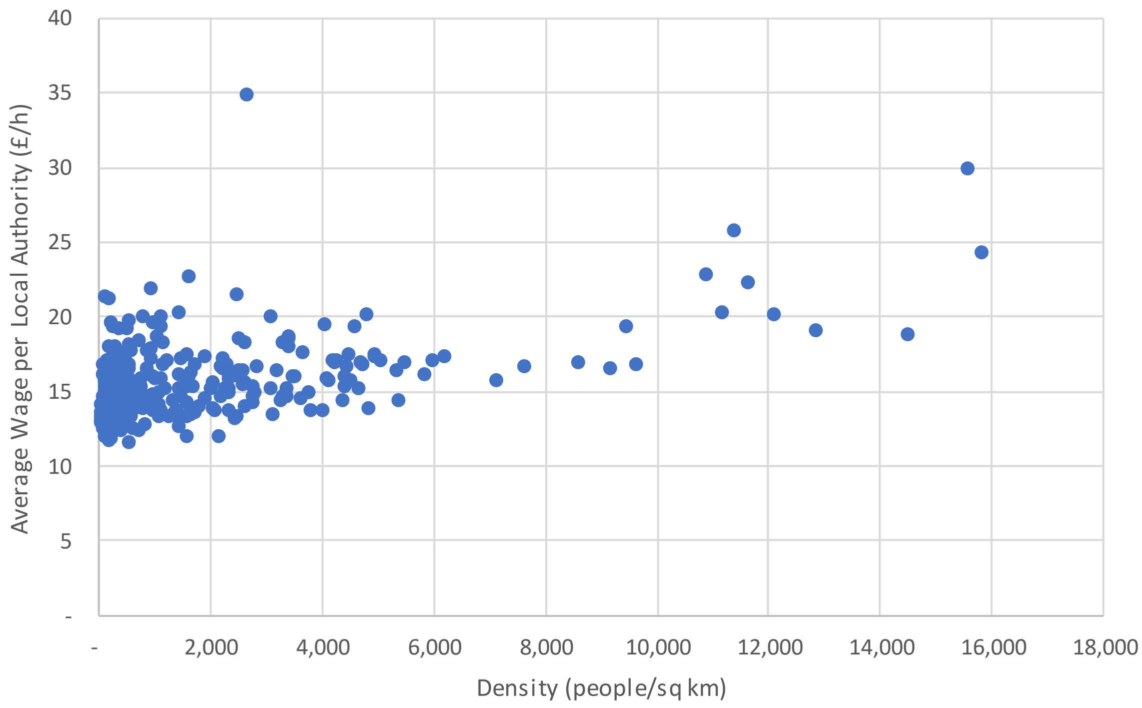
Figure 4.2: Ofwat Wage Measure vs Density by Region (excluding London)



As the figure shows, outside of London, population density is highest in the North West (shown in amber), where average wages are not high relative to the national average. Rather, wages are highest in the South East and East (shown in red), where 64 per cent of Affinity's network is located, where population density is comparable with regions with much lower wages. These data suggest that, using Ofwat's own measures of regional wages and density, density variables generally do not fully capture variation in regional wage pressures.

We have also evaluated Ofwat's hypothesis that density and wages are linked at a more granular level, comparing the average wage to density at the local authority level in Figure 4.3. Note that, due to data limitations, the wage data in Figure 4.3 does not distinguish between occupations (unlike Figure 4.2 which uses the measures of wages identified as relevant to the water industry by Ofwat).

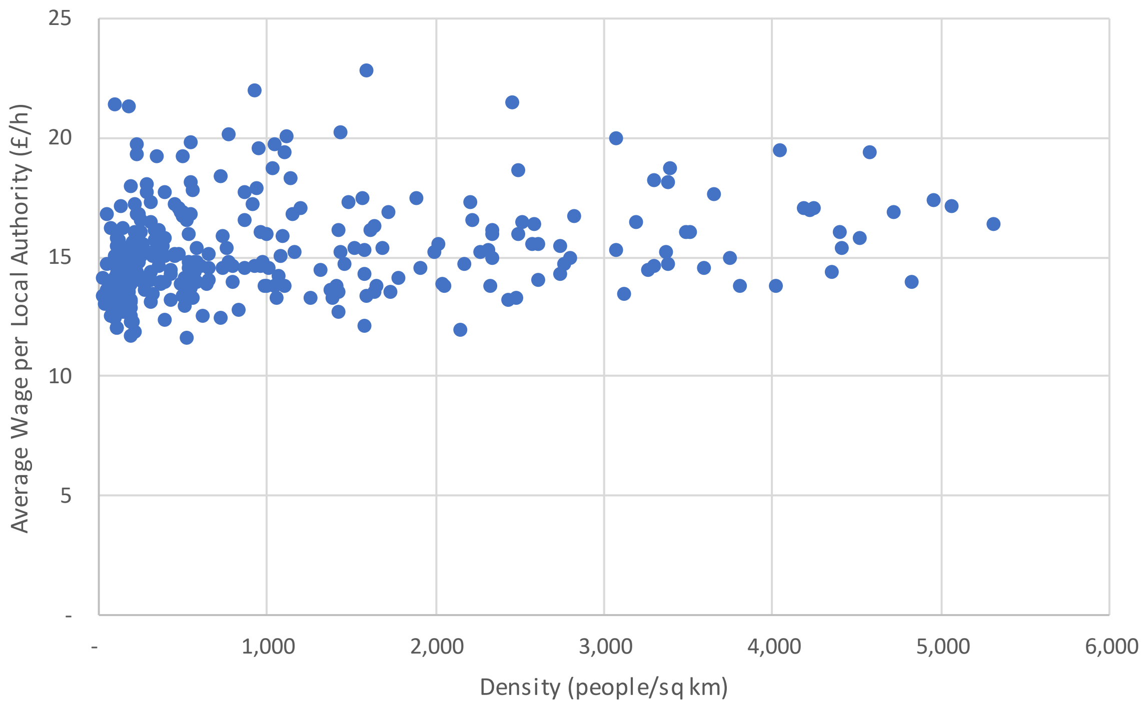
Figure 4.3: Wage vs Density by Locality (including London)



The figure shows only a weak relationship between density and local average wages, with a correlation coefficient of 0.5102. However, this data includes local authorities within London, which is an outlier both in terms of density and wages. The reasons for this are probably factors unrelated to Ofwat's hypothesised relationship between wages and density (e.g. the large presence of the financial and professional services sectors in London).

When we exclude London, the relationship becomes even weaker, as shown in Figure 4.4 below. In this case, the correlation coefficient drops to 0.2425.

Figure 4.4: Wage vs Density by Locality (excl London)



This data suggests that density is not a strong driver of wage variation. Hence, Ofwat's argument that the inclusion of density in its econometric models as a control for regional wage variation is not sufficient to control for both effects on water companies' costs. Ofwat's approach only serves as a crude proxy because the correlation between density and wages is weak.

If Ofwat uses density variables to proxy for regional wage differences, it will in effect capture true regional wage differences with error. As a result, the coefficients on the density variables will suffer from attenuation bias, meaning that the model will fail to capture the full extent to which density and regional labour factors together drive higher costs.

This attenuation bias will cause Ofwat's models to understate the efficient costs of companies operating in high-wage regions, even if they also operate in a high-density region, because the coefficients on the density variables are lower in magnitude than the true relationship between density, wages, and costs would require.

4.4. Ofwat's Claim that Density Results in Cost Savings

In its review of Affinity's cost adjustment claim, Ofwat claims that "Affinity fails to recognise the off-setting benefits of urban density on salaries", which ostensibly derives from "better match between skills and needs, and greater flexibility to hire and fire and to fill in part-time jobs".[35]

[35] Ofwat (January 2019), Affinity Water Cost Adjustment Claims Feeder Model, Tab "AFW-WN602001", Cell D38.

Ofwat is incorrect in this respect. While there are good reasons to believe that higher density could yield some labour savings, the wage data collected by the ONS implicitly reflects the balance of all factors, positive and negative, which drive the wages paid to employees.

For example, all water companies employ civil engineers. The wage that a civil engineer earns is a product of the supply and demand for their particular role. If a particularly specialised civil engineer is one of very few in a sparsely-populated region, they may command a higher wage due to higher demand for their particular services. Water companies may also have to pay them higher wages to compensate them to travel longer distances to work. On the other hand, they may also command a lower wage due to lower cost of living in the region. The balance of these effects will be reflected in the wage reported in the ONS dataset.

We see no reason why water companies would be fundamentally different from other employers in terms of matching skills with needs, so the wages reported in the ASHE dataset should reflect reasonably accurately the cost pressures actually faced by water companies, including the effects of density on wages in their regions.

4.5. Management Control over Regional Wage Variation

Ofwat does not include regional wage variables into its cost assessment modelling in part because it argues that "companies can exercise control to mitigate this impact".[36] It rejected Affinity's cost adjustment claim in part for similar reasons.[37]

However, these arguments do not apply to any measures of regional labour costs discussed in this report or in Affinity's original cost adjustment claim. The regional labour factors we discuss (and submitted by Affinity) are estimated from ONS data and reflect the wages paid by many different employers. These regional wage measures reflect the underlying pressures acting on the supply and demand for each labour type, such as costs of living in the region and the amenity of living/working in the region. Each of these factors is outside of the control of any individual water company. Thus, any measure of regional wage represents the wage *pressure* faced by each company, rather than the specific labour costs incurred by an efficient or inefficient company.

While a company can indeed reduce its wage bill if it negotiates effectively with its employees, this would represent an improvement in efficiency which conceptually should be rewarded (or penalised, in the opposite case) by the cost assessment process. A company that negotiates wages effectively but operates in a high-wage region, may pay higher wages than a company that negotiates wages ineffectively but operates in a low-wage region.

4.6. Conclusion

For the reasons set out above, Ofwat's explanation of why it proposes not to control for regional wage variation, either within its econometric modelling or through allowing special factor claims, is flawed.

[36] Ofwat (January 2019), Supplementary technical appendix: Econometric Approachp.15-16.

[37] Ofwat (January 2019), Affinity Water Cost Adjustment Claims Feeder Model, Tab "AFW-WN602001", Cell D39.

Its proposal rests on an arbitrary interpretation of statistics, and an unsupported assertion that the correlation between density and wages is sufficient to control for this factor. Ofwat's suggestion that regional wage variation is within management control is also irrelevant, as companies' efficiency in managing the cost pressures they face is addressed through its comparative efficiency modelling.

Ofwat could address this flaw in its approach through either by incorporating regional wages into its econometric modelling as a driver or an off-model adjustment, or by applying special factor adjustments as we discuss further below.

5. Quantifying a Cost Adjustment Claim

Assuming that Ofwat does not change its econometric modelling approach in the Draft Determination, we have quantified a special factor claim for Affinity that would control for the relatively high wages it faces in its region.

5.1. Rationale for an Adjustment

The rationale for applying a cost adjustment claim for Affinity stems from the large share of labour in water companies' costs, and the relatively high wages in Affinity's service area as compared to the national average. Regional wage variation is not within management control, as long as the wage indices selected are not dominated by individual water utilities. Any differences in companies' ability to manage regional wage differences efficiently would be reflected in their performance in comparative benchmarking models. There is also the wide-spread regulatory precedent for controlling for this factor, as we explain in Chapter 3.

The rationale for this adjustment also follows from the arguments we make in Chapter 4. In particular, the evidence presented by Ofwat and CEPA that the econometric models already control for this factor is extremely weak. It rests on arbitrary and excessively demanding statistical thresholds related to the R-squared parameter, and an analysis of the link between costs and wages/density which is affected by attenuation bias that prevents the model from accurately controlling for the high costs faced by companies in regions with high wages and density.

5.2. Magnitude of a Cost Adjustment Claim for Affinity

We calculate a cost adjustment claim for Affinity's regional wage costs by performing an off-model adjustment (to all companies' costs) using Ofwat's 2-digit SOC code data. We then re-estimate models 3-5 using the adjusted cost data and reserve the adjustment to estimate Affinity's modelled efficient costs. Comparing this result with Ofwat's view of efficient costs allows us to estimate the implicit allowance that Affinity receives, based on the density of the region and other explanatory variables included in the model.

We use the off-model adjustment approach (rather than the cost driver approach) because it avoids issues around attenuation bias because the wage variable is measured with error. We do not perform an adjustment within the WRP models because Affinity's original cost adjustment claim focuses specifically on the Networks Plus price control, so we assume regional wage pressures for water resources are immaterial. We note that our approach may understate any wage pressures in raw water distribution and water treatment, which are included in the Networks Plus price control but assessed in the WRP models, but these pressures are partially captured by the off-model adjustment we perform on the WW models.

We assume that 35 per cent of botex is labour across all companies, taken from Europe Economics' Real Price Effects and Frontier Shift report. We note that this is likely an underestimate, as this represents the labour share of *total expenditure*, and capital enhancement expenditure (which is included in total expenditure but not botex) may be less labour-intensive than other components of total expenditure. Because we do not perform an adjustment on the WRP models, which will tend to understate the required adjustment, we assume that 100 per cent of labour within the other models must be co-located with the network.

Following this approach, we find that Affinity's AMP7 allowances are understated by **£8.8 million** over the five-year period. This is close to the 1 per cent materiality threshold set by Ofwat to apply a cost adjustment claim, depending on the denominator selected.

We note, however, that Ofwat's 1 per cent materiality threshold is inherently arbitrary. A cost adjustment claim worth 1.01 per cent of costs is very similar in magnitude to a claim worth 0.99 per cent of costs, but Ofwat's approach would only accept the former. Instead, we suggest Ofwat should accept claims which are well-justified without setting an arbitrary cut-off point.

Additionally, this £8.8 million estimate is probably biased downwards because it relies on Ofwat's data series based on the weighted average of each region's wages.

We also calculated a cost adjustment claim using LAD-level wage data, based on wages in the specific localities where each company operates. Under this sensitivity, we calculate a cost adjustment claim of **£22.3 million** for Affinity. However, that LAD-level data is not occupation specific, so this result may not reflect the types of labour required by Affinity.

To address this, we calculated a cost adjustment claim using regional average wages across all occupations and industries (SOC code 0). Based on average wages per region, we calculated a cost adjustment claim of **£16.5** million for Affinity. This result suggests that the effect of using relevant categories of labour on the cost adjustment claim for Affinity Water is £16.5 - £8.8 = £7.7 million, as compared to an adjustment in which we do not correct for occupational differences.

Applying this estimated effect of occupation/industry-specific wages to the cost adjustment for Affinity based on LAD level data for Affinity gives a revised adjustment of £22.3 - £7.7 = **£14.6 million** for Affinity. Because this estimate controls for wages in both the specific locations served by Affinity and the types of labour required by the sector, this is our preferred calculation of the impact of regional wages on Affinity Water's costs.

Qualifications, assumptions and limiting conditions

NERA Economic Consulting ("NERA") was commissioned by Affinity Water Ltd ("Affinity") to review the need for a cost adjustment claim for regional labour factors in the PR19 price control process. The primary audience for this report includes employees and internal stakeholders of Affinity and the Office of Water Regulation ("Ofwat").

NERA shall not have any liability to any third party in respect of this report or any actions taken or decisions made as a consequence of the results, advice or recommendations set forth herein.

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First Economics report on frontier efficiency

A REVIEW OF OFWAT'S PR19 APPROACH TO ESTIMATING FRONTIER SHIFT

John Earwaker

March 2019

EXECUTIVE SUMMARY

- One important component part in a suite of PR19 documents published by Ofwat in January 2019 was an initial estimate of the rate of frontier shift that is likely to impact on water industry wholesale costs through to 2024/25.

- The methodology that Ofwat uses in its analysis is unusual. Instead of adopting the now--standard regulatory approach of making a forecast of real price effects (RPEs) and deducting an allowance for ongoing productivity growth, Ofwat elects at this time not to make any allowance for wholesale RPEs, principally on the grounds that CPIH indexation of price controls will automatically 'capture' industry input price inflation.

- Ofwat makes no such argument in relation to productivity growth – i.e. it does not recognise that CPIH indexation challenges water companies to match the productivity improvements achieved by the firms that supply goods and services to UK households. I regard this as a pick'n'mix error. If Ofwat wishes to argue that CPIH inflation indexation captures industry input price pressures, it also has to acknowledge that CPIH inflation, in and of itself, captures a non---trivial level of ongoing productivity growth. Alternatively, if Ofwat wishes to make a completely stand---alone allowance for productivity growth, it must also make a stand---alone allowance for RPEs.

- There are also a series of other problems with Ofwat's analysis of RPEs:

--- Ofwat effectively limits its analysis of RPEs to two cost categories – wage inflation and materials, plant and equipment inflation. These inputs constitute only approximately 55% of totex. All cost items within the other 45% of totex are deemed individually to be immaterial even though collectively they constitute a very large proportion of companies' annual expenditures and are capable in combination of generating non--zero RPEs;

--- Ofwat insists that RPEs can only be factored into price controls if input price increases are outside of management control. However, many of the steps that Ofwat says that firms can take to 'control' prices – e.g. the use of long---term contracts, hedging, input substitution – enable firms to manage price volatility rather than avoid input price increases entirely. As such, Ofwat fails to evidence that companies are capable of holding input costs at 2017/18 prices all the way through to March 2025; and

--- Ofwat's consultant, Europe Economics, dismisses forecasts produced by the Office of Budget Responsibility (OBR) and BEIS as "unreliable". This leads Ofwat, in effect, to adopt Europe Economics' house view of RPEs – i.e. projections which, for the most part, sit a long way outside of current consensus forecasts for the AMP7 period.

- I consider that these deficiencies, when taken together, cause Ofwat to reach faulty conclusions about the RPEs that water companies are likely to encounter in the next seven years and, hence, cause Ofwat to make insufficient allowance in its cost assessment for future industry cost escalation.

- Ofwat's estimate of the historical, long---term rate of productivity growth in the water industry is, for the most part, based on a much more reliable benchmarking methodology (subject to the earlier point about the RPE/productivity pick'n'mix error). Ofwat's 0.6% to 1.2% benchmark range for productivity growth is also broadly in line with recent regulatory precedent.

- An important question for Ofwat in PR19, and for economic regulators more generally at present, is whether past experience of productivity improvement offers a reasonable guide to the future. Elsewhere in the economy, productivity growth has stalled since the global financial crisis, and the likes of the OBR and the Bank of England have been cutting forecasts of future productivity growth quite markedly.

Table A: Bank of England estimates of annual total factor productivity growth

	1998---07	2008---10	2011---14	2015---18Q3	2018Q4---22Q1
TFP growth	1.0%	---0.6%	---0.1%	0.2%	0.3%

- The water industry is not immune from factors that are affecting other firms, not least because water companies contract out a significant amount of their expenditure to alliances and supply chain partners. I would like to see Ofwat give more attention in the remainder of PR19 to the structural break that seems to have occurred in 2008, including by considering the possibility that it might be necessary to scale back expectations of productivity growth in line with the lowering of productivity forecasts that there has been across the UK economy in recent years.

- Ofwat also needs to consider very carefully whether it has the evidence to justify factoring an extra amount of cost reduction into PR19 base expenditure allowances due to regulatory innovations introduced in PR14. Ofwat has noticeably backed off from the very large overlay that it tentatively suggested one year ago, but it is still worrying reliant on a simplistic and subjective interpretation of recent experience in the energy industry. More fundamentally, it is not at all clear why the kinds of regulatory innovation that Ofwat is talking about – totex and outcome regulation – should lead to reduction in recurring expenditures; rather, there is a respectable argument that Ofwat's incentives will typically lead to companies incurring higher ongoing expenditures in the short term as part of a drive towards whole---life cost optimisation.

INTRODUCTION

This paper[42] contains a review of Ofwat's approach to estimating AMP7 RPEs and frontier productivity growth (collectively "frontier shift"). It is intended to be a contribution to the water industry's PR19 periodic review of water and sewerage price controls, focusing especially on the methodological framework that regulator and companies can use to identify and estimate the rate at which a frontier company's costs might be expected to change during the period 2017/18 to 2024/25.

The paper is structured into five main parts as follows:

- section 2 briefly summarises the key points that Ofwat made in January 2019 when it published its initial assessment of companies' business plans,[2] and seeks to position Ofwat's approach in relation to wider regulatory practice;
- section 3 identifies an inconsistency as regards Ofwat's treatment of RPEs and its approach to making allowance for future productivity growth;
- section 4 makes a number of additional observations about Ofwat's RPE analysis; • section 5 looks in more detail at Ofwat's productivity growth benchmarking; and
- section 6 concludes.

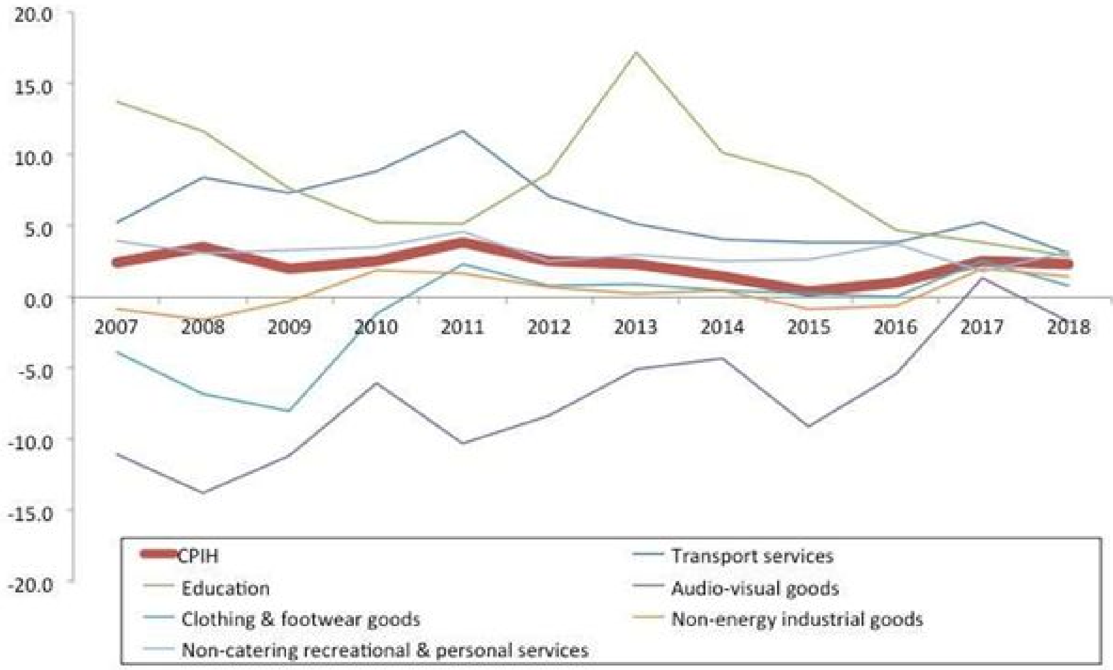
BACKGROUND

Ofwat's allowances for the base expenditure (botex) that water companies are likely to incur in AMP7 (2020/21 to 2024/25) are being built piece---by---piece from a number of complementary cost assessment models. Much of the evidence that Ofwat is assembling entails identifying the prevailing level of efficient costs during the period 2011/12 to 2017/18 and then rolling forward this benchmark level of expenditure through to the end of AMP7. This requires companies and Ofwat to think carefully about the extent to which the industry cost frontier might itself move during the next few years, and in particular how much:

- input price inflation might cause costs to increase from one year to the next; and
- ongoing productivity growth is likely to offset such cost increases.

A key consideration in this analysis is that all of Ofwat's wholesale price controls will automatically index in line with out---turn CPIH inflation. This is akin to a very rough initial estimate of, and allowance for, the aforementioned cost drivers. However, it is highly unlikely that CPIH inflation will exactly match the particular combination of input price inflation and ongoing productivity growth that will impact on companies' AMP7 expenditures. Elsewhere in the economy, it can be observed that the costs of very few, if any, goods and services move exactly in line with CPIH; rather, there are some sectors of the economy in which costs/prices tend to increase by more than consumer price inflation, and some sectors in which costs/prices tend to increase by less than CPIH inflation (or where costs/prices even tend to fall year on year). This is illustrated in the chart overleaf. Figure 1: Annual % change in prices of selected goods and services

[42] This paper was originally prepared for attendees of First Economics' *Economic Regulation Forum*. [2] Ofwat (2019), Technical appendix 2: securing cost efficiency.



Note: to keep the chart readable, yet still illustrate the point I am trying to make, I have picked out just six of the 34 aggregate goods and services price series that the ONS publishes as part of its CPIH data set.

PR19 is not the first review in which companies and regulator have had to determine the trajectory that a frontier company's costs are likely to move on. Since 2009, there have been more than half a dozen price reviews in which regulators have made an explicit allowance for frontier shift. Almost all of these calculations have been built by putting numbers on the terms in the following formula:

frontier shift in real terms

= forecast nominal industry input price inflation

less underlying industry frontier productivity growth less forecast consumer price inflation

or, equivalently:

frontier shift in real terms

= forecast RPEs

less underlying industry frontier productivity growth (1)

Specific assumptions made by different regulators are summarised in table 1. Table 1: Assumptions made by regulators about frontier shift

Regulator/review	RPEs	Productivity growth	Frontier shift
CC, Bristol Water, 2010	RPI + 0.65%	0.9%	RPI – 0.25%

Ofgem, RIIO---GD1/T1, 2012	RPI + 0.2% to + 0.8%	0.7% to 1.0%	RPI --- 0.7% to + 0.1%
CC, Northern Ireland Electricity, 2014	RPI – 1.5% to + 0.8%	1.0%	RPI – 2.5% to – 0.2%
Ofgem, RIIO---ED1, 2014	RPI – 1.4% to + 0.6%	0.7% to 1.1%	RPI – 2.3% to – 0.3%
Utility Regulator, NI Water, 2014	RPI + 0.1% to + 0.9%	0.6% to 0.9%	RPI – 0.5% to – 0.1%
CMA, Bristol Water, 2015	RPI + 0.5%	1.0%	RPI – 0.5%
Utility Regulator, GD17, 2016	RPI + 0% to + 1.0%	1.0%	RPI – 1.0% to + 0%
Ofwat, PR19, 2019 (consultation range)	CPIH + 0%	1.5%	CPIH – 1.5%

Source: regulators' documents.
Note: the ranges in the table come from different calculations for different years and/or from separate calculations for opex and capex.

Ofwat's initial estimate of AMP7 frontier shift was unveiled on 31 January 2019, and is a noticeably different take in comparison to the other entries in table 1. First, the headline frontier shift estimate of CPIH – 1.5% stands well below the medium---term rates of frontier shift that regulators in the electricity, gas and water sectors have previously factored into price controls. (NB: the low---end estimates in table 1 are typically for a single year only.) Second, the methodology that Ofwat used to derive its CPIH – 1.5% was atypical in a number of respects. Most notably, where recently it has become standard regulatory practice to estimate forecast nominal input price inflation less productivity growth less forecast consumer price inflation directly (see equation 1 and table 1 above), Ofwat took a different approach in which it laid out a number of tests that companies would have to pass before it could consider making any allowance for RPEs.

Figure 2: Ofwat's PR19 approach to RPEs and productivity growth

<u>RPEs</u>

Q1: Is an input cost category a material part of a company's expenditure (i.e. >10% of totex)?

Q2: Is there reason to think that input price increases will not be 'captured' by CPIH indexation?

Q3: Will RPEs be significantly different from zero?

Q4: Is a company's exposure to input price inflation something that management cannot control?

<u>Productivity growth</u>

Q5: At what rate will leading companies be able to go on improving productivity?

Ofwat's initial assessment was that there is no category of wholesale input costs for which it can answer all of questions 1, 2, 3 and 4 in the affirmative. In particular, it found that no input cost passes tests 2 and [43]. This led Ofwat to conclude that it does not need to make any allowance for RPEs when it sets PR19 price controls. Ofwat did, however, determine that the sector's leading

[43] Europe Economics (2019), Frontier shift and real price effects.

companies ought to be capable of making productivity improvements worth 1.5% per annum, and, hence, that frontier companies are capable of holding increases in botex to a net CPIH – 1.5% per annum over the remainder of AMP6 and the whole of AMP7.

It is not my intention in this paper to question this estimate directly or to table my own, alternative estimate of frontier shift. Rather, it is principally the novel nature of Ofwat's *methodology* that I wish to focus on. 14 of the 17 companies will be submitting revised business plans to Ofwat on 1 April and it is for the individual companies to come to their own views about numbers. I do think it is important, however, that Ofwat has a comprehensive and reliable analytical framework with which to assess the reasonableness of the forecasts it receives, and that its draft determination and final determination allowances for frontier shift are neither biased up nor down.

In the remainder of this paper, I first consider the coherence of Ofwat's overall approach to RPEs and productivity growth. I then look in more detail at the line---by---line RPE and productivity growth calculations.

COHERENCE OF METHODOLOGY

The stand---out feature of Ofwat's PR19 approach to frontier shift is the different thought processes that Ofwat is applying in the case of RPEs and productivity growth. As set out in figure 2, Ofwat is saying in the case of RPEs that there has to be a compelling case in order for Ofwat to make an allowance for above--- or below---CPIH cost escalation, in accordance with its four tests. But in the case of productivity growth, Ofwat is happy to proceed straight to an unconditional assessment of the scope for companies to reduce costs year---on---year via efficiency improvements.

I offer the following observations about this.

3.1 Does CPIH capture input price inflation and productivity growth?

Looking at Ofwat's RPE tests, my eye is immediately drawn to the critical importance that criterion 2 takes on in Ofwat's framework of analysis. Ofwat's consultant, Europe Economics, in a report that Ofwat published alongside its January 2019 initial assessment of plans, explains the logic behind this test in the following terms:[3]

> … if the share of a cost item in totex is similar to the share of that cost item in CPIH, then CPIH indexation should already be capturing well the evolution of that cost item in company costs … A cost item fails against this criterion if there is no conclusive evidence that CPIH fails to adequately capture the input price.

I consider the workability (or otherwise) of this test in section 3.2. But at the very outset it is important to emphasise that if Ofwat wishes to approach RPEs in this way, it also has to approach productivity growth with the same mindset. CPIH is an index that tracks the price of a basket of goods and services bought by UK households. Individual prices can fluctuate for a variety of reasons, but two of the key drivers of product prices increases and price reductions will be (a) changes in the costs of the inputs that firms use, and (b) the scale of any unit cost reductions resulting from productivity improvements. As a rough approximation, over a period of several years, it is not unreasonable to think of CPIH inflation as an indicator of the average rate of input price inflation affecting the firms that supply goods and services to UK households less the average rate of productivity growth that such firms are able to achieve, i.e.:

CPIH inflation
≈ average input price inflation
less average productivity growth (2)

Ofwat's criterion 2 starts from the premise that in---period CPIH indexation is akin, in part, to in--period input price indexation. But Ofwat then fails to acknowledge that if CPIH indexation compensates water companies for an average rate of labour, materials, etc. input price inflation, it also challenges water companies to match the average rate of productivity growth that is being achieved by the companies that supply goods and services to households.

The consequences that this omission has can be seen can be seen clearly if we substitute the relationship between CPIH inflation, input price inflation and productivity growth from equation 2 into the earlier equation 1, i.e.:

	frontier shift in real terms
=	forecast nominal industry input price inflation
less	underlying industry frontier productivity growth
less	forecast consumer price inflation
=	forecast nominal industry input price inflation – average input price inflation
less	underlying industry productivity growth – average industry productivity growth
	(3)

This expression says that scale and direction of the PR19 CPIH ± z% roll forward of efficient industry costs can be calibrated by reference to the extent to which water industry input price inflation exceeds or falls short of the average rate of input price inflation feeding into the prices of the goods and services in the CPIH basket *and* the extent to which water industry productivity growth exceeds or falls short of average productivity growth. Europe Economics and Ofwat seize upon the first of these things when they observe that CPIH inflation might 'capture' industry input price inflation. But they do not go on to recognise that there is a corollary for productivity improvement – i.e. that CPIH indexation might also 'capture' industry productivity growth.

Ofwat ought to recall this point was given some prominence in the work that it carried out at previous periodic reviews, as set out in the box overleaf.

Box 1

During PR99 and PR04, Ofwat, advised by Europe Economics, viewed real terms frontier shift via a comparative lens. That is to say that it allowed for RPEs only to the extent that it considered that the input mix in a typical water and sewerage company was different from the input mix in the economy as a whole. Similarly, Ofwat allowed for productivity growth only to the extent that it considered that the underlying pace of productivity growth in the sector exceeded the rate of productivity growth in the rest of the economy.

A Europe Economics report from 2003 highlights the point very explicitly[44]

> ... if the trends in input prices in the water and sewerage industries reflect the input price trend in the economy as a whole, the water and sewerage industries will be able to achieve real cost reductions (measured against the RPI) to the extent that they can improve TFP faster than the economy as a whole.

(NB: the reference to RPI reflects Ofwat's use of RPI as its preferred inflation metric at that time.)

Despite using the same consultants that helped Ofwat develop the PR99/PR04 framework, Ofwat is not re---using its old methodology in PR19. But neither is it moving to the more modern methodology that the likes of the CMA, CAA, Ofgem and the NI Utility Regulator have used in their recent periodic reviews, involving stand---alone calculations of nominal input price inflation, industry productivity growth and forecast consumer price inflation (i.e. equation 1). Instead, Ofwat has alighted on a sort of pick'n'mix approach in which it looks at RPEs in the old, comparative equation 3 way and then considers ongoing productivity growth in absolute equation 1 terms.

The obvious problem with this contradictory and inconsistent approach is that it will give Ofwat an inadmissible estimate of overall frontier shift.

3.2 Should Ofwat approach PR19 frontier shift in comparative or absolute terms?

If Ofwat is willing to accept this uncontroversial statement, it will need to decide whether to reassemble its analysis in either the framework provided by equation 1 or the framework of equation 3. My strong advice is that it should opt for the former.

I am not aware of any price review that has taken place in the UK in the last ten years in which a regulator has deemed it appropriate to use the comparative approach set out in equation 3. The

[44] Europe Economics (2003), Scope for efficiency improvement in the water and sewerage industries: final report, available at: https://webarchive.nationalarchives.gov.uk/20100514023213/http://www.ofwat.gov.uk/legacy/aptrix/ofwat/publish.nsf/Content/efficiency_report.html

principal reason for this is that no one can say for sure what average rate of input price inflation or what average rate of productivity improvement feed into CPIH inflation. It used to be that regulators and their consultants would try to reference average UK economy input price inflation rates and average UK economy productivity growth, respectively, until a number of us pointed out that many of the goods that appear in the CPIH basket are nowadays manufactured overseas. This means that the averages feeding into CPIH inflation are not UK economy averages but are partly a function of domestic input price inflation and domestic productivity growth and partly a function of input price inflation and productivity growth in overseas economies – the average values of which I do not think anyone could hope to pinpoint with any accuracy.

Ofwat will recall that its PR09 consultant, Reckon, endorsed criticisms of the comparative equation 3 approach in a report a decade ago:[45]

> At best, this approach seems unnecessarily complicated; at worst, the forecasts of future cost reductions will be based on unjustified assumptions …

Given the unknowns in any comparative exercise, the framework that equation 1 provides is far more straight---forward for everyone to analyse frontier shift with. A regulator and/or a company only needs to assemble their best current estimates of the rate at which input costs like wages, materials prices, electricity purchase costs etc. will increase or decrease over the AMP7 period. It can then combine these input price forecasts with the kind of productivity growth assumption that Ofwat has already been assembling in its PR19 work. Placed together, these two parameters will give a sense of the nominal cost escalation that a frontier company is likely to experience in the coming years, which can be translated into a real terms equivalent, if desired, by deducting a forecast of CPIH inflation.

The likes of the Competition Commission, the Competition & Markets Authority, Ofgem and the NI Utility Regulator have all been comfortable using this approach in recent periodic reviews, as have the companies that they regulate. I can see absolutely no reason why Ofwat should not be using the same approach in PR19.

OTHER OBSERVATIONS: REAL PRICE EFFECTS

The other three limbs in Ofwat's RPE tests are that:

- a cost item must be material;
- there must be a discernible wedge between input price inflation and CPIH inflation (or the wedge must be highly volatile); and
- the wedge must be outside management control.

I now consider each of these points in turn.

4.1 Materiality test

[45] Reckon (2008), PR09 scope for efficiency studies, available at: https://webarchive.nationalarchives.gov.uk/20150604082240/http://www.ofwat.gov.uk/publications/commissioned/rpt_com_scopeefficiencyreckon.pdf

Ofwat's materiality test requires that a cost item must represent more than 10% of wholesale totex (i.e circa £900m per annum) in order to warrant any regulatory consideration. As a consequence of this criterion, Ofwat deems that only two cost items – labour costs and materials, plant and equipment costs – are eligible for above--- or below---CPIH allowances. Table 2 shows that, by Ofwat's calculations, labour and materials, plant and equipment costs constitute approximately 55% of wholesale expenditure. This means that Ofwat is unwilling to consider provision for RPEs in respect of almost half of water companies' input costs.

Table 2: Input costs considered eligible for an RPE allowance

Input category	Percentage of totex
Labour ~~Energy~~ ~~Chemicals~~ Materials, plant and equipment Other	35% ~~8%~~ ~~2%~~ 20% not stated
Total	55%

In other price reviews, it is not uncommon to see regulators focus mainly on major cost items. But in this case, it feels like Ofwat is narrowing its field of vision far too much. As evidence of this, I note that:

- in its 2010 and 2015 Bristol Water determinations, the CC/CMA considered six categories of wholesale opex input price inflation, leaving it with a residual 'other' amount of only [46]--12% of totex;6
- in its 2014 price control for NI Water, the NI Utility Regulator had ten totex input cost categories, leaving an 'other' amount of only 5%;[47] and
- in its 2014 decision for NIE – as an example of practice in another industry – the CC considered four input types and had an 'other' basket of 11---15% of totex.[48]

In these other price reviews, the regulators were therefore able to obtain a much more comprehensive picture of aggregate input price inflation. I think that Ofwat should be seeking to compile a similarly thorough assessment in PR19. For example, Ofwat could, without much difficulty:

- discard Europe Economics' arbitrary 10% cut---off line and admit analysis of all separately identifiable input cost categories; and

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[46] CC (2010), Bristol Water plc, appendix K; and CMA (2015), Bristol Water plc.

[47] Utility Regulator (2014), Water and sewerage services price control 2015---21: final determination, annexes O and S, available at: https://www.uregni.gov.uk/publications/pc15---final---determination

[48] CC (2014), Northern Ireland Electricity Limited, appendix 11.1, available at: https://assets.publishing.service.gov.uk/media/534cd4b4ed915d630e000041/appendices---glossary.pdf

- dig deeper into what at the moment feels like an over---sized bucket of 'other' costs with a view to ascertaining if this expenditure can be further broken down into meaningful cost categories or is otherwise allocatable to labour, materials etc. input types.

Once armed with an understanding of the input price inflation driving, say, 80---90% of expenditure, Ofwat will be able to make more robust conclusions about future cost escalation. This will be essential if Ofwat accepts the recommendations in section 3 and proceeds to make a stand---alone RPE allowance. But I also note, as an aside, that it would also be vital if Ofwat were to continue with its comparative approach. (As things stand, Ofwat has satisfied itself that there is a reasonable mapping between 55---65% or so of companies' input costs and 55---65% or so of CPIH. But it cannot conclude its analysis of RPEs without having some confidence that the other 35---45% of water industry input costs also map reasonably well to the remaining 35---45% of CPIH (which likely includes CPIH basket items like agriculture products, goods manufactured in less---developed countries and housing costs, many of which will not match up readily to water industry cost categories).)

4.2 Use of independent forecasts

Arguably the most eye---catching aspect of Europe Economics', and, by implication, Ofwat's approach to RPEs is the consultant's out---of---hand dismissal of the OBR's and BEIS' forecasts of real wage inflation and electricity prices, respectively.

At the time of writing, the OBR and BEIS each have central forecasts in which wages and electricity prices escalate on a path that differs from forecast CPIH inflation. I would have thought it natural and obvious that an economic regulator like Ofwat should factor these independent forecasts into its AMP7 cost projections.

Europe Economics, though, advises against this. Its reasons for not using the OBR and BEIS projections is "the lack of reliability" of previous OBR and BEIS forecasts"[49]. This is a very odd position to take. The last ten years have been a very challenging period for all economic forecasters, and it is undoubtedly the case that many previous forecasts turned out to be wrong. However, it is a very big leap to say that the latest OBR and government forecasts should now simply be ignored. This is a particularly worrying position to take when Europe Economics separately acknowledges that OBR and BEIS projections are 'in the pack' with other economic forecasts – essentially, Europe Economics is advising Ofwat not only to disregard two highly regarded forecasts, but also to pay no attention to expert opinion more generally.

The folly in this position becomes even more clear one recognises that Europe Economics actually wants Ofwat to supplant consensus forecasts with Europe Economics' own house take on input prices – i.e. that all types of input price can reasonably be assumed to move in line with CPIH inflation. I would have hoped that Ofwat would have been able to see that this is an extreme position. It means, for example, that Ofwat is assuming that a typical UK household is not going to see any real wage growth and accompanying improvement in living standards over a seven---year period, having already suffered an unprecedented loss of purchasing power over the ten years since the global financial crisis. This is not an inadmissible prediction, but it sits well outside of

[49] Europe Economics report p.24 and p.30.

mainstream thinking and ought, at the very least, to have been acknowledged and defended as such by Ofwat in its own document.

4.3 Management control

The final criterion on Europe Economics'/Ofwat's RPEs list requires Ofwat to be satisfied that exposure to input price pressures is not something that management can control. On the face of it, this is a reasonable test to apply, but the particular way in Europe Economics interprets 'controllability' is not very intuitive.

At various points, Europe Economics points out that companies can:

- control labour and materials costs by tying staff and contractors into long---term contracts;
- hedge against future volatility in energy prices; and
- substitute from expensive inputs to cheaper alternatives.

In all of these cases, I think that Europe Economics is conflating the question of whether firms can take steps to *manage* input price pressures with the question of whether firms can take steps to *avoid* input price increases entirely. It may well be that long---term contracts, hedging and input substitution constitute sensible management action in the face of input inflation risks, but it is not at all clear that they enable companies to side---step cost increases for a full seven--year period. I would have thought it likely that long---term contracts, for example, would entail factoring upfront a basic level of cost escalation into future wages, electricity purchases costs and supply chain prices. A firm might be able to protect itself to some degree against future input price volatility via such contracts but it is highly unlikely that it will be able to persuade the people and businesses it contracts with to go on supplying inputs to it at 2017/18 prices all the way to through to 2024/25.

As such, I do not find Europe Economics' fourth criterion adds a great deal to the discussion.

OTHER OBSERVATIONS: PRODUCTIVITY GROWTH

Ofwat's allowance for productivity growth comprises:

- a long---term, underlying water and sewerage industry productivity growth trend; and
- a short---term boost to productivity growth in AMP6 and AMP7 arising from Ofwat's PR14 switch towards totex and outcome regulation.

5.1 The water industry's underlying productivity growth potential

Ofwat's and Europe Economics' analysis of the natural, long---term rate of productivity growth in the water industry sits much more consistently with analysis carried out by regulators in other sectors. Europe Economics' conclusions – i.e. that companies might be able to increase productivity by between 0.6% and 1.2% per annum – are also broadly in line with the conclusions reached in other periodic reviews, as set out in table 3.

Table 3: Assumptions made by regulators about rates of annual frontier productivity growth

	Opex	Capex
CC, Bristol Water, 2010	0.9%	---

Ofgem, RIIO---GD1/T1, 2012	1.0%	0.7%
CC, Northern Ireland Electricity, 2014	1.0%	1.0%
Ofgem, RIIO---ED1, 2014	1.0%	0.7% to 1.1%
Utility Regulator, NI Water, 2014	0.9%	0.6%
CMA, Bristol Water, 2015	1.0%	---
Utility Regulator, GD17, 2016	1.0%	1.0%
Ofwat, PR19, 2019 (current consultation range)	0.6% to 1.2%	

The one departure that I can see from standard regulatory practice is Europe Economics' remark that in calculating the upper bound of its range it "takes note of Ofwat's approach of setting stretching performance targets for the water sector" and so "focuses on the TFP growth performance of the stronger performing comparator sectors (rather than taking an average across all comparator sectors as we do for determining the lower bound)". This turns what is otherwise a very logical piece of benchmarking into an apples---to---pears comparison to rates of productivity growth in other parts of the UK economy. It means, in particular, that Ofwat is asked to discard comparisons to the construction and transport and storage sectors of the economy. These two sectors always feature prominently in any 'nature of work' benchmarking, principally because a significant proportion of water and sewerage companies' costs come from activities that entail construction, transport and storage. I do not think that they can dismissed in the course of a consultant's attempt to manufacture a range.

This said, the main observation that I wish to make on productivity growth is that Ofwat ought to be reflecting in PR19 much more than it has on the implications of the slowdown in productivity growth that has affected the UK and the other western economies since the global financial crisis. This is one of the big macroeconomic issues of the day, yet, curiously, it does not get a single mention in Ofwat's January 2019 document.

The following charts and tables hopefully bring out the importance of the point. Table 4 contains the ONS' estimates of average annual total factor productivity growth over the period 1998 to 2018, together with the Bank of England's forecast out to 2022. It can be seen that the Bank of England is currently expecting productivity to grow at less than half the rate seen prior to the onset of the global financial crisis.

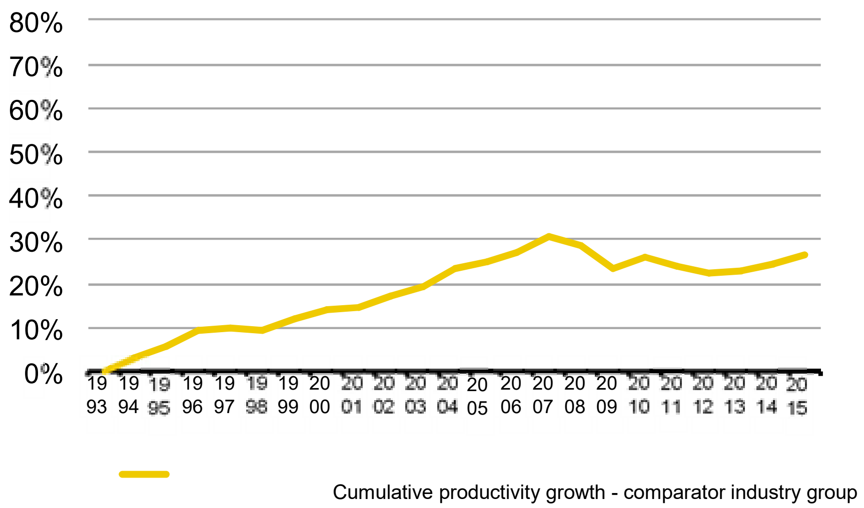
Table 4: Bank of England estimates of annual total factor productivity growth

	1998---07	2008---[50]	2011---14	2015---18Q3	2018Q4---22Q1

[50] The full set of comparator industries feeding into this calculation is: construction; manufacture of chemicals and chemical products; manufacture of electrical and optical equipment; manufacture of transport equipment; transport and storage; electricity, gas & water supply; sale, maintenance and repair of motor vehicles and the retail supply of fuel; renting of machinery and equipment

TFP growth	1.0%	---0.6%	---0.1%	0.2%	0.3%

Figure 3 shows that the sectors which Ofwat and Europe Economics (and other regulators/consultants) pick out as useful comparators for the water and sewerage industry[10] have been as affected as any other parts of the economy by stalled productivity growth. Figure 3: Total factor productivity growth in comparator sectors to the water and sewerage industry (cumulative)

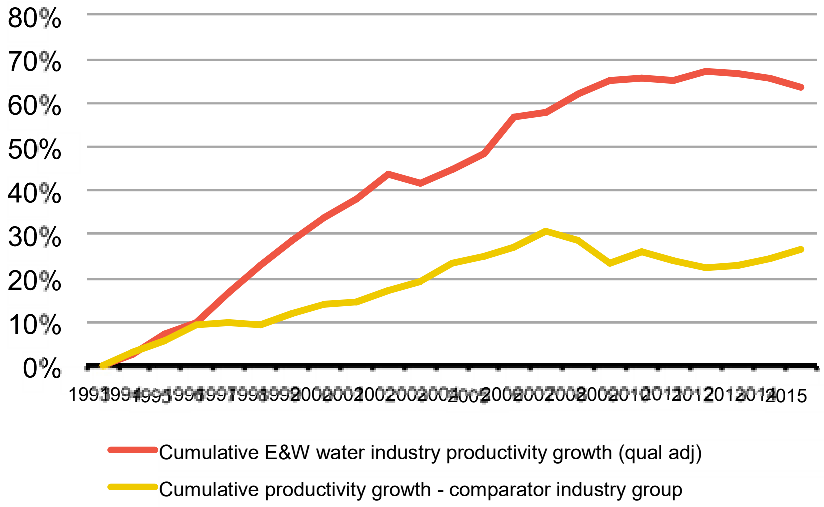


Source: Frontier Economics.

Figure 4 reproduces analysis published by Frontier Economics in late 2017, which indicates that the productivity growth in the water industry has also been broadly flat in recent years.

Figure 4: Total factor productivity growth (cumulative)

and other business activities; finance, insurance, real estate and business services; financial intermediation; post and telecommunications.



Source: Frontier Economics.

These numbers are clearly telling an important story. A variety of explanations have been put forward for the "productivity puzzle" that the table and charts depict. I provide a brief survey in the box below.

Box 2: Explanations for the fall in productivity growth

The following is a synthesis of research and views that have come from the Bank of England, the Office of National Statistics and the Office for Budget Responsibility (OBR) during the last 12 months. References are given in the appendix.

Sector---specific effects

When economists have dug below the whole---economy productivity data, they have found that certain sectors of the economy have contributed disproportionately to lower/flat productivity growth.

A chief culprit is the finance sector. Prior to the financial crisis, the finance sector was one of the engines of UK GDP and productivity growth. Since 2008, the ratio of output to inputs in this industry has fallen markedly. This can be seen to be a function of the underlying credit cycle: in the good times leading up to recession, increased leverage and higher risk taking boosted activity and sector revenues beyond sustainable levels; since the credit bubble burst, activity levels have fallen off and profits have been much harder to come by.

The contraction – which to some extent has been a deliberately policy choice – is estimated to account for as much as two fifths of the UK's recent loss of productivity growth. *Lower capital investment*

Other sectors which have contributed disproportionately to the slowdown in productivity growth include manufacturing, professional services and ICT. In these sectors, there are not the kind of exceptional circumstances like there are in the finance sector. Instead, attention has been given to lower levels of R&D and capital investment, over---reliance on labour and the effect that capital shallowing might have had on innovation and productivity growth.

Some of the possible reasons for low under---investment are intertwined with factors that I go on to pick out under subsequent headings below. However, one over---arching narrative is that managers might have become more risk averse after living through the financial crisis. This risk aversion appears to have caused firms to prefer to deleverage or accumulate cash reserves rather than invest, especially where new investment entails borrowing or taking on risk.

In the last two years, uncertainties about Brexit may also have had an effect on UK firms' appetites for new investment.

Market concentration and competition between firms

Empirical work suggests that there is a noticeable and growing disparity between efficient companies that operate at the frontier of their industries and a long---tail of less efficient, non--frontier companies that fail to keep pace with innovation. Normally one would expect to see a diffusion of technical progress across firms. In recent years, this doesn't appear to have been happening to the same extent as in the past.

This could be because there are increasingly large barriers to competition in modern---day markets, e.g. restrictions on patents and intellectual property. It could also be because certain markets are more concentrated than in the past, with larger players dominating certain sectors and firms generally facing much less in the way of competitive threat from rival firms. *Loose monetary policy*

Some commentators have argued that there is a link between accommodative interest rate policy and low productivity growth. The contention is that loose monetary policy has primarily benefited low---productivity companies who might otherwise have failed, and that policy actions may therefore have inhibited the processes of "creative destruction" that would normally affect industries.

The continued existence of these "zombie firms" may be regarded as a problem in its own right. But there may also have been a multiplier effect if the survival of low---productivity firms has prevented the reallocation of labour and capital to more productive sectors of the economy. *Slower technological progress*

Some economists believe that the persistence of low productivity growth, not just in the UK but across much of the developed world, is evidence that there has been a slowdown in innate technological progress. This could be because there are inherently diminishing returns from new research and development. Or it could be because the particular revolution that has been impacting on the global economy since the 1990s, centring on the harnessing of IT, is now quite mature, meaning that current and future waves of IT innovations are unlikely to have the same potential as past innovations.

At first sight, it might seem like a regulated, monopoly industry like the water and sewerage sector should be less affected by the above developments in comparison to other industries. However, it is important to remember that modern---day network businesses tend to contract a significant proportion of their expenditures through alliance and other supply chain partners. Even if regulated companies should not have been unduly affected internally by some of the above factors, any sense in which increasing market concentration, lower R&D and capital investment, a slowdown in the rate of creative destruction, etc. have weighed at all on the contractor market would mean that the resulting slowdown in productivity growth will ultimately also feed through into a slowdown in overall water industry productivity growth.

In the circumstances, I do not think that it is tenable for companies or Ofwat to assume automatically that productivity growth in the rest of AMP6 and throughout AMP7 will come out in line with the rates of productivity growth that were seen up to 2007. Europe Economics does recognise this when they set the lower bound of their range with reference to EU KLEMS data for a more recent 2010---14 period. However, I do not think that this is sufficient, for two reasons:

- first, the 0.6% is a curiously high number when put next to the ONS' flat productivity data[51] for the whole 2008---17 period (see table 4) . This is because Europe Economics is putting undue weight on the immediate bounce---back that there was from the very low, middle---of---recession productivity levels in its chosen base year of 2009 and overlooking evidence of stagnant productivity over a longer time horizon; and
- second, Ofwat and other stakeholders can easily misinterpret a presented range to be a reflection of inherent imprecision in productivity measurement rather than a function of very different perspectives on future economic fundamentals.

When it comes to make its draft and final determinations, I think Ofwat has to select a point productivity estimate based on the position that it takes on the uncertainties that I have just outlined – i.e. it can go towards the top of the Europe Economics range if it judges that companies are capable of replicating pre---2008 productivity growth with near---immediate effect or it can go towards the bottom end of the range (or lower) if it considers that there are short--to---medium term obstacles to productivity improvement in the sector. Not only will this make its regulatory judgment more transparent, it also precludes the possibility that RPE forecasts and assumptions about productivity growth become misaligned – e.g. if Ofwat were to settle on a relatively low real wage forecast but a relatively high productivity growth figure.

5.2 Uplift for totex and outcome regulation

The rate of productivity growth that Ofwat allows for in its initial assessment of plans includes an uplift to the Europe Economics 0.6% to 1.2% range. This uplift comes principally from a report by KPMG, which argues that the PR14 switch to totex and outcomes regulation has enabled water and sewerage companies to make additional productivity gains during the 2015--20 regulatory period and will continue to exert a downward influence on costs in the 2020---25 regulatory period.

The numerical evidence that KPMG relies upon in its report relates primarily to the totex performance of electricity distribution network operators (DNOs) during the early part of the 2015---23 RIIO---ED1 price control period. I urge extreme caution in attributing what is actually quite a modest amount of DNO out---performance[52] to totex--- and outcomes---driven ongoing efficiency improvement, for a number of reasons:

- first, it is incontrovertibly the case that some of the DNOs' under---spending against Ofgem's RIIO---ED1 allowances has been due to slower---than---forecast GDP growth and slower---than---expected technological change, e.g. in relation to the take---up of electric vehicles and heat pumps.[53] KPMG should not be confusing this under---spending with efficiency improvement;

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[51] Available at: https://www.ons.gov.uk/economy/economicoutputandproductivity/productivitymeasures/datasets/multifactorproductivityexperimentalestimatesreferencetables

[52] Ofgem's latest RIIO---ED1 annual report states that companies expect to underspend eight---year totex allowances by 5%. See Ofgem (2019), RIIO---ED1 annual report 2017/19, para 4.20, available at: https://www.ofgem.gov.uk/system/files/docs/2019/03/riio---ed1_annual_report_2017---18.pdf

[53] ibid. para 4.11.

- second, Ofwat will be aware that there have been criticisms in recent years about the alleged 'softness' of Ofgem's determinations (see, for example, the Citizens Advice report

Energy Consumers' Missing Billions,[54] the Energy and Climate Change Committee report Energy Network Costs: Transparent and Fair?[55] and Dieter Helm's Cost of Energy Review[56]). While I do not necessarily agree with these critiques, they do serve to illustrate an important point, namely that out---performance can be as much about the quality of a regulator's starting baseline as of year---on---year efficiency improvement; and

- finally, and most obviously, even if it were possible to establish that energy networks have made genuine new productivity improvements, it is would be impossible to attribute the savings to specific regulatory innovations or to conclude that companies in the water sector are capable of replicating the DNOs' productivity performance over a ten---year period.

Rather than grasp for simple takeaways from the complex experiences of a different class of regulated company, Ofwat is far better off concentrating on the actions that water companies have taken since 2015 and on the behaviours that it think its PR19 framework of incentives are likely to stimulate. On the first of these points, KPMG presents case studies which indicate that totex and outcome regulation have unlocked genuine whole---life cost savings. The main question I have after reading this material is: how many of these initiatives led to a reduction in recurring *botex*? The thinking is normally that:

- totex regulation encourages firms to take on opex solutions where previously companies would have preferred capex solutions, implying that totex regulation might have increased not reduced AMP6 botex; and
- one desirable consequence of outcome regulation is to encourage companies to go beyond their performance commitments within period if and/when there is customer benefit in incurring additional expenditure in order to further improve customer outcomes. This might also have led to higher costs at some companies since 2015.

If am not sure, therefore, that I see the direct link that Ofwat is seeing between totex/outcomes regulation and *botex* reduction. I note that KPMG explicitly states that its numbers relate to the scope for *totex* reduction, and I worry, in the absence of any clear statement from Ofwat on the transmission mechanism between regulatory incentives and recurring costs, that Ofwat is mistakenly loading a quite flimsily justified totex reduction target on to exactly the wrong part of companies' cost allowances.

CONCLUSION

The critique set out in this paper leads me to conclude that Ofwat needs to make some quite fundamental changes to its January 2019 analysis before it issues its draft and final PR19 determinations. My main recommendations are as follows.

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[54] https://www.citizensadvice.org.uk/Global/CitizensAdvice/Energy/EnergyConsumersMissingBillions.pdf

[55] https://www.publications.parliament.uk/pa/cm201415/cmselect/cmenergy/386/386.pdf

[56] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/654902/Cost_of_Ener gy_Review.pdf

1. Ofwat should reconstitute its analysis of RPEs and productivity growth under a more standard methodological framework in preference to the pick'n'mix approach given to it by Europe Economics.

2. The analysis of RPEs should extend to all major cost categories, with the aim of covering at least 80---90% of totex by value.

3. Ofwat by default should use OBR/BEIS/consensus forecasts of input prices, where available, as the best current predictions of input price changes, unless Ofwat has compelling insights as an expert regulator to justify departing from independent projections.

4. In its analysis of productivity growth, Ofwat should consider more explicitly the observable slowdown in the rates of productivity growth in the wider economy and the implications that this might have for water company / water industry contractor costs.

5. Before layering on a stretch productivity target, Ofwat should explain clearly why totex and outcome regulation should lead and has led to reductions in recurring botex (as opposed to reductions in whole---life costs).

The first three suggestions on this list would do no more than align Ofwat's PR19 methodology with what I think is widely considered to be best regulatory practice. The fourth recommendation is one that I have been making to companies and regulators since late 2016 when the OBR and the Bank of England started cutting growth forecasts (i.e. after the regulatory decisions listed in table 3 in this paper). It reflects my sense that it is increasingly untenable for regulators to use the hitherto sensible ~1% rule---of---thumb for frontier productivity growth that emerged from regulators' analysis of pre---2008 productivity data. The fifth point is more specific to PR19.

I do not know how much Ofwat's initial CPIH – 1.5% estimate of frontier shift might change if it takes these suggestions on board. Indeed, I would caution anyone from trying to pre---judge what a 'reasonable' frontier shift number might prior to completing a detailed analysis of both RPEs and productivity growth potential. As I noted in section 2, there are some goods and services whose costs/prices increase quite naturally ahead of CPIH inflation and other goods and services who costs/prices tend to move on a below---CPIH trend, and at the moment there is no reason that I can think of why one should presume a priori that water and sewerage costs will necessarily fit to a greater or a lesser extent into one of these categories.

What is clear is that Ofwat's conclusions on frontier shift are a very significant element in the PR19 cost assessment. It is not therefore sufficient to take a relaxed, hands---off approach to RPEs and/or productivity growth on the grounds that companies and customers will split any forecasting error, say, 50:50, as Ofwat seemed to imply in January. The difference between a frontier shift assumption computed on the basis of robust, defensible assumptions and a frontier shift assumption computed using a faulty methodology could easily be worth at least ±5% of industry totex by 2024/25, and I would hope that Ofwat will be willing to give the issues raised in this paper as much focus as any other totex item that impacts bills to tune of several hundreds of millions of pounds. Appendix: References for further reading on the UK productivity puzzle

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Appendix AFW.CE.A1.15

Action ref AFW.CE.A1

Transience study

IMPACT OF TRANSIENCE ON RESIDENTIAL RETAIL COSTS

IAP Response Report for Affinity Water

March 2019

Economic Insight

This paper examines Ofwat's assessment of Affinity Water's (Affinity's) cost adjustment claim (CAC) for population transience. In its Business Plan, Affinity submitted a transience CAC for £7.8 million relating to its residential retail costs across PR19. While accepting that transience does affect retail costs, Ofwat rejected the CAC, primarily on the grounds that its econometric models already captured the impact of population transience on Affinity's costs. Our overall assessment is that Ofwat's reasons for rejecting the CAC are flawed - and that Ofwat's modelling does not adequately account for the impact of transience on Affinity's costs (in fact, Ofwat's approach actually means that Affinity's allowed residential retail costs are lower due to its high levels of transience, which is counter-intuitive and also contradicts Ofwat's own position). As such, in our view it would be appropriate for Ofwat to approve Affinity's submitted CAC. The scope of this paper is narrowly focused on assessing the primary reason given by Ofwat for the rejection of the CAC. We will subsequently provide our own, independent, evidence regarding the CAC itself.

1. Introduction

Ofwat used an econometric benchmarking approach to residential retail costs for the first time at PR19. In its March 2018 consultation on cost assessment, Ofwat acknowledged the principle that population transience (or 'changes in household occupancy') could affect costs, in particular bad debt related costs, stating:

> *'High transience rates can result in reduced ability to recover unpaid bills.'*[1]

The models that Ofwat presented in the March 2018 consultation did not, however, include any controls for population transience – either in bad debt related cost models, or in models for other cost types (total retail costs and other retail costs). Accordingly, reflecting Ofwat's acknowledgement that transience *does* affect retail costs; but also the fact that control variables for transience were absent from the cost models Ofwat consulted on, Affinity's business plan included a transience CAC of £7.8 million over PR19.

While the retail models that Ofwat used at its January 2019 Initial Assessment of Plans (IAP) were broadly similar to those in the March 2018 consultation, an important difference was that one bad debt model included a control variable for population transience. It appears that it was primarily on the basis of this model that Ofwat disallowed Affinity's CAC, arguing that its inclusion meant that the impact of

[1] *'Cost assessment for PR19: a consultation on econometric cost modelling.' Ofwat (2018); page 25.*

population transience on Affinity's costs was already captured within the econometric modelling.

In this short paper, we examine Ofwat's assessment of Affinity's CAC; and its contention that the impact of transience on costs is already captured by its econometric cost modelling. We first briefly set out the 'in principle' reasons for expecting population transience to affect residential retail costs, before going on to provide greater detail on Affinity's CAC and Ofwat's assessment of it. We then analyse Ofwat's contention that the impact of transience is already reflected in its approach, before setting out our conclusions.

2. The impact of transience on retail costs

It is well established that, in principle, greater levels of transience drive higher residential retail costs – primarily through bad debt related costs. This can happen through transient customers leaving behind unpaid bills and debt, which are harder (and more costly) to track and recover - thereby increasing debt management costs. There may also be a link between transience levels and doubtful debt, as inflowing customers may accumulate more arrears, if they are delayed in switching their payments to a new supplier (or transient customers may just have a higher probability of default and arrears). Due to these potential effects – and bearing in mind the trade-off between debt management and doubtful debt expenditure levels – the level of transience a company faces will likely affect either or both of these costs. In practice, companies have some control over whether the impact of this is primarily felt through doubtful debt, or debt management – but the overall impact is that there will be an unavoidable increase in efficient costs (as the underlying cause, population transience, is outside of efficient management control).

Transience will likely also impact transaction related costs. Specifically, customers relocating naturally triggers 'touch points' with companies associated with the costs of processing and administrating address changes, amongst other things. In addition, there will be an interaction with metering levels. Specifically, metered customers typically pay in arrears – which means (all else equal) they are more likely to build arrears over time and have a higher probability of default. Consequently, the cost impact of transience could be magnified for a company with a higher proportion of metered customers.

3. Affinity's cost adjustment claim

3.1 Affinity's claim

Affinity made a transience CAC for three primary reasons: (i) the company has a higher rate of transience than most others; (ii) the transient customers are costlier to serve than non-transient ones; and (iii) Ofwat did not take account of transience in their retail models in the March 2018 consultation (nor did Ofwat allow for transience related costs through any other mechanism). As such, Affinity concluded that a CAC was necessary for it to be efficiently financed to deliver retail services to its customers. Addressing these issues in turn.

- Across the water industry the average rate of transience is 11.25%, whereas Affinity has a transience rate of 14.08%, the second highest in the country and a percentage gap which equates to 33,000 extra transient customers per annum.

- In its CAC, Affinity calculated that the annual cost to serve per transient customer is 3.9 times higher than for regular customers. The calculations behind this figure are shown in Table 1 below, which shows that the cost to serve each transient customer per year is £62.43, compared to £15.85 for non-transient customers.

- At the time of writing its plan, Affinity had no reason to expect that Ofwat would change its models to include a transience variable or proxy (such as population density or proportion of rented properties).

Table 1: Annual unit costs for transient and non-transient customers

Cost category	Customer services	Debt management	Doubtful debts	Meter reading	Other opex	Total
Total costs (£m)	7.65	2.04	8.63	2.89	8.93	30.14
Transient costs (£m)	**2.08**	**1.23**	**5.21**	**0.46**	**2.43**	**11.41**
Non-transient costs (£m)	5.57	0.81	3.42	2.44	6.5	18.73
No. of transient customers (000s)	**183**	**183**	**183**	**91**	**183**	**822.7**
No. of non-transient customers (000s)	1,182	1,182	1,182	636	1,182	5,363.15
Cost per transient customer (£)	**11.4**	**6.74**	**28.49**	**4.99**	**13.31**	**62.43**
Cost per non-transient customer (£)	4.71	0.68	2.89	3.83	5.5	15.85

Source: Affinity Data Table Commentaries

Affinity's CAC for transience was £7.80m over the five-year price control, equivalent to £1.56m per year. This number was calculated by multiplying the additional cost per transient customer of £47.31 by the amount by which Affinity's number of transient customers per year exceeds the average rate, which is 33,000.[2] The cost claim calculations are summarised in the table below.

Table 2: Affinity's cost adjustment claim calculation

Parameter	Value	Calculation
Average transience (a)	11.25%	-
Affinity transience (b)	14.08%	-
Gap from average (c)	2.80%	(b)-(a)
Population equivalent (d)	33,000	(c)*population served
Additional cost per transient customer (e)	£47.31	-
Total annual additional cost (f)	£1,561,230	(d)*(e)

Source: Affinity Data Table Commentaries

[2] *Affinity Water: PR19 – 3 September 2018 Submission – Table Commentaries v2; p.172.*

3.2 Ofwat's assessment

Upon reviewing Affinity's CAC, Ofwat concluded that the company should **not** be allowed an adjustment for transience. This judgement was reached by evaluating the CAC against three assessment areas: (i) a high level overall IAP quality score; (ii) materiality (i.e. the value of the claim compared to what Ofwat implicitly allows for); and (iii) three lower level 'assessment gates':

- need for adjustment;
- whether the cost claimed for is outside of management control; and
- robustness and efficiency of costs.

On test (i) Ofwat gave Affinity a 'marginal pass', on the basis that the company does face an above-average level of transience – which it has evidenced well – but does not provide sufficiently robust nor transparent calculations to reach the amount claimed. Ofwat judges the company to fail on test (ii), stating that because transience is included as a cost driver in the model suite used for the IAP, the value of the claim is implicitly allowed for in the models and so no adjustment is required. Finally, on test (iii) Affinity passes for the claim being outside of management control - but fails on the need for an adjustment and the robustness and efficiency of costs. The justification for the former failing is, again, that transience is already accounted for in the model suite; the latter fails due to Affinity basing its calculations on unit costs, for which there are no cross-industry figures and so (in Ofwat's view) one cannot say whether or not their figure is efficient.

Overall, the primary justification for Ofwat's rejection of the transience CAC is Affinity's failing of the 'materiality' and the 'need for adjustment' criteria. The basis for Ofwat failing the company on these tests appears to be the inclusion by Ofwat of transience within its residential retail cost assessment model suite.

4. Analysis

We have concerns with Ofwat's stated reasons for rejecting Affinity's CAC, which we set out in turn.

- The one model in Ofwat's suite that includes transience attaches a negative coefficient to this variable. This implies that, other things equal, Affinity's modelled costs are, in fact, reduced on account of its higher transience level.

- In practice, transience is incorporated within only one of Ofwat's econometric retail cost models. As modelled efficient costs are triangulated across eight other models, the impact of the inclusion of transience is diluted and so (even if the one model in which transience was included accurately captured its cost impact – which, as noted above, it does not) Ofwat's assessment does not adequately reflect the impact of transience on Affinity's costs.

Contrary to Ofwat's claims in rejecting Affinity's CAC, the evidence and analysis we set out below shows clearly that Affinity's modelled costs are, in fact, lower, as a result of the way in which Ofwat has incorporated transience within its models. Given that, as noted above, Ofwat has accepted the point that transience increases retail costs, this is counter-intuitive.

4.1 Sign of transience in Ofwat's model

Ofwat has argued that because transience is included within its retail models, Affinity is being compensated for the impact of transience on its costs, and so its CAC is not required. In practice, Ofwat has included transience in only one model (referred to as RDC3). This model, which we present in the following table, includes a negative coefficient on population transience. This implies that, other things equal, the impact of Affinity's higher population transience on its modelled costs is, in fact, to reduce them. While this does not necessarily mean that Affinity's modelled costs are reduced overall by the inclusion of RDC3, this does contradict Ofwat's contention that the inclusion of transience in this model accurately compensates Affinity for its higher population transience.

Table 3: Ofwat model RDC3

Parameter	Description/coefficient
Dependent variable (log)	Bad debt and bad debt management costs per household
Average bill size	1.079***
Percent of household income deprivation	0.057**
Percent of net migration (transience)[3]	-0.015
Constant	-4.327***
R-squared	0.76
Number of observations	88

Source: Ofwat

4.2 Impact of triangulation

In addition to model RDC3 itself not, in fact, allowing for 'greater' costs with 'higher' levels of transience, it is also important to note that overall retail cost allowances reflect the fact that Ofwat 'triangulates' across its full suite of nine retail models. Consequently, even if RDC3 itself accurately captured the positive impact of transience on retails costs, Affinity's overall retail cost allowance would not reflect this, as the 'impact' of transience is diluted due to averaging across multiple models. In fact, we find that model RDC3 receives an effective weight of only 4.8% overall in Ofwat's residential retail cost allowances.

This is because Ofwat's triangulation process involves the following.

- It first triangulates within each cost category. Ofwat had three bad debt models, and each received equal weighting of 33%.

[3] *Note: We have recreated model RDC3 and confirmed that the negative sign reported by Ofwat on the transience coefficient is correct and not a typographical error.*

- For bottom-up models, Ofwat then added the triangulated costs from bad debt and other cost models. This applied an implicit weighting of 71% to 'other retail cost' models and 29% to the bad debt related cost models.

- Ofwat then calculated the overall cost allowance by placing 50% weight on its top-down (total retail cost) models; and 50% on its bottom-up models. Overall, then, model RDC3 received a weighting of 4.8% in Ofwat's suite of models.

We summarise these calculations in the table below.

Table 3: Triangulation within Ofwat's model suite

<table>
<tr><th>Model type</th><th>Model identifier</th><th>Weight within cost category</th><th>Weight between debt and other costs</th><th>Weight (top-down versus bottom-up</th><th>Overall weight</th></tr>
<tr><td rowspan="4">Top-down models</td><td>RTC1</td><td>25%</td><td rowspan="4">Not applicable</td><td rowspan="4">50%</td><td>12.5%</td></tr>
<tr><td>RTC2</td><td>25%</td><td>12.5%</td></tr>
<tr><td>RTC3</td><td>25%</td><td>12.5%</td></tr>
<tr><td>RTC4</td><td>25%</td><td>12.5%</td></tr>
<tr><td rowspan="5">Bottom-up models</td><td>RDC1</td><td>33%</td><td rowspan="3">29%</td><td rowspan="5">50%</td><td>4.8%</td></tr>
<tr><td>RDC2</td><td>33%</td><td>4.8%</td></tr>
<tr><td>RDC3</td><td>33%</td><td>4.8%</td></tr>
<tr><td>ROC1</td><td>50%</td><td rowspan="2">71%</td><td>18%</td></tr>
<tr><td>ROC2</td><td>50%</td><td>18%</td></tr>
</table>

4.3 Estimated financial impact of the inclusion of transience

It is possible to determine how Ofwat's residential retail cost allowances for Affinity would change, if it had not included transience in model RDC3. We looked at this issue in two ways:

- We calculated how Affinity's cost allowance would change if model RDC3 was excluded altogether from the triangulation exercise. This suggests that modelled total costs and bad debt costs would be £1m and £2.9m higher respectively, while modelled other retail costs would be £0.4m lower.

- We calculated how Affinity's cost allowance would change if model RDC3 was retained, but its transience variable was excluded. This suggests that modelled total and bad debt costs would be £0.3m and £0.8m higher respectively. There would be no change in modelled other retail costs.

We set this out in the following table. Overall, then, excluding model RDC3 and excluding transience from this model both imply that Affinity's overall cost allowances for both total costs and bad debt costs would, in fact, be slightly higher than modelled. As noted previously, this illogical result arises from the counter-intuitive sign for the transience coefficient in Ofwat's model RDC3. The implication of this is that, without further changes to Ofwat's models, the regulator's approach to incorporating transience actually means that (all else equal) Affinity requires a greater CAC than the one it submitted, in order to ensure it receives cost allowances consistent with delivering efficient retail services to its customers.

Table 4: Impact of transience on modelled costs

Costs	Total	Bad debt and debt management	Other retail costs
Ofwat's assessment of Affinity's business plan costs			
Business plans modelled costs (m)	£169.00	£47.80	£121.20
Original cost allowance (m)	£138.90	£38.80	£95.40
Impact of exclusion of model RDC3			
Exclude model RDC3 (m)	£139.80	£41.80	£95.00
Change in allowed costs (m)	**£1.00**	**£2.90**	**-£0.40**
Impact of exclusion of a transience variable in model RDC3			
Exclude transience variable in RDC3 (m)	£139.20	£39.60	£95.40
Change in allowed costs (m)	**£0.30**	**£0.80**	**£0.00**

Source: Economic Insight calculations based on Ofwat FM_RR4

5. Conclusions

Drawing on the above, our conclusions about Ofwat's assessment of Affinity's cost adjustment claim are as follows.

- There are strong reasons to expect transience to increase retail costs. We welcome the fact that these arguments have been accepted by Ofwat both 'in principle' and 'in practice', with the incorporation of a transience variable within its suite of retail cost models.

- Ofwat appears to have rejected Affinity's claim for a transience related CAC on the basis that the inclusion of transience in Ofwat's retail modelling suite means that the impact of transience on Affinity's (efficient) costs is fully funded. However, Ofwat has provided no evidence to support this assertion.

- In fact, Ofwat only includes transience within one of its nine retail models. In relation to this model, the coefficient on the transience variable is, in fact, negative. This means that Ofwat's modelling actually results in Affinity's allowed costs being reduced as a consequence of its high levels of transience. This is counter-intuitive and contradicts Ofwat's previous acceptance that transience increases retail costs.

- Further to the above, the one Ofwat model in which transience is included is attached a weight of less than five percent in Ofwat's overall retail cost allowances. So, as a matter of principle, even if this model adequately captures the impact of transience on Affinity's costs, the model suite as a whole will capture only a fraction of its impact on Affinity's costs.

- Overall, therefore, we consider that Ofwat's primary reason for rejecting Affinity's transience related CAC is not supported by the evidence. As such, it would be appropriate for Ofwat to award a CAC to Affinity on this matter.

7. Annex: Ofwat's retail modelling suite

The table below shows Ofwat's top-down cost models (RTC1 to RTC4).

Table 5: Ofwat's top-down cost models

Ofwat model identifier	RTC1	RTC2	RTC3	RTC4
Dependent variable	Log(total retail costs per household)			
Log(bill size)	0.458***	0.518***	0.488***	0.378***
% households with default	0.021	0.030**		
% of council tax collection rate				-0.263***
% of income deprived households			0.042**	
% of net migration				
% of dual customers				
% of metered customers	0.003	0.004	0.002	0.003
Log(connected households)		-0.065	-0.058	
Constant	0.077	0.343	0.775*	26.886***
R2	0.65	0.69	0.65	0.72
Estimation method	RE	RE	RE	RE
N (sample size)	88	88	88	88

Source: Ofwat

The table below shows Ofwat's bottom-up cost models (RDC1 to RDC3 and ROC1 to ROC2).

Table 6: Ofwat's bottom-up retail cost models

Ofwat model identifier	RDC1	RDC2	RDC3	ROC1	ROC2
Dependent variable	Log(bad debt costs per household)			Log(other retail costs per household)	
Log(bill size)	1.138***	1.070***	1.079***		
% households with default	0.060**				
% of council tax collection rate		-0.324***			
% of income deprived households			0.057**		
% of net migration			-0.015		
% of dual customers				0.002**	0.003**
% of metered customers				0.006***	0.006***
Log(connected households)					-0.054
Constant	-5.629***	28.078***	-4.327***	2.469***	3.184**
R2	0.78	0.78	0.76	0.16	0.19
Estimation method	RE	RE	RE	RE	RE
N (sample size)	88	88	88	88	88

Source: Ofwat

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Appendix AFW.CE.A1.16

Action ref AFW.CE.A1

Leakage enhancement need and wider benefits

Leakage enhancement – need and wider benefits

In our revised draft water resources management plan we demonstrate a need for investment in both supply side and demand side options to meet our longer term water supply challenges.

Required reductions from existing sources to secure sustainable abstractions, coupled with other long-term external pressures including population growth and climate change, drive a baseline deficit of 36.86 Ml/d in 2025 rising to 121.13 Ml/d at 2050.

Accordingly, we need to act now to enhance the supply demand balance position, to meet our statutory duty to maintain this supply demand balance. That is, in setting ambitious leakage targets, we are responding to our obligation to maintain a supply demand balance in the face of external factors outside our control.

Our revised draft WRMP cost benefit analyses show that demand management options provide the best value for customers under all scenarios. And with this, leakage reduction is a key component of demand-side options to reduce the deficit.

Our customers research shows that their preferences are to increase leakage reduction (89%) and protecting the environment. This is reflected in our latest rdWRMP, where our consultation highlights an increased ambition for a 18.5% reduction over AMP7.

From Ofwat's and government's directions it is also clear that leakage needs to continue to fall significantly more widely, especially in water stressed regions such as ours. Meeting these obligations will require a programme of activities beyond the plans we put in place during in AMP6.

This increased programme of work will also accelerate the delivery of other benefits to our customers in a number of dimensions, including more controlled management of our network and better live information. This will help to improve our capacity to respond to and recover from network events, thus enhancing our resilience over the longer term.

Hence, in order to deliver to achieve the required demand management targets, we will need to undertake a wide range of interconnected activities during AMP7 including:

- accelerated implementation of wider leak and pressure monitoring
- further integration of our newly installed Advanced Meter Reading (AMR) meters systems platforms (that distinguish customer supply pipe leakage and internal water loss)
- improved monitoring of strategic mains
- enhancing the capability of our Situational Awareness systems (to monitor the interaction of leakage campaigns with other planned events, to reduce overall impact on supplied customers and road users); and
- a further programme of pressure monitoring, augmenting our current extensive critical point monitors in all leakage zones.

Arising from this accelerated programme of activities, we expect our enhanced leakage reduction targets will help to enable additional service and asset health benefits to current and future customers including:

- Technology and data-led reductions in leak run times and flow rates ("first time find") will lead to service improvements from reductions in pressure drop repeats, and improvements in pressure stability;
- Enhanced control of pressure systems will help to prevent pressure spikes and associated bursts

- Optimisation of interventions, and reduced reliance of the wholesale renewal of pipes, should lead to increased infrastructure serviceability and life over the longer term;
- The development of a systematic, proactive and planned approach to network interventions will reduce the harmful impacts of emergency street works on other users of the shared infrastructure environment;
- Improving system monitoring for leakage will improve the response to system shocks (events) and
- Development of improved understanding over the relationships between activities, costs and outcomes in our specific network will increase the potential for industry sharing of best practice and collaboration.

Overall our enhanced leakage reduction programme will unlock wider resilience and other benefits, through the improved reliability of our processes and information, and our enhanced ability to respond and recover quickly, so that customer service impacts are minimised.

As part of our commitment to develop an action plan for a system-based approach to resilience(action LR.A2) we propose to examine how we can realise the above types of benefits from increased demand management more rapidly.

To help us to assess and monitor our success in delivering these benefits, we will also develop and work on the development of a new Network Resilience Response measure that combines the various facets of service measured by pressure (duration, extent and frequency and of service loss), the quality of customer connections, as measured by the type and frequency of contact and the timeliness and reliability of the information which we provide during events and incidents.

Appendix AFW.CE.A1.17

Action ref AFW.CE.A1

NERA Economic Consulting - Assessing Ofwat's Funding and Incentive Targets for Leakage Reduction

Assessing Ofwat's Funding and Incentive Targets for Leakage Reduction

Prepared for SES Water in collaboration with Affinity Water, Anglian Water, Dwr Cymru, South East Water, South Staff Water, Southern Water, Thames Water and Yorkshire Water

26 March 2019

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Contents

Executive Summary

NERA Economic Consulting (NERA) has been commissioned by SES Water, in collaboration with Affinity Water, Anglian Water, Dwr Cymru, South East Water, South Staffs Water, Southern Water, Thames Water and Yorkshire Water, to review the Office for Water Services' (Ofwat) PR19 Initial Assessment of Plans (IAP).[1]

Specifically, SES Water has asked us to review the basis for Ofwat's proposed targets for leakage reduction over the next Asset Management Period (AMP), and the proposed funding arrangements for achieving leakage reduction.

Ofwat's Approach to Funding Leakage Reduction at PR19

Leakage reduction is a high-profile output provided by water companies, and has been given a great deal of prominence in Ofwat's "Delivering Outcomes for Customers" regime at PR19. Ofwat therefore expected companies "to propose stretching performance commitment levels for leakage".[2]

At PR19, Ofwat requires all companies to have a Performance Commitment (PC) and a financial Outcome Delivery Incentive (ODI) for leakage. Ofwat standardises the definition of leakage targets and prescribes a method for how companies should set their target at PR19, or justify why they have not adopted the prescribed method. Ofwat "expect[s] companies to propose forecast upper quartile performance levels" for four PCs, including leakage. [3]

As well as its expectation that companies propose UQ performance, it also sets out instructions on the minimum target for leakage improvement that companies are required to achieve,[4] including that the target must be for at least 15 per cent reduction, "one percentage point more than the largest reduction commitment at PR14",[5] and to "achieve the largest actual percentage reduction achieved by the company since PR14".[6]

Ofwat has not allowed the enhancement expenditure for leakage reduction requested by half of the companies for achieving the leakage reduction targets set out in their business plans. However, Ofwat partially allowed enhancement expenditure for leakage reduction by 10 companies forecasting leakage reduction beyond defined thresholds.

1 Ofwat (January 2019), PR19 initial assessment of plans.

2 Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 65.

3 Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 61 and page 65.

4 Ofwat namely states that "Companies should set stretching leakage performance commitment levels to: […] achieve at least achieve at least a 15% reduction in leakage (one percentage point more than the largest reduction commitment at PR14) – or justify why this is not appropriate". Source: Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 65.

5 Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 65

6 Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 65

By disallowing companies' enhancement expenditure below its target, Ofwat has proposed that companies should fund leakage reduction through their base cost allowances.[7] Ofwat's stated rationale for this approach to funding leakage reduction is that: "[c]ustomers should not pay extra costs for companies to deliver stretching targets" for leakage reduction.[8]

As we set out in this report, there are several reasons why Ofwat's proposed funding for leakage reduction will not result in regulated revenues sufficient for companies to finance the efficient costs of meeting the "stretching" PCs on leakage reduction which Ofwat has itself asked companies to target.

Ofwat's Base Allowances Do Not Allow Funding of Leakage Reduction to Attain the More "Stretching" PR19 Targets

It may be intuitively appealing for Ofwat to argue that companies have been reducing leakage in recent years, so base allowances calibrated to historical levels of expenditure must necessarily fund ongoing leakage reduction. However, as we explain in this report, this statement rests on assumptions that do not hold in reality.

It is correct that some companies have reduced leakage during the historical period over which Ofwat calibrated its econometric models. Also, cost targets established through comparative benchmarking may (to some extent) identify the level of leakage expenditure required to minimise water companies' costs.

However, the econometric modelling performed to set base allowances has a number of limitations that mean it will not identify the level of expenditure required to achieve leakage targets set over the next AMP. They do not identify how the optimal level of leakage varies over companies, they may be distorted by variation in companies' historical investment cycles, and they do not capture the required increase in leakage reduction activity by the industry over the next AMP.

We have conducted empirical analysis that supports these arguments, demonstrating that controlling for differences between companies' actual leakage and SELL has a statistically significant impact on companies' costs.

We have also shown that the marginal cost of leakage reduction rises as companies reduce leakage to lower levels than observed historically, which is another factor not accounted for by Ofwat's base expenditure modelling.

We therefore conclude that base expenditure forecasts generated from Ofwat's models will systematically understate companies' investment requirements in a period in which companies are accelerating the rate of leakage reduction, as they will not capture the required step-change in companies' leakage reduction expenditure.

7 Ofwat rejected enhancement expenditure for reducing leakage for Bristol Water, SES, Severn Trent, South East Water, South West Water, Southern Water, Wessex Water, Yorkshire Water. Source: Ofwat (2019), Action summary tables for each affected company.

8 Ofwat (January 2019), PR19 initial assessment of plans, Technical appendix 2: Securing cost efficiency, page. 18.

Failure to Allow for Enhancement Expenditure to Fund Leakage Reduction Contradicts with Ofwat's Approach at PR14 and Regulatory Precedent

Ofwat's decision not to provide companies with allowances for enhancement to bridge the gap between SELL and its "stretched" leakage targets means that the funding package as a whole does not fund achievement of the leakage reduction targets. In essence, there is an inconsistency between Ofwat's cost allowances (both base allowances and enhancement) and its targets.

By contrast, there was no such inconsistency in Ofwat's approach at PR14, as PCs for leakage reduction were set to reflect local conditions affecting leakage/SELL, with funding for companies stretching their performance beyond the PCs coming through ODIs. Past regulatory determinations by Ofgem have also allowed companies to recover the costs of new regulatory requirements that trigger significant investment.

Ofwat's Single Median Unit Cost Approach to Enhancement Funding is Flawed

Ofwat's approach of allowing enhancement expenditure based on a single median unit cost across the industry is flawed on several grounds.

Ofwat' single unit cost approach fails to capture any potential variation across companies' marginal costs because of differences in the costs companies face to reduce leakage, and the level of leakage reduction efforts conducted historically. It also fails to capture the tendency of unit costs to be increasing for maintaining or attaining lower levels of leakage.

Ofwat's approach may undermine companies' incentives to reduce leakage at least-cost, as companies achieving the median do not benefit from doing so in terms of higher allowances.

Also, Ofwat's allowed unit cost for leakage reduction is based in part on ODI out/underperformance rates proposed by companies, which tend to capture marginal benefits, which as Ofwat itself notes are likely to be less than marginal costs. ODI rates are also scaled by a 50 per cent sharing factor, so Ofwat's calculation may understate the efficient unit costs of leakage reduction.

We Recommend Changing the Funding Package for Leakage Reduction to Allow Companies to Recover Efficiently Incurred Costs

Based on the above, change to Ofwat's funding package for leakage reduction is therefore required to ensure companies can fund the efficient costs of meeting the industry's leakage reduction targets. One option would be to develop its cost assessment modelling tools, so that companies' base allowances better-reflect the growing need for work to reduce leakage. Alternatively, Ofwat could revise its "gated" approach to allowing companies' claims for enhancement expenditure to reduce leakage in a way that provides funding for them to bridge the gap between their proposed PCs and the levels of leakage reduction activity conducted historically.

We have also shown that the marginal cost of leakage reduction rises as companies reduce leakage to lower levels than observed historically, which is another factor not accounted for by Ofwat's base expenditure modelling, or its allowances for enhancement expenditure for companies exceeding the target.

A possible solution to this problem could lie in modelling more thoroughly the unit cost of leakage reduction, as a function of the levels of leakage reduction companies target and other factors influencing the cost of leakage reduction. Essentially, we recommend that Ofwat considers improving on its approach of basing allowances on proposed ODI rates (which are in any event inappropriate as a guide to the cost of leakage reduction) and industry median unit costs.

1. Introduction

NERA Economic Consulting (NERA) has been commissioned by SES Water, in collaboration with Affinity Water, Anglian Water, Dwr Cymru, South East Water, South Staffs Water, Southern Water, Thames Water and Yorkshire Water, to review the Office for Water Services' (Ofwat) PR19 Initial Assessment of Plans (IAP).[9]

Specifically, SES Water has asked us to review the basis for Ofwat's proposed targets for leakage reduction over the next Asset Management Period (AMP), and the proposed funding arrangements for achieving leakage reduction.

This report is structured as follows:

- Chapter 2 provides an overview of Ofwat's IAP proposals on how to set targets for leakage reduction and how to fund companies' leakage reduction efforts;
- Chapter 3 assesses the extent to which Ofwat's approach to setting base allowances funds companies' proposed leakage reduction targets;
- Chapter 4 assesses whether Ofwat's approach to appraising companies' requests for enhancement expenditure funds leakage reduction targets;
- Chapter 5 assesses Ofwat's approach to setting the allowed unit cost of leakage reduction; and
- Chapter 6 concludes and makes recommendations.

9 Ofwat (January 2019), PR19 Initial Assessment of Plans.

2. Overview of Ofwat's IAP Proposals on Leakage

2.1. Background on Ofwat's Leakage Proposals

Leakage reduction is a high-profile output provided by water companies, and has been given a great deal of prominence in Ofwat's "Delivering Outcomes for Customers" regime at PR19. Ofwat therefore expected companies "to propose stretching performance commitment levels for leakage".[10]

At PR19, Ofwat requires all companies to have a Performance Commitment (PC) and a financial Outcome Delivery Incentive (ODI) for leakage. Ofwat standardises the definition of leakage targets and prescribes a method for how companies should set their target at PR19, or justify why they have not adopted the prescribed method. Ofwat "expect[s] companies to propose forecast upper quartile performance levels" for four PCs, including leakage.[11]

As well as its expectation that companies propose UQ performance, it also sets out instructions on the minimum target for leakage improvement that companies are required to achieve,[12] including that the target must be for at least 15 per cent reduction, "one percentage point more than the largest reduction commitment at PR14",[13] and to "achieve the largest actual percentage reduction achieved by the company since PR14".[14]

At PR14, Ofwat also required all companies to set common targets on leakage.[15] However, Ofwat did not intervene to standardise targets for all companies, or set targets to reflect an UQ level of performance. In response, most companies proposed caps and collars and deadbands on the incentive, to limit rewards and penalties if outturn leakage diverged materially from the PC.

By specifying a 15 per cent leakage reduction target at PR19, Ofwat has diverged from the approach it expected companies to use when setting leakage targets at PR14. Ofwat accepted lower leakage reduction targets at PR14 "because companies' proposals on leakage aligned with the sustainable economic level of leakage (SELL) and local issues (such as availability of water resources and statutory abstraction reductions) significantly influence the SELL".[16] Under the SELL approach at PR14, companies set leakage targets such that the marginal cost

[10] Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 65.

[11] Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 61 and page 65.

[12] Ofwat namely states that "Companies should set stretching leakage performance commitment levels to: […] achieve at least achieve at least a 15% reduction in leakage (one percentage point more than the largest reduction commitment at PR14) – or justify why this is not appropriate". Source: Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 65.

[13] Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 65

[14] Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 65

[15] Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 8.

[16] Ofwat (December 2014), Setting price controls for 2015-20, Final price control determination notice: policy chapter A2 - outcomes, page. 21.

of water leakage would equal to the marginal cost of leakage control, reflecting both the private costs (i.e. the operating and capital costs of leakage control) and the external social and environmental costs of leakage.

By contrast, at PR19 Ofwat is now concerned that the SELL approach "has not driven sufficient efficiency improvements or innovation in leakage reduction", and that it therefore is no-longer a sufficient leakage target.[17]

Reflecting this Ofwat policy, companies proposed leakage reductions broadly in accordance with Ofwat's 15 per cent target in their PR19 business plans: the proposed reductions ranged between -14.4 per cent and -25.4 per cent.[18] Correspondingly, companies also requested additional enhancement expenditure to fund the leakage reduction targets, which "stretched" beyond the SELL that reflects local conditions.[19]

2.2. Ofwat's Approach to Funding Leakage Reduction

In its IAP, Ofwat does not grant enhancement expenditure allowances for reducing leakage to seven companies,[20] stating that "Customers should not pay extra costs for companies to deliver stretching targets. The delivery of stretching performance is to be funded from base costs".[21]

During its webinar, Ofwat further clarified its position stating that companies' have been engaging in "network maintenance and leakage reduction" in the past and therefore the costs of these activities "are included in […] base allowances".[22] To support its statement, Ofwat mentions that two companies have not requested enhancement funding to deliver the 15 per cent leakage reduction target, and that the 3 fast tracked companies "have accepted [Ofwat's] base allowance to achieve a 15% leakage reduction".[23]

Ofwat defines base costs as "routine, year on year costs, which companies incur in the normal running of their business" including operational and capital maintenance costs.[24] The base cost allowance consists of an unmodeled and a modelled cost component, with the modelled component determined by an econometric benchmarking exercise (see Section 3.1).

While Ofwat rejected many companies' requests for enhancement allowances to fund leakage reduction, Ofwat partially approved enhancement expenditure to support leakage reduction

17 Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 63.

18 Ofwat (January 2019), Supply-demand balance enhancement: Feeder model summaries, page. 13.

19 Ofwat describes the leakage reduction targets at PR19 as "stretching performance commitment levels for leakage". Source: Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 65.

20 This includes: Affinity Water, Hafren Dyfrdwy, SES Water, Southern Water, South West Water, United Utilities Water and Wessex Water. Ofwat (January 2019), Supply-demand balance enhancement: Feeder model summary, page 16.

21 Ofwat (January 2019), PR19 initial assessment of plans, Technical appendix 2: Securing cost efficiency, page. 18.

22 Ofwat (7 February 2019), Ofwat webinar: Securing cost efficiency, Q&A, p.3.

23 Ofwat (7 February 2019), Ofwat webinar: Securing cost efficiency, Q&A, p.3.

24 Ofwat (January 2019), PR19 initial assessment of plans, Technical appendix 2: Securing cost efficiency, page. 9.

for 10 companies.[25] The partial funding is set by multiplying an allowed unit cost of leakage reduction (£1.6m/Ml/d) by an allowed volume of leakage reduction, conditional on passing one of two tests:

- If a company forecast leakage reduction in excess of the 15 per cent target, but does not achieve an upper quartile level of leakage, it receives funding for leakage reduction *beyond* 15 per cent.
- If a company achieves the upper quartile level of leakage by 2024-25, in both normalised measures (per km of main and per property), it receives funding for leakage reduction *beyond* the upper quartile level.
- If a company passes both the above tests, it receives the maximum of the funding under the two tests.

Ofwat has set the allowed unit cost of leakage reduction that applies to allowed enhancement expenditure through its Supply-Demand Balance (SDB) enhancement modelling that uses data from companies' business plans. The proposed allowed unit cost at PR19 is £1.6m/Ml/d, and is the average of: [26]

- median leakage unit costs derived from the PR19 SDB enhancement analysis;
- median incentive rate for underperformance reported in companies' business plans; and
- median incentive rate for outperformance reported in companies' business plans.

2.3. Conclusion

Ofwat has disallowed the enhancement expenditure for leakage reduction requested by half of the companies for achieving the leakage reduction targets set out in their business plans. However, Ofwat partially allowed enhancement expenditure for leakage reduction by 10 companies forecasting leakage reduction beyond defined thresholds, with allowances calculated at an allowed unit cost set by Ofwat, multiplied by the volume beyond the threshold.

By disallowing companies' enhancement expenditure below its target, Ofwat has proposed that companies should fund leakage reduction through their base cost allowances. Ofwat defines base cost as "routine, year on year cost, which companies incur in the normal running of their business", and estimates the efficient level of base costs through five econometric benchmarking models.[27]

Ofwat's stated rationale for this approach to funding leakage reduction is that: "[c]ustomers should not pay extra costs for companies to deliver stretching targets" for leakage reduction.[28]

[25] This includes: Anglian Water, Bristol Water, Northumbrian Water, Portsmouth Water, South East Water, South Staff Water, Severn Trent Water, Thames Water, Welsh Water, Yorkshire Water. Source: Ofwat (January 2019), Supply-demand balance enhancement: Feeder model summary, page 16.

[26] Ofwat (January 2019), Supply-demand balance enhancement: Feeder model summary, page. 15.

[27] Ofwat (January 2019), PR19 initial assessment of plans, Technical appendix 2: Securing cost efficiency, page. 9.

[28] Ofwat (January 2019), PR19 initial assessment of plans, Technical appendix 2: Securing cost efficiency, page. 18.

As we discuss in the sections below, there are several reasons why Ofwat's proposed funding for leakage reduction will not result in regulated revenues sufficient for companies to finance the efficient costs of meeting the "stretching" PCs on leakage reduction which Ofwat has itself asked companies to target.

3. Assessing the Funding of Leakage Reduction through Base Allowances

As explained above, Ofwat states that its base allowances are sufficient to fund companies' leakage reduction targets. In this section, we therefore review Ofwat's econometric methods and assess whether its approach to setting base allowances will produce revenues sufficient for efficiently operated companies to fund the leakage reduction targets Ofwat has set. As discussed below, in performing this assessment, we consider factors such as the ability of Ofwat's models to control for the determinants of companies' leakage performance, as well as the effects of different historical leakage reduction expenditure and investment cycles across companies.

3.1. Econometric Models Used to Set Base Allowances

Ofwat set total expenditure (totex) allowances for each company using four main building blocks:[29]

- *modelled base cost*, including operating and capital maintenance expenditure;
- *unmodeled base costs*, including business rates, abstraction charges, Traffic Management Act costs, wastewater industrial emissions directive costs;
- *enhancement costs* reported in PR19 business plans; and
- *adjustments* based on claims submitted by companies.

As discussed in Section 2, Ofwat proposes that water companies should fund leakage reduction through their base costs allowance.[30] Ofwat sets modelled base cost allowances for water through the following stages:

- Ofwat's econometric benchmarking models use historical data on base costs and drivers over a seven-year period between 2011-12 to 2017-18. Ofwat constructs 5 econometric models with different cost and cost driver specifications. It regresses "botex" (operating expenditure excluding unmodeled opex, plus capital maintenance) on selected cost drivers, with cost drivers selected to reflect the scale, complexity, topography and density of a water network (see Table 3.1).
- Ofwat then calculates each company's efficiency score, the ratio of each company's actual botex in the modelling period to its modelled botex. It then ranks companies' efficiency score and selects the upper quartile value (95.2 per cent, set by South West Water) to be used as the efficiency challenge during AMP7. This efficiency target "triangulates" the results from Ofwat's 5 econometric models.
- Next, Ofwat forecasts levels of cost drivers for AMP7, generally by extrapolating trends from the historical period, and multiplying forecast drivers by the estimated model coefficients to generate modelled AMP7 botex for each company.

[29] Ofwat (January 2019), PR19 initial assessment of plans, Technical appendix 2: Securing cost efficiency, page. 7-8.

[30] Leakage reduction is not a component of unmodeled base costs, hence modelled base costs is the relevant building block for assessing whether the base cost allowance provides adequate funding for companies' leakage PCs.

- Ofwat then multiplies modelled AMP7 botex by (1) the efficiency challenge of 95.2 per cent; and (2) an ongoing productivity or frontier shift of 1.5 per cent cost reduction per annum. This calculation produces Ofwat's view of efficient modelled WW botex.
- Finally, Ofwat adds any company-specific factors which are not adequately controlled for by the econometric models (known as "cost adjustment claims") as well as allowances for unmodelled botex to arrive at a final view of efficient botex.

Table 3.1: Cost Drivers Included in Ofwat's Econometric Models for WW

Category	Cost Driver
Scale	Number of properties (log); or length of main (log)
Complexity	% of water treated at treatment works with complexity level 3 or higher; or weighted average treatment complexity level
Topography	Number of booster pumping stations / length of main (log)
Density	Weighted average density (log); and squared term of log of weighted average density

Source: Ofwat[31]

3.2. The Exclusion of Enhancement from the Definition of Botex

Ofwat's own definition of botex suggests that its base allowances do not allow funding of leakage to attain more "stretching" PR19 targets.

At PR14 Ofwat set companies' total expenditure (totex) allowance by relying on modelled totex which included operating expenditure and capital expenditure, defined as including both capital maintenance and enhancement expenditure. Any expenditure to reduce leakage beyond base levels would have been captured by enhancement expenditure and therefore be included in baseline modelled costs.

At PR19, Ofwat has decided not to use totex benchmarking and as described above, opted to set companies' modelled cost using "botex" as a dependent variable in the econometric models, i.e., operating costs plus capital maintenance.

According to the Regulatory Accounting Guidelines (RAGs), at PR19 capital expenditure is defined as "expenditure to maintain the long-term capability of the assets and to deliver base levels of service".[32] Any capital expenditure therefore deployed to deliver levels of service beyond the base, including expenditure to reduce the levels of leakage beyond the base, is classified as "enhancement expenditure".[33] It follows that Ofwat's botex models will not account for the any expenditure that is required to deliver enhancements in the level of

[31] Ofwat (January 2019), PR19 initial assessment of plans, Supplementary technical appendix, Econometric approach, page. 12-14.

[32] Ofwat (November 2017), RAG 4.07 – Guideline for the table definitions in the annual performance report, p.12.

[33] Ofwat's RAG also note that "Where projects have drivers both of enhancement and capital maintenance, companies should apply a method of proportional allocation to allocate costs between enhancement and capital maintenance". Source: Ofwat (November 2017), RAG 4.07 – Guideline for the table definitions in the annual performance report, p.12.

leakage of companies. This contradicts Ofwat's own assertion that companies' leakage reduction efforts "are included in […] base allowances".[34]

3.3. The Ability of Ofwat's Models to Fund Current Levels of Leakage

3.3.1. The levels of leakage achieved by each company will affect their performance in comparative benchmarking models

Leakage rates are (to some extent) within management control, and choices made about companies' target levels of leakage reduction may affect their performance in comparative benchmarking models.

If companies minimise their own costs, and the models capture the drivers of leakage, then the base allowances emerging from the models will fund the levels of leakage consistent with minimising water companies' own costs. However, as we explain below, this conclusion does not hold in practice and Ofwat's models may fail to fund efficient leakage reduction.

3.3.2. In practice, companies do not target the least cost level of leakage

In practice, over Ofwat's cost assessment period companies have not been targeting the least-cost level of leakage, but targeted levels of leakage that are consistent with the Sustainable Economic Level of Leakage (SELL) and other local issues.

As noted in Section 2.1, the concept of SELL identifies the point at which companies set leakage targets such that the marginal cost of water leakage equals to the marginal cost of leakage control. This definition captures both the operating and capital costs of the company to control leakage, and the *external* social and environmental costs of leakage. These include for instance the environmental impact of reduced leakage (e.g. the benefit of reduced abstraction), the environmental and social impact of leakage control (e.g. disruptions, low pressure) and the carbon impact of leakage and active leakage management (the cost of carbon due to electricity/fuels for power for abstraction, treatment and pumping).[35]

A 2012 study by the Environment Agency, Ofwat and Defra acknowledges that "a key factor in determining SELL is believed to be costs which are external to the company".[36] The study highlights that although these factors may "have a relatively small impact on the calculation of SELL", they should be accounted for in setting leakage targets.[37] In line with Ofwat's PR14 decision, companies included measures of external costs when setting SELL and their leakage targets.[38]

[34] Ofwat (7 February 2019), Ofwat webinar: Securing cost efficiency, Q&A, p.3.

[35] Environmental Agency, Ofwat and Defra (October 2012), Review of the calculation of sustainable economic level of leakage and its integration with water resource management planning, page 14-15.

[36] Environmental Agency, Ofwat and Defra (October 2012), Review of the calculation of sustainable economic level of leakage and its integration with water resource management planning, page 5.

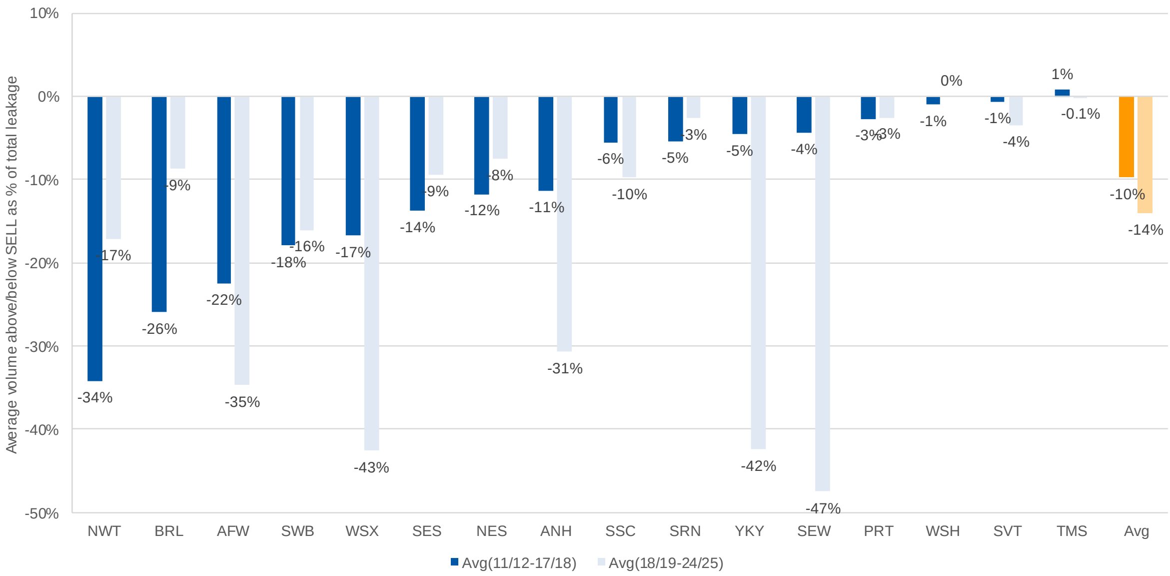
[37] Environmental Agency, Ofwat and Defra (October 2012), Review of the calculation of sustainable economic level of leakage and its integration with water resource management planning, page 7.

[38] Ofwat states: "The final methodology statement specifically required companies to include incentives in only two areas. These were: leakage, reflecting its importance to customers and the potential environmental and efficiency benefits of

Leakage targets set to achieve SELL are therefore calibrated to provide other benefits to society beyond minimising water companies' costs, so achieving SELL implies companies will reduce leakage beyond the level that would optimise their performance in econometric benchmarking models.

In practice, as Figure 3.1 shows, over Ofwat's cost assessment period (2011/12 – 2017/18) all companies have been operating on average below SELL, except for Thames Water which has been operating marginally above SELL.[39] Likewise, over the next AMP on average companies across the industry forecast that they will remain below SELL.[40]

Figure 3.1: Collectively Companies Have Been Operating Below SELL Over the Cost Assessment Period (2011/12 – 2017/18)



Source: NERA analysis of Ofwat's Stata Input file for water.

Therefore, because companies have been operating beyond the level of leakage that minimises companies' own costs, companies achieving the lowest levels of leakage will tend to appear less efficient in Ofwat's modelling as a result. Moreover, target levels of expenditure implied by Ofwat's modelling are likely to be influenced by those companies which relatively high levels of leakage, closer to the levels that minimise water companies' private costs.

As we explain in Section 3.4.4, Ofwat implicitly acknowledges this feature of its modelling to set base allowances by allowing Anglian Water a cost adjustment for achieving and maintaining lower levels of leakage.

its reduction". Source: Ofwat (December 2014), Setting price controls for 2015-20, Final price control determination notice: policy chapter A2 – Outcomes, page10.

39 Note the figure provides for each company the total volume of leakage above/below SELL as a percentage of total leakage over the 2011/12 – 2017/18 period.

40 Note the figure provides for each company the total volume of leakage above/below SELL as a percentage of total leakage over the 2018/19 – 2024/25 period.

3.3.3. Ofwat's models also fail to capture the differences between companies that affect the least cost level of leakage

Ofwat's selection of cost drivers (see Table 3.1) has a material effect on what proportion of variation in companies' costs appear to be inefficient.

Some of the variables included in Ofwat's benchmarking models may be related to the amount of leakage companies experience. For instance, companies with longer mains or more customers may have higher underlying levels of leakage. However, none of the variables included in the botex models control directly for *normalised* leakage, i.e. a measure of leakage volumes that controls for differences in companies' scale.

None of the cost drivers included in Ofwat's models reflect companies' historical efforts to reduce leakage. Ofwat decided not to include cost drivers in its models which reflect leakage directly. Ofwat did not include the volume of water treated as cost driver, as companies can influence it "through leakage reduction and water efficiency schemes, which [Ofwat] wish[es] to incentivise".[41] Instead, Ofwat selected length of mains and number of connections as the "scale" cost drivers, as discussed in Section 3.1.

In a similar vein, Ofwat's cost drivers fail to capture characteristics of water companies' assets like the age, condition and type of mains, which influence efficient levels of leakage and the costs of leakage reduction and are largely driven by asset inheritance. Also, for companies serving areas of the country with a relatively tight supply-demand balance, it might be economic to target lower levels of leakage as the value of the water lost through leakage is greater.

Ofwat argued against including the volume of water abstracted as a cost driver because it is under management control through leakage reduction, and hence "could send the wrong signal or create a perverse incentive for the regulated companies":[42] Ofwat explains the perverse incentives as "the model will imply higher costs for the company that is less water efficient (and therefore abstracts more water)".

Failure to account for variation in leakage across companies was one of the reasons cited by the CMA in support of its conclusion that Ofwat's PR14 cost assessment "did not adequately reflect Bristol Water's costs".[43] One of CMA's recommendations was to define cost drivers in terms of distribution input per household. The CMA stated that one improvement of this decision that it "does not overlook the additional costs of achieving lower levels of leakage".[44]

41 Ofwat (January 2019), PR19 initial assessment of plans, Supplementary technical appendix, Econometric approach, page 12.

42 Ofwat (March 2018), Cost assessment for PR19: a consultation on econometric cost modelling, page. 10.

43 CMA (6 October 2015), Bristol Water plc, A reference under section 12(3)(a) of the Water Industry Act 1991, Report, para. 24.

44 CMA (6 October 2015), Bristol Water plc, A reference under section 12(3)(a) of the Water Industry Act 1991, Report, para 4.135-4.136.

3.3.4. Ofwat's model cannot differentiate expenditure to reduce leakage from expenditure to maintain a relatively low level of leakage

Another reason why Ofwat's models may not fund efficient leakage reduction is the possibility of asynchronous investment cycles across companies.

Suppose two water companies that are otherwise identical have asynchronous investment cycles, the UQ target in Ofwat's base cost models will be set by those companies that happen to be conducting relatively little expenditure during the modelling period in question. Conversely, any company that is currently at a high-point in an investment cycle will appear relatively inefficient and be disadvantaged.

As described above, Ofwat's base allowance includes capital maintenance expenditure. The CMA noted at PR14 that, because capital maintenance includes "a greater proportion […] of non-recurring costs from year-on-year", "one year's capital maintenance, or even one regulatory period's capital maintenance, will not necessarily be a good predictor of the future".[45]

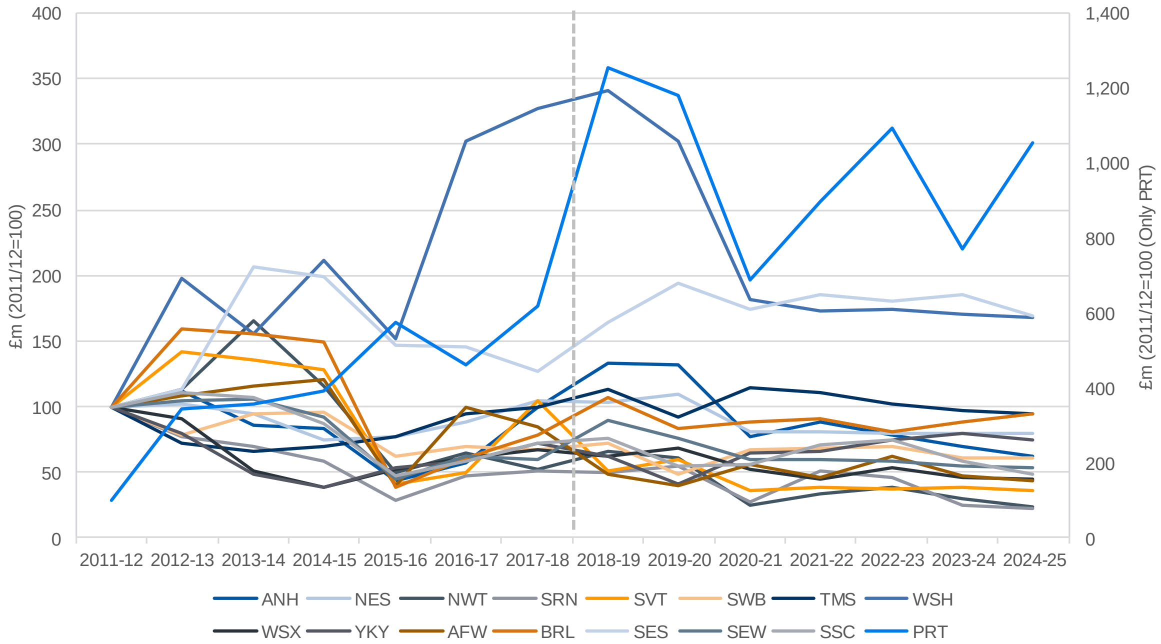
As Figure 3.2 shows, over Ofwat's relatively short assessment period capital maintenance is relatively lumpy and fluctuations in expenditure levels across companies do not appear to follow a synchronous pattern. Some companies such as Portsmouth Water, have increased capital maintenance expenditure over the modelling period, while other companies (e.g. Affinity Water) have reduced their capital maintenance expenditure.

A corollary of this feature of Ofwat's base cost models is that, if it is repeated over time and all companies have different investment cycles, the frontier will tend to be set by those companies that conduct relatively little capital expenditure at any point in time. Hence, if the benchmarking is conducted repeatedly, no company should expect to recover its efficient investment costs over the investment cycle as a whole.

Because companies' efforts to reduce leakage may entail lumpy expenditure (e.g. capital maintenance activities), differences in leakage reduction effort in a particular AMP could appear as inefficiency in Ofwat's models, and cost targets may be influenced by those companies performing relatively little leakage reduction work in a particular modelling period.

[45] CMA (6 October 2015), Bristol Water plc, A reference under section 12(3)(a) of the Water Industry Act 1991, Report, para. 124.

Figure 3.2: Capital Maintenance Expenditure Tends to be Lumpy and Asynchronous Across the Industry



Note: Portsmouth Water (PRT)'s capital maintenance expenditure is reported on the secondary axis.
Source: NERA analysis of Ofwat data.

3.3.5. Modelled allowances are probably determined by the companies spending least on leakage reduction during the modelling period

As we explain above, Figure 3.1 shows that companies have typically achieved a level of leakage close to, or beyond, SELL. Hence, most of the industry is probably achieving a level of leakage beyond the level that would minimise their own costs, which has historically been justified based on customers' preferences and the externalities associated with leakage. However, the benchmarking models do not capture differences in companies' leakage performance, or remunerate those choosing to go beyond SELL. Hence, those sustaining the lowest levels of leakage will tend not to be provided with base allowances to cover the costs of doing so.

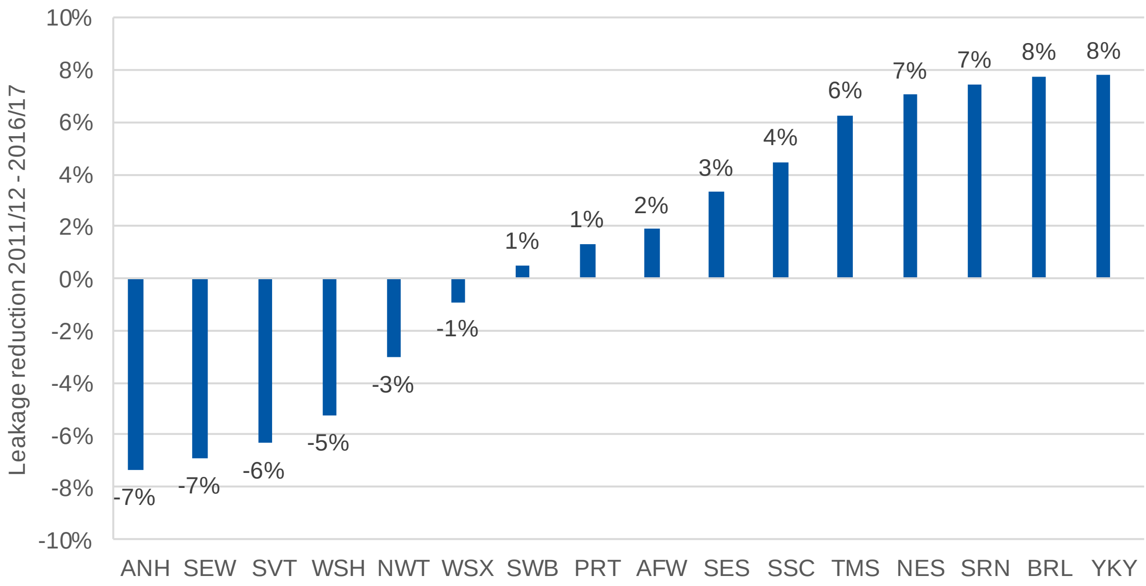
In addition to this evidence discussed in Section 3.3.1, the trajectory of leakage reduction also affects companies' expenditure. The expenditure targets emerging from Ofwat's models will tend to reflect the expenditure incurred during the historical modelling period to reduce leakage. If all companies had incurred similar levels of expenditure to reduce leakage during the historical modelling period, the allowances predicted for AMP7 would reflect a continued level of expenditure by company. However:

- Variation in companies' investment cycles, as we discuss in Section 3.3.4, means modelled costs will tend to be determined by the companies' spending relatively little to reduce leakage during the historical modelling period.

- Also, as Figure 3.3 below shows, half of all companies have increased or reduced leakage by less than 3 per cent over the 2011/12 – 2016/17 period.[46] As such, if the funding provided through the base allowances reflects the typical levels of leakage reduction achieved during the historical period, the base allowances for leakage reduction in AMP7 will continue to be minimal.

Therefore, Ofwat is wrong to argue that companies' have been engaging in "network maintenance and leakage reduction" in the past and therefore the costs of these activities "are included in […] base allowances".[47] Ofwat's base allowances will only tend to fund current levels of leakage and leakage reduction.

Figure 3.3: Leakage Reduction by Company Over the 2011/12 – 2016/17 Period



Source: NERA analysis of Ofwat's Stata Input datafile for water.

3.4. The Ability of Ofwat's Models to Fund PR19 Leakage Reduction Targets

While Section 3.3 explains that Ofwat's base allowances will fund companies for achieving current levels of leakage and historical rates of leakage reduction, we also consider below whether its approach will fund the more stretching levels of leakage reduction targeted by the industry at PR19.

46 2017/18 leakage data for some companies (e.g., SVT) is substantially different from leakage volumes in the previous years. We therefore rely on 2016/17 as the latest available year for total leakage volumes. However, we cross-check our results with leakage reduction over Ofwat's entire assessment period (2011/12 - 2017/18). Accordingly, we find that half of the companies experienced an increase in leakage volumes (in Ml/d), with only four water companies reducing total leakage by no more than 8 percent. Source: NERA analysis of Ofwat's Stata Input datafile for water.

47 Ofwat (7 February 2019), Ofwat webinar: Securing cost efficiency, Q&A, p.3.

3.4.1. Ofwat's approach to setting base allowances does not fund the more stretching PR19 leakage reduction targets

As explained in Section 3.2, Ofwat's selected drivers do not reflect variation – either across time or companies – in leakage reduction expenditure. As such, the predicted values from the models that define water companies' allowances will not change in a way that reflects changes in effort by the industry to reduce leakage.

Nonetheless, it would still be possible for Ofwat's base allowances to include the costs of leakage reduction, to the extent the historical cost data used to calibrate the model includes the required level of leakage reduction expenditure over the next AMP. However, this is not the case.

In fact, Ofwat expects companies to stretch their leakage reduction targets beyond the most ambitious leakage reduction proposal at PR14. As discussed in Chapter 2, Ofwat recommended that companies set 15 per cent leakage reduction targets between 2019-20 – 2024-25. This target is "one percentage point more than the largest reduction commitment at PR14".[48]

Ofwat's recommended target also represents a step change compared to recent historical leakage reduction performance. As Figure 3.3 above shows, none of the water companies in the sample have achieved a level of reduction of 15 per cent over Ofwat's cost assessment period. The largest reduction over the 2011-12 – 2016-17 period is equal to 7 per cent by Anglian Water, almost half the target set by Ofwat.[49]

It follows that models used by Ofwat to set base allowances will not produce predicted values that reflect the more stretching (unobserved) level of leakage reduction effort in the next AMP. Rather, they will reflect (at most) the historical efforts to reduce leakage during the modelling period.

3.4.2. Even if Ofwat's models included leakage reduction variables, they would still not reliably estimate the costs of meeting PR19 targets

Even if Ofwat's base cost models took leakage reduction into account, e.g. by including explanatory variables reflecting companies' historical leakage reduction efforts, the base cost allowance could still be inadequate to fund the efficient costs of Ofwat's proposed 15 per cent leakage target. The proposed leakage targets are higher than leakage reduction observed in the past, so the benchmarking method might not be able to capture the true cost of achieving the target because more rapid reductions in leakage could be costlier than leakage reduction efforts in the past. In essence, Ofwat's modelled allowances are likely to be unrealistic if they are used for "out of sample" prediction when using models calibrated using historical data to predict how leakage reduction costs will change in the future.

[48] Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, page. 65

[49] 2017/18 leakage data for some companies (e.g., SVT) is substantially different from leakage volumes in the previous years. We therefore rely on 2016/17 as the latest available year for total leakage volumes. However, we cross-check our conclusions using 2017/18 data and find that largest reduction over the entire assessment period is equal to 8 percent, i.e., around half of the reduction target requested by Ofwat.

As shown above and further below, the level of leakage (in percentage terms) that Ofwat is targeting for the industry has not been observed in the historical data used to calibrate its model. Requiring companies to reduce leakage to new lows in relative terms could increase the marginal cost of achieving and sustaining its desired leakage reduction targets, as companies undertake more expensive measures to reduce leakage.

3.4.3. Ofwat's base allowances fail to consider that more demanding PCs are associated with more expensive leakage reduction schemes

A further reason why Ofwat's models may not provide a sound basis for predicting how the costs of leakage reduction efforts will change is that they fail to capture the tendency for the marginal cost of leakage reduction to rise as companies reduce leakage further beyond SELL.

As noted above, Ofwat's cost models set base allowances that cover the costs associated with (at most) existing levels of effort in the industry to reduce leakage, which as Figure 3.3 shows, means its base allowances will only fund very low levels of leakage reduction.

However, in addition to this problem, Ofwat's models fail i) to account for the incremental cost of achieving leakage reduction beyond SELL, and ii) to capture any potential variation across companies' incremental costs because of differences in companies' leakage control programmes. For instance, companies that have attained SELL may incur higher incremental costs for any additional unit of leakage reduction; compared to companies that have not achieved SELL.

In practice, there are a range of leakage reduction measures companies can undertake. First, at high levels of leakage, companies may implement "find and fix" processes and pressure management that have low marginal costs. Then, once all leakage reduction achievable through such measures has been achieved, companies may resort to more ambitious and innovative solutions (e.g. accelerating their mains replacement programmes) to achieve more ambitious leakage reduction targets. Hence, companies face an "upward sloping supply curve" of leakage reduction projects, with an increasing marginal cost of leakage reduction as they target lower levels of leakage.

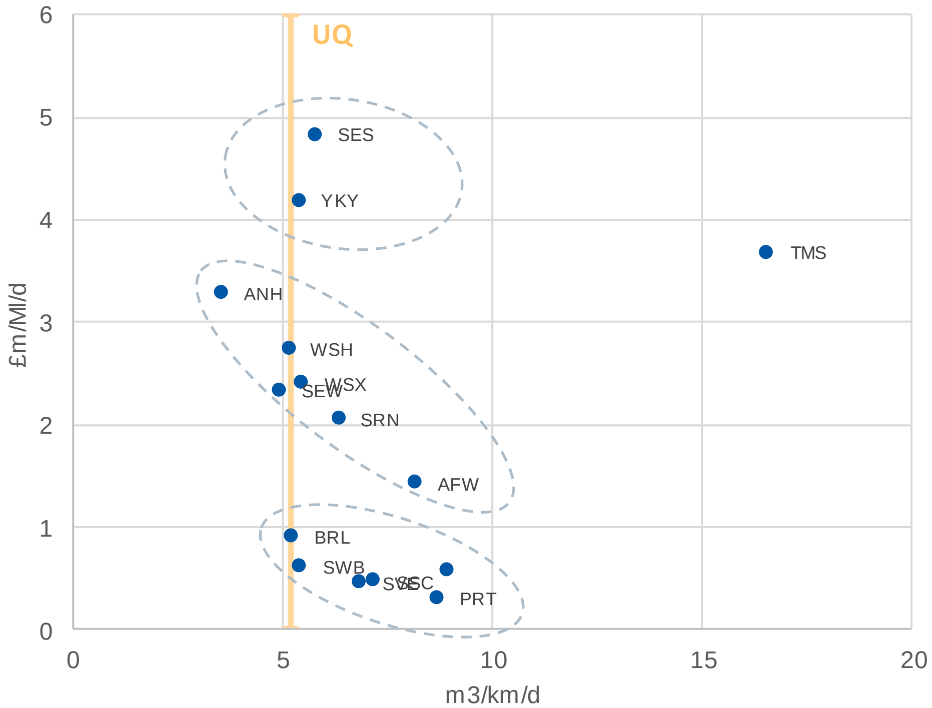
The slope of each company's "supply curve" of leakage reduction projects will also differ because of other factors, e.g. network configuration, geography, network age etc. For instance, companies with a larger proportion of older networks may have to resort more quickly, i.e. at lower leakage reduction targets, to expensive leakage reduction solutions like accelerated mains replacement.

In its IAP, Ofwat defined the UQ performance by using two measures of leakage which control for scale: litres per property per day (l/prop/d) and cubic metre per kilometre per day (m3/km/d). Figure 3.4 and Figure 3.5 below show the relationship between companies' planned leakage targets at the end of PR19 (2024-25), after controlling for scale, and the marginal cost they expect to incur to provide these levels of leakage reduction. As the figures show, companies closer to the upper quartile leakage performance target tend to expect higher unit costs of leakage reduction compared to companies that are further away the UQ target. At lower levels of leakage reduction, marginal costs appear to be lower.

Optically, the negative correlations shown in the figures between unit costs and leakage rates appear relatively weak, suggesting other factors are also affecting companies' marginal costs of leakage reduction. However, this appearance of weak negative correlation may be misleading. For instance, there appear to be some outliers (notably Thames Water, possibly due to the relatively high costs of serving a dense urban area in London). Also, the scatter diagrams in the figures suggest downward sloping relationships between leakage levels and unit costs may exist for "clusters" of companies, as indicated by the dashed lines around some of the data points in the figure. Such clustering of companies may reflect factors such as differences in their asset inheritance, availability of water resources and statutory abstraction reductions.

However, despite these potential differences, we have tested the significance and direction of this effect by running a number of regressions of the unit costs of leakage reduction in £m/Ml/day on the level of leakage targeted at the end of the AMP,[50] measured in l/prop/day and m3/km/d and a cross-product term, using a simple cross-sectional Ordinary Least Squares regression across all companies, except Thames Water. We exclude Thames Water on grounds that it is an outlier based on a visual inspection of the scatterplots below. We find that there is a statistically significant negative relationship between companies' unit cost and leakage reduction (see Appendix A). This confirms that across all companies, excluding Thames Water, marginal costs tend to increase as leakage reduction targets become more stretching.

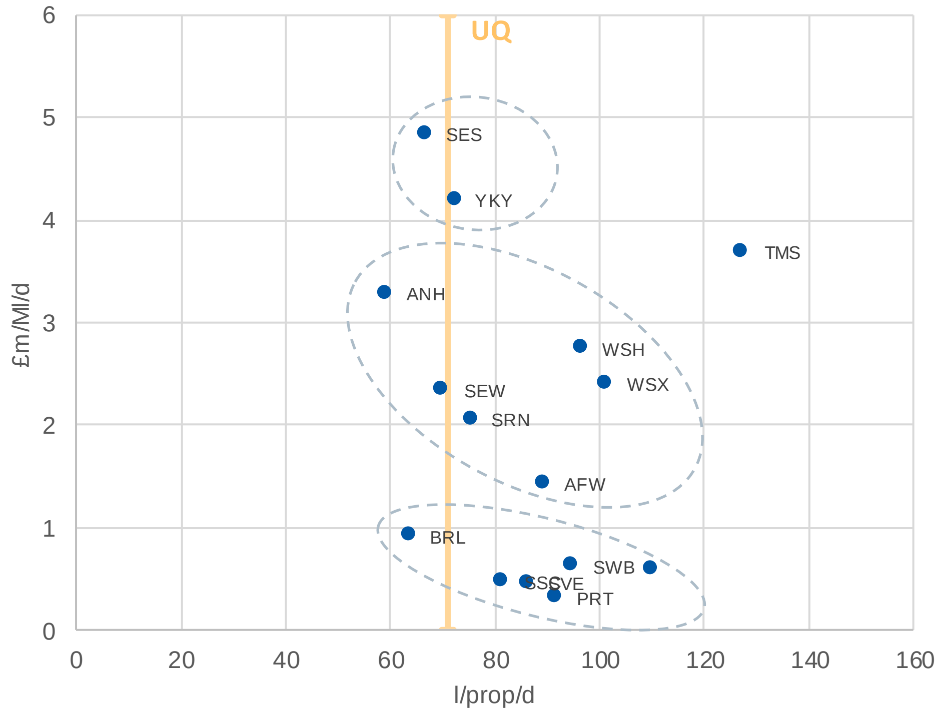
Figure 3.4: Correlation between Leakage Reduction Targets and Marginal Cost of Leakage Reduction Schemes



Source: NERA analysis of Ofwat data as reported in the Wholesale Water Supply-demand balance enhancement – feeder model.

50 Ofwat's test relies upon the forecast 3-year average leakage positions in 2024-25 that companies have provided as part of their common performance commitments. We have cross-check our results using this measure of leakage instead of leakage at the end of AMP7 (i.e., 2024-25). As Appendix A shows, the results are consistent across all models.

Figure 3.5: Correlation between Leakage Reduction Targets and Marginal Cost of Leakage Reduction Schemes



Source: NERA analysis of Ofwat data as reported in the Wholesale Water Supply-demand balance enhancement – feeder model.

Failure to account for this systematic relationship between companies' marginal cost of leakage reduction and the underlying level of leakage implies that Ofwat's base allowance, set using historical costs and drivers, does not reflect the true economic costs of achieving more demanding leakage reduction targets beyond SELL.

3.4.4. Anglian Water's special factor claim shows that Ofwat's base allowances would not fund leakage performance

Ofwat's IAP has already recognised the increasing marginal cost of achieving and sustaining lower levels of leakage in its assessment of a special factor claim submitted by Anglian Water. However, Ofwat has not recognised this feature of the cost pressures facing water companies in setting base allowances.

In its business plan submission, Anglian Water requested a special factor adjustment of £147.9 million over AMP7 to maintain frontier leakage performance.[51] Ofwat partially accepted Anglian Water's claim.[52] Anglian Water argued that it is currently at the frontier of the sector in terms of leakage reduction and that maintaining frontier leakage performance therefore "requires greater expenditure compared to maintaining, for instance, the industry

[51] Anglian Water, PR19 Water Data Tables Commentary, page 172.

[52] Ofwat, Excel file "M_CAC_ANH_IAP.xlsx".

average level of leakage".[53] Anglian Water's special factor claim therefore covers "the additional expenditure that will be required to maintain leakage at the current frontier level rather than at [SELL]".[54]

Anglian Water's special factor adjustment reflects the inability of Ofwat's base cost modelling to predict required expenditure levels to achieve more stretching (above-industry average) targets of leakage reduction at AMP7. By relying on historical costs and cost drivers, and not including leakage-specific cost drivers, Ofwat's cost modelling will therefore penalise companies with above industry-average leakage reduction rates by allowing lower base costs than actually required to meet such target. Conversely, all else equal, Ofwat's base allowance will be more generous for those companies that perform below industry average.

However, by accepting Anglian Water's cost adjustment claim Ofwat is implicitly acknowledging increasing marginal costs of maintaining and/or achieving low levels of leakage and that base allowances not capture this feature of companies' incremental leakage costs.[55]

3.5. Empirical Assessment of the Impact of Leakage on Modelled Efficiency Gaps

As set out above, Ofwat's models may conflate companies' level of leakage performance (relative to SELL) and/or their leakage reduction efforts during the modelling period with variation in companies' relative efficiency. Specifically, the omission of companies' efforts to reduce leakage to a level beyond SELL means the predicted values generated from the modelling cannot reflect the costs companies will incur to further reduce leakage over the next AMP. As such, Ofwat's models do not fund through base allowances the increased level of leakage reduction that companies and Ofwat are targeting.

While the theoretical basis for this argument is clear from examining Ofwat's model specifications, we have also demonstrated this empirically by adding leakage reduction beyond SELL into Ofwat's Treated Water Distribution (TWD) and Wholesale Water (WW) econometric models. To do this, we took data on companies' historical SELL and leakage reduction from Ofwat's PR19 input files, and tested whether this factor has a material effect on companies' botex in a number of ways.

First, we regressed the residuals from Ofwat's TWD model on the difference between companies' SELL and leakage. We perform this calculation in Ml/day (i.e. in levels) because for some companies this variable is negative, so cannot be logged (Model 1a in Table 3.2). We include the difference between SELL and leakage in both linear and squared form, to capture the possibility that, as leakage falls further from SELL, the marginal cost of reducing and maintaining lower levels of leakage could rise (see Section 5).

As the results below show, we find that the coefficients on the linear and quadratic terms of the difference between SELL and leakage are statistically significant at the 5 and 10 per cent significance levels respectively. They are also positive, suggesting companies with leakage

53 Anglian Water, PR19 Water Data Tables Commentary, page 174.

54 Anglian Water, PR19 Water Data Tables Commentary, page 172.

55 Ofwat, Excel file "M_CAC_ANH_IAP.xlsx".

performance beyond SELL have higher costs than companies with leakage closer to SELL, and the further beyond SELL companies reduce leakage, the more their costs tend to rise.

To test the effect of logging this variable, we also regressed residuals from Ofwat's TWD model on the natural logarithm of the difference between SELL and leakage, plus 200 Ml/day (Model 1b in Table 3.2). The purpose of adding 200 Ml/day was to ensure this variable was positive for all companies so we could run the model in logarithmic form.[56] As for Model 1a in which we include these variables without logging them, we find positive and statistically significant coefficients at the 10 per cent significance level.

We have also included these same variables directly within the Ofwat TWD and WW models, as shown in Table 3.2. In all cases, we find that including these variables gives statistically significant coefficients. The impact on the other modelled coefficients is relatively small, as the results below show. We also find no material changes in the statistical robustness tests applied by Ofwat. For instance, like Ofwat's base models, none of these adapted models violate the Ramsey RESET or normality of errors tests.

56 We have added a value of 200Ml/day to ensure positive values for this variable (necessary for a logarithmic transformation). However, any other larger number would achieve the same affect, and the choice of any adder is inherently arbitrary. The choice affects the estimated elasticities but not the underlying relationship, so we tested the effect of adding (arbitrarily) 1,000 instead of 200, and found it made little difference to our finding of statistically significant coefficients.

Table 3.2: Econometric Modelling of the Link Between (SELL-Leakage) on Companies' TWD and WW Botex

Model Description:	**(1a) Residuals + Leakage1**	**(1b) Residuals + Leakage2**	**(2) Ofwat TWD Model**	**(2a) = (2) + Leakage1**	**(2b) = (2) + Leakage2**	**(3) Ofwat WW1 Model**	**(3a) = (3) + Leakage1**	**(3b) = (3) + Leakage2**	**(4) Ofwat WW2 Model**	**(4a) = (4) + Leakage1**	**(4b) = (4) + Leakage2**
Dependent Variable:	**Ofwat TWD Model Residuals**	**Ofwat TWD Model Residuals**	**TWD Botex (Log)**	**TWD Botex (Log)**	**TWD Botex (Log)**	**WW Botex (Log)**	**WW Botex (Log)**	**WW Botex (Log)**	**WW Botex (Log)**	**WW Botex (Log)**	**WW Botex (Log)**
Independent Variables:											
Leakage above SELL	0.00133**			0.00149**			0.00141***			0.00145***	
	(0.000666)			(0.000706)			(0.000353)			(0.000338)	
Sq Leakage above SELL	5.97e-06*			7.27e-06**			1.08e-05***			1.08e-05***	
	(3.49e-06)			(3.31e-06)			(2.16e-06)			(2.14e-06)	
Leakage above SELL + 200 (Log)		-1.544*			-1.794**			-1.836***			-1.834***
		(0.926)			(0.875)			(0.517)			(0.514)
Sq Leakage above SELL + 200 (Log)		0.175*			0.202**			0.200***			0.200***
		(0.105)			(0.0998)			(0.0581)			(0.0573)
Lengths of Main (Log)			1.013***	1.016***	1.019***						
			(0.0277)	(0.0280)	(0.0278)						
Boosters per Length (Log)			0.465***	0.463***	0.460***	0.515***	0.534***	0.533***	0.517***	0.531***	0.529***
			(0.150)	(0.151)	(0.151)	(0.122)	(0.127)	(0.126)	(0.0976)	(0.0998)	(0.0996)
Density (Log)			-3.068***	-2.857***	-2.860***	-1.711***	-1.541***	-1.565***	-1.473***	-1.337***	-1.371***
			(0.412)	(0.482)	(0.484)	(0.378)	(0.390)	(0.386)	(0.287)	(0.306)	(0.306)
Sq Density (Log)			0.245***	0.230***	0.230***	0.126***	0.114***	0.116***	0.109***	0.0994***	0.102***
			(0.0287)	(0.0342)	(0.0343)	(0.0250)	(0.0258)	(0.0256)	(0.0191)	(0.0204)	(0.0205)
Properties (Log)						0.993***	0.987***	0.991***	0.984***	0.980***	0.983***
						(0.0239)	(0.0283)	(0.0282)	(0.0208)	(0.0244)	(0.0242)
% Treated 3-6						0.00311***	0.00281***	0.00275***			
						(0.00101)	(0.00102)	(0.00101)			
Average Treatment Comp.									0.371***	0.351***	0.351***
									(0.0726)	(0.0762)	(0.0743)
Constant	0.0143	3.289*	5.777***	5.039***	8.842***	-1.273	-1.679	2.457	-2.267**	-2.586**	1.579
	(0.0369)	(1.969)	(1.274)	(1.567)	(1.972)	(1.236)	(1.328)	(1.890)	(0.988)	(1.099)	(1.755)
Observations	124	124	124	124	124	124	124	124	124	124	124
Overall R2	0.000287	1.92e-05	0.968	0.967	0.967	0.978	0.978	0.978	0.979	0.980	0.980

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

We have also considered the materiality of the effect on Ofwat's cost modelling that comes from omitting this factor. We have used the coefficients estimated in Table 3.2 (models 2a, 3a and 4a in place of 2, 3 and 4) to quantify the change in allowances over the next AMP due to all companies' reducing leakage by 15 per cent below current levels. When averaged across all companies, we estimate that botex allowances would increase by £647 million (around 4 per cent) over AMP7 if Ofwat were to control for cost increases resulting from 15 per cent leakage reduction.

The analysis shown above is not sufficient to prove that this particular variable (the difference between SELL and actual leakage) should be included in Ofwat's econometric models. For instance, the inclusion of this variable would ideally require Ofwat to re-examine other choices it made during its model selection process. There may also be other measures of leakage reduction that would yield more robust models. Before these results were used for setting allowances, it would also be important to cross check the coefficient estimates against other sources that have sought to estimate the marginal cost of leakage reduction.

Nonetheless, the calculations shown above demonstrate the importance of companies' level of leakage reduction in driving their efficient costs. Hence, the use of models that omit this factor to set base allowances cannot capture the expenditure required for companies to further reduce leakage over the next AMP. Addressing this limitation of Ofwat's existing base expenditure modelling could be achieved through adjustments to this modelling, or through other changes to the price control such as allowing enhancement expenditure to fund leakage reduction or through additional financial incentives to remunerate leakage reduction (see Section 6).

3.6. Conclusion

It may be intuitively appealing for Ofwat to argue that companies have been reducing leakage in recent years, so base allowances calibrated to historical levels of expenditure must necessarily fund ongoing leakage reduction. However, as explained in Section 3.3, this statement rests on assumptions that do not hold in reality.

It is correct that some companies have reduced leakage during the historical period over which Ofwat calibrated its econometric models. Also, cost targets established through comparative benchmarking may (to some extent) identify the level of leakage expenditure required to minimise water companies' costs.

However, the econometric modelling performed to set base allowances has a number of limitations that mean it will not identify the level of expenditure required to achieve leakage targets set over the next AMP. They do not identify how the optimal level of leakage varies over companies, they may be distorted by variation in companies' historical investment cycles, and they do not capture the required increase in leakage reduction activity by the industry over the next AMP.

We have conducted empirical analysis that supports these arguments, demonstrating that controlling for differences between companies' actual leakage and SELL has a statistically significant impact on companies' costs.

We have also shown that the marginal cost of leakage reduction rises as companies reduce leakage to lower levels than observed historically, which is another factor not accounted for by Ofwat’s base expenditure modelling.

We therefore conclude that base expenditure forecasts generated from Ofwat’s models will systematically understate companies’ investment requirements in a period in which companies are accelerating the rate of leakage reduction, as they will not capture the required step-change in companies’ leakage reduction expenditure.

A possible solution to this problem could lie in adjusting the modelling procedure used to set base allowances, though we do not necessarily advocate the particular changes in base expenditure models presented in Section 3.5. Alternatively, as discussed in the following chapters, Ofwat could adjust its assessment of companies’ claims for enhancement expenditure related to leakage reduction.

4. The Need for Allowed Enhancement Expenditure to Fund Leakage Reduction

As demonstrated in Chapter 3, Ofwat's base allowances do not provide adequate funding for companies to finance their efficient costs of delivering UQ leakage levels nor meeting the proposed leakage reduction target. Despite this, Ofwat has rejected 7 companies' proposed enhancement expenditure for leakage reduction, while allowing some funding for 10 companies to reduce leakage at an allowed unit cost.[57]

To ensure companies can fund the efficient costs of achieving Ofwat's leakage reduction target, it will be necessary to allow them some enhancement expenditure. Indeed, it is common regulatory practice to allow for additional funding when regulated companies are asked to deliver investment programmes which would not be required to minimise costs and go beyond the levels of investment that have been required in the past.

4.1. Ofwat's Proposals to Partially Fund Leakage Reduction through Enhancement Expenditure

4.1.1. Ofwat only allows part of companies' requests for enhancement expenditure

As stated above, Ofwat approved partial enhancement expenditure for leakage reduction for 10 firms at PR19. The partial funding is conditional on passing one of two tests:

- Test A: Does the company forecast leakage reduction in excess of the 15 per cent recommended target, but not in the UQ of companies when ranked according to the leakage reduction targets in their business plans?
- Test B: Will the company be in the UQ by 2024-25 (again, when ranked according to the leakage reduction targets in their business plans), in both normalised measures of leakage: per km of main and per property?

Ofwat allows enhancement expenditure for companies passing Test A or B, with funding determined by an allowed unit cost multiplied by a funded volume of leakage reduction. The allowed unit cost is equal to the minimum of the industry forecast median unit cost (£1.6m/Ml/d) or the company's proposed unit cost. The funded volume of leakage reduction is set as:

1. All leakage reduction *beyond 15 per cent*, if the company passes Test A;
2. All leakage reduction *beyond the UQ level*, if the company passes Test B; or
3. The maximum of (1) and (2), if the company passes both tests.

4.1.2. Ofwat's "gated" approach is inconsistent with its base allowances, which do not fund leakage reduction

As set out in Section 4.1.1, Ofwat applies a "gated" assessment of companies' requests for additional leakage funding. Specifically, companies only receive funding for their enhancement required to reduce leakage beyond the 15 per cent target and/or the upper

[57] Ofwat (January 2019), Supply-demand balance enhancement: Feeder model summaries, page. 12.

quartile. This approach is inconsistent with the methods it has used to set base allowances. As demonstrated in Section 3, which shows that Ofwat's models are only likely to provide companies with allowances for maintaining the rate of leakage reduction achieved over the modelling period, which as Figure 3.3 shows, has been close to zero.

As such, for companies to fund an accelerated rate of leakage reduction, some additional allowances above the those provided by Ofwat's base expenditure modelling will be required. This need for additional funding is not recognised by Ofwat's decision only to fund the leakage reduction above 15 per cent target and/or the upper quartile through allowed enhancement.

4.2. Regulatory Precedent on Funding New Performance Targets

In its IAP, Ofwat has allowed for additional "reasonable" funding requests by companies, both to base allowances and enhancement expenditure, to deliver levels of service beyond what was required in the past. This includes, for instance, additional allowances for some water companies to accommodate more demanding safety regulations (e.g. Dŵr Cymru and Hafren Dyfrdwy) or customer expectations (e.g. South Staff Water).[58] Failure to follow the same approach for leakage therefore appears inconsistent with Ofwat's broader approach at PR19 and regulatory practice in the UK.

More broadly across the regulated industries, there are a number of precedents of regulated companies being asked to meet new requirements imposed on them by regulators, in a similar way to Ofwat's requirement for faster leakage reduction, in areas that require investment that would not form part of an efficient (i.e. least-cost) solution in order to provide improved outcomes. In such cases, and in contrast to Ofwat's proposed approach to leakage reduction, regulators have made specific allowances to fund the investments required to meet such new targets.

4.2.1. At PR14 Ofwat's "cap and collar" system remunerated companies for reducing leakage beyond targets reflecting SELL

At PR14, Ofwat provided additional funding for leakage reduction beyond companies' PCs (referred to as stretching performance improvements beyond commitments) through ODIs providing financial rewards for "delivering stretching performance improvements beyond commitments".[59]

The companies' commitments themselves were set to reflect SELL. Ofwat stated that the threshold for receiving additional funding for leakage reduction was in line with companies' SELL and regional conditions affecting leakage reduction. The PC on leakage reduction was not subject to UQ benchmarking at PR14. Instead, Ofwat accepted the leakage reduction targets "because companies' proposals on leakage aligned with the sustainable economic

[58] NERA analysis of Ofwat's Cost adjustment claim feeder models for each company.

[59] Ofwat (December 2014), Setting price controls for 2015-20, Final price control determination notice: policy chapter A2 - outcomes, page. 21.

level of leakage (SELL) and local issues (such as availability of water resources and statutory abstraction reductions) significantly influence the SELL". [60]

Specifically, companies committed to reduce leakage by 158 Ml/d (a 5 per cent reduction in leakage) at PR14. In contrast, Ofwat's new leakage reduction standard has led to companies to propose a 489 Ml/d reduction in leakage during AMP7, a 16.3 per cent reduction over the period and a 209 per cent increase in the leakage reduction commitment compared to PR14.

Hence, at PR14 Ofwat provided funding for companies going beyond SELL, via payment for outperformance on ODIs. By contrast, Ofwat's IAP has set more demanding targets than SELL, and provided no funding that allows companies to bridge the gap between SELL and the proposed targets.

4.2.2. Ofgem has allowed replacement expenditure at RIIO-GD1 to fund replacement of iron mains to achieve higher safety outcomes

Gas Distribution Networks (GDNs) are obliged to follow the Health and Safety Executive's (HSE) iron mains replacement programme to reduce the risk of leakage, which require decommissioning of all iron mains within 30 metres of a building by 2032. In essence, this programme requires GDNs to provide a higher level of safety outcomes.

As part of its RIIO-GD1 determination, Ofgem has put in place a number of mechanisms to ensure GDNs can fund the efficient costs of iron mains replacement, which would not be required solely to minimise the costs of gas distribution. For instance, it included a cost driver reflecting repex workload, and made specific allowances for funding investment requirements over the control period estimated using unit costs differentiated by iron main type.[61]

Ofgem's approach to funding GDNs' repex programmes to meet the HSE's targets is analogous to the challenge Ofwat faces when funding water companies' leakage reduction beyond SELL. The HSE requirement was a regulatory mandate to achieve certain targets that were not least-cost for the GDNs. Similarly, Ofwat's specific leakage reduction recommendations at PR19 require companies to be ambitious, setting leakage reduction targets beyond the most ambitious company at PR14. This requires companies to provide levels of investment beyond the least-cost option.

4.2.3. At RIIO-ED1, Ofgem also recognised the need to fund investments to provide improved outputs outside of base allowances

Ofgem has faced a similar challenge in the electricity distribution industry. Similar to the iron mains replacement in gas, Ofgem also recognised a mandate on Distribution Network Operators (DNOs) to conduct a large volume of safety-related work that would not have been

[60] Ofwat (December 2014), Setting price controls for 2015-20, Final price control determination notice: policy chapter A2 - outcomes, page. 21.

[61] Ofwat included a "bottom-up" repex analysis which regressed repex workload on repex for all types of mains. Only repex, which did not have a sensible cost driver were excluded from the analysis.

Ofwat (17 December 2012), RIIO-GD1: Final Proposals – Supporting document - Cost efficiency, page 27, 52 and 91.

least-cost for the companies due to the Electricity Safety, Quality and Continuity Regulations (ESQCR) requirements.

These regulations required DNOs to incur maintenance and replacement expenditure to meet new standards. Ofgem required DNOs to submit costs for each maintenance activity category, accepted the volumes and remunerated DNOs by multiplying these volumes by an allowed unit cost.[62] Ofgem remunerated efforts to comply with ESQCR using as unit cost the industry median (at each relevant voltage level) over 13 years (including therefore both historical and forecast unit costs).[63]

Ofgem also sought to ensure consistency between its outcome targets and its cost assessment. For instance, for its “secondary deliverables targets”, which concerns the health, criticality and risks of network assets,[64] Ofgem cross-checked its cost assessment modelling results, and made qualitative adjustments to its targets where appropriate to ensure companies were only obliged to deliver the level of service for which they were remunerated under the price control.[65]

4.3. Conclusion

From the discussion above in Chapter 3, we concluded that Ofwat’s methods for setting base allowances do not fund the expenditure required to achieve its stretching leakage reduction targets. As discussed in this chapter, Ofwat’s decision not to provide companies with allowances for enhancement to bridge the gap between SELL and its “stretched” leakage targets means that the funding package as a whole does not fund achievement of the leakage reduction targets. In essence, there is an inconsistency between Ofwat’s cost allowances (both base allowances and enhancement) and its targets.

By contrast, there was no such inconsistency in Ofwat’s approach at PR14, as PCs for leakage reduction were set to reflect local conditions affecting leakage/SELL, with funding for companies stretching their performance beyond the PCs coming through ODIs. As discussed above, past regulatory determinations by Ofgem have also allowed companies to recover the costs of new regulatory requirements that trigger significant investment.

Change to Ofwat’s funding package for leakage reduction is therefore required. One option would be to develop its cost assessment modelling tools, so that companies’ base allowances better-reflect the growing need for work to reduce leakage. Alternatively, Ofwat could revise its “gated” approach to allowing companies’ claims for enhancement expenditure to reduce

62 Ofgem (28 November 2014), RIIO-ED1: Final determinations for the slow track electricity distribution companies Business plan expenditure assessment, page. 86-87.

63 Ofgem (28 November 2014), RIIO-ED1: Final determinations for the slow track electricity distribution companies Business plan expenditure assessment, page. 35.

64 Secondary Deliverables targets relate to asset health, criticality and risk, and were defined for the RIIO-ED1 period in Standard Condition 51 (Network Asset Indices Methodology) of the electricity distribution licence.
Ofgem (18 June 2015), RIIO-ED1 regulatory instructions and guidance: Annex A – Glossary, page 119.

65 Ofgem cross-checked its modelling results using “against historical and forecast information, condition information contained in the secondary deliverables for asset health and criticality, scheme papers and other justification”.

Ofgem (28 November 2014), RIIO-ED1: Final determinations for the slow track electricity distribution companies Business plan expenditure assessment, page. 29.

leakage in a way that provides funding for them to bridge the gap between their proposed PCs and the levels of leakage reduction activity conducted historically.

5. Ofwat’s Allowed Unit Costs of Leakage Reduction

As discussed in Chapter 2, Ofwat sets a constant unit cost for leakage reduction beyond either 15 per cent leakage reduction, or the UQ level of leakage reduction.

This chapter assesses whether Ofwat’s method of setting unit cost is consistent with the need for efficiently operated companies to fund their leakage reduction targets. We also consider whether Ofwat’s approach provides incentives for water companies to reduce leakage efficiently.

5.1. Ofwat’s Allowed Unit Costs of Leakage Reduction

Ofwat has set the allowed unit cost of leakage reduction that applies to allowed enhancement expenditure using the marginal costs from its Supply-Demand Balance (SDB) enhancement modelling and companies’ proposed ODI incentive rates. The proposed allowed unit cost is £1.6m/Ml/d, and is the average of: [66]

- median leakage unit costs derived from the PR19 SDB enhancement analysis;
- median incentive rate for underperformance reported in companies’ business plans; and
- median incentive rate for outperformance reported in companies’ business plans.

5.2. Accounting for the Increasing Marginal Cost of Leakage Reduction

5.2.1. Ofwat’s approach fails to account for the increasing marginal cost of leakage reduction

Ofwat’s approach fails to consider that the marginal cost of leakage reduction potentially increases, as companies reduce leakage. As mentioned in Section 3.4.3 above, historically, companies may have reduced their leakage by “picking the lowest-hanging fruit” to achieve their leakage reduction targets.

However, as evidence in Figure 3.4 above shows, more demanding leakage reduction targets are associated with higher marginal costs related to the more expensive leakage reduction solutions companies must deploy. Hence, requiring companies to meet more ambitious targets will increase the marginal cost of reducing leakage.

As we explain in Section 3.4.3, Ofwat’s approach of allowing enhancement expenditure based on a single median unit cost across the industry fails to capture any potential variation across companies’ marginal costs because of differences in the costs companies face to reduce leakage, and the level of leakage reduction efforts conducted historically.

5.2.2. A solution is to link allowed unit costs to a modelled estimate that controls for differences between companies

It is therefore important that, in order to fund the efficient costs of leakage reduction through enhancement, Ofwat sets unit costs in a way that addresses the factors causing unit costs to vary across companies. In particular, to address the tendency for the marginal cost of leakage

[66] Ofwat (January 2019), Supply-demand balance enhancement: Feeder model summaries, page. 15.

reduction to rise as leakage falls, and for the costs of leakage reduction to vary across companies for other reasons related to network characteristics, Ofwat could consider developing a targeted, disaggregated model of leakage reduction costs. Such a model would, for instance, link allowed unit costs of leakage reduction to an increasing function of companies' leakage reduction performance capturing both the rate and speed of change of companies' unit costs, and possibly control for other external factors.

5.3. Impact on Companies Incentives for Efficient Leakage Reduction

5.3.1. Ofwat's approach may undermine companies' incentives to reduce leakage at least-cost

Setting targets at the minimum of company's *proposed* unit costs and the industry median is likely to affect incentives for cost reduction detrimentally, as companies achieving the median do not benefit from doing so in terms of higher allowances. Firms with median or lower unit costs of leakage reduction do not benefit from being more efficient, beyond the totex sharing factor at the end of the relevant AMP. There is no additional benefit for a company to reduce its unit cost beyond the median (e.g. reducing a unit cost of £1.6m/Ml/d to £1.4m/Ml/d). Hence, under this structure companies do not have an incentive to improve their unit cost of leakage reduction to achieve industry median or lower unit costs.

This problem also could be addressed by setting all companies' allowed enhancement based on a unit cost predicted by a targeted leakage reduction unit cost model, as suggested in Section 5.2.2.

5.3.2. Ofwat's rationale for using out/under-performance unit rates is not justified

As explained above, Ofwat used leakage ODI outperformance and underperformance rates in setting the allowed unit costs for leakage reduction. For the reasons set out below, this approach is unlikely to produce an accurate estimate of the marginal cost companies face to reduce leakage.

In its final methodology, Ofwat presents companies with a series of options for how they should calculate their ODI incentive rates.[67] Ofwat states companies can use the incentive rate formulas used at PR14:[68]

$$\text{ODI(underperformance)} = \text{Incremental benefit} - (\text{incremental cost} \times p)$$

$$\text{ODI(outperformance)} = \text{Incremental benefit} \times (1 - p)$$

Where 'p' is the customer share of totex outperformance (50%). Ofwat also stated that companies could use other customer evidence to propose changes to the ODI outperformance

67 Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, p. 90-91.

68 Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, p. 91.

and underperformance payment rates calculated according to the existing formulas, "provided the changes are well justified".[69]

From reviewing Ofwat's IAP documents, we understand that most companies have based their incentive rates on Ofwat's standard formula, meaning that underperformance incentive rates are based on a combination of marginal costs and marginal benefits, and outperformance incentives are based on marginal benefits.

The first problem with Ofwat's use of these ODI rates is that both outperformance and underperformance incentive rates discount the proportion of out/underperformance which is shared with consumers (i.e. 'p' in the formulas above). It is not appropriate to discount the customer share when applying these rates to enhancement expenditure, since allowances for enhancement expenditure are subject to the totex outperformance sharing mechanism as a component of controllable totex.

Further, Ofwat incorrectly uses incentive rates which take account of marginal benefits as well as marginal costs, and, in the case of the outperformance formula, Ofwat takes account only of marginal benefits, such as marginal willingness to pay, and not marginal costs.

Ofwat does not explain its rationale for using the outperformance incentive rate as a proxy for the marginal cost of reducing leakage, although in its outcomes methodology, Ofwat explains that in its outperformance formula, it effectively assumes that incremental cost is equal to marginal benefit.[70] However, Ofwat goes on to explain that while this assumption is appropriate for setting an incentive rate for performance above a PC, it is not likely to hold in practice. Ofwat states that assuming marginal cost equals marginal benefit "allows for the fact that in reality a company is only likely to outperform its performance commitment if it reduces it marginal cost", but that "typically you would expect beyond the performance commitment for marginal cost > marginal benefit". In other words, since Ofwat explains that marginal benefits are likely to be less than marginal costs, it is inconsistent for Ofwat to use marginal benefits as an estimate of the efficient unit costs of leakage reduction.

Finally, while Ofwat states that it has taken incentive rates directly from companies' business plan data tables, for some companies we have been unable to reconcile the "leakage under/out performance unit rates" which Ofwat has reported in its calculation of unit costs, with the data in companies' business plan data tables. For instance, United Utilities and Yorkshire Water's business plan Data Table reports different incentive rates for its leakage ODI to those which Ofwat reports in its "Supply demand balance enhancement feeder model".

5.4. Conclusion

Ofwat has set the allowed unit cost of leakage reduction that applies to allowed enhancement expenditure through its SDB enhancement modelling that uses data from companies' business plans. The allowed unit cost at PR19 is £1.6m/Ml/d and reflects an average of

[69] Ofwat (January 2019), PR19 initial assessment of plans, Technical appendix 1: Delivering outcomes for Customers, p. 9.

[70] Ofwat, Delivering Water 2020: Our methodology for the 2019 price review. Appendix 2: Delivering outcomes for customers, p. 92.

median of unit costs submitted by companies and ODI incentive rates. Ofwat's approach is flawed for several reasons.

First, Ofwat's approach of allowing enhancement expenditure based on a single median unit cost across the industry fails to capture any potential variation across companies' marginal costs because of differences in the costs companies face to reduce leakage, and the level of leakage reduction efforts conducted historically. It also fails to capture the tendency of unit costs to be higher when companies maintain or attain lower levels of leakage.

Secondly, setting targets at the minimum of company's *proposed* unit costs and the industry median is likely to affect incentives for cost reduction detrimentally, as companies achieving the median do not benefit from doing so in terms of higher allowances. Hence, Ofwat's approach may undermine companies' incentives to reduce leakage at least-cost.

Also, Ofwat's rationale for using ODI out/under-performance rates to set allowed unit costs for leakage reduction is not well-justified and unlikely to produce an accurate estimate of the marginal cost companies face to reduce leakage. The ODI underperformance formula takes into account both marginal benefits as well as marginal costs, and the ODI outperformance formula only accounts for marginal benefits. However, Ofwat itself notes that beyond the performance commitments marginal benefits are likely to be less than marginal costs. It is therefore inconsistent for Ofwat to use marginal benefits as an estimate of the efficient unit costs of leakage reduction.

Finally, ODI outperformance and underperformance incentive rates discount the proportion of out/underperformance which is shared with consumers. It is however not appropriate to discount the customer share when applying these rates to enhancement expenditure, since allowances for enhancement expenditure are subject to the totex outperformance sharing mechanism as a component of controllable totex.

It is therefore important that, in order to fund the efficient costs of leakage reduction through enhancement, Ofwat sets unit costs in a way that addresses the factors causing unit costs to vary across companies.

To address the tendency for the marginal cost of leakage reduction to rise as leakage falls, and for the costs of leakage reduction to vary across companies for other reasons related to network characteristics, Ofwat could consider developing a targeted, disaggregated model of leakage reduction costs. Such a model would, for instance, link the allowed unit costs of leakage reduction to an increasing function of companies' leakage reduction performance capturing both the rate and speed of change of companies' unit costs, and possibly control for other external factors.

6. Conclusions and Recommendations

For PR19, Ofwat expects companies to target more stretching levels of leakage reduction than they have achieved historically, which targets a level of leakage reduction that requires additional expenditure by the industry to achieve.

Despite requiring companies to enhance their leakage reduction efforts, Ofwat has disallowed many companies' requests for enhancement expenditure, funding leakage reduction that goes beyond a defined target. Ofwat has not allowed any enhancement expenditure to bridge the gap between current levels of leakage reduction and the target. By disallowing this enhancement expenditure, Ofwat relies on companies' ability to fund leakage reduction through their base cost allowances,[71] stating that "[c]ustomers should not pay extra costs for companies to deliver stretching targets" for leakage reduction.[72]

This aspiration, that companies should fund higher levels of service that require rising expenditure without funding for enhancement represents wishful thinking by Ofwat.

Leakage reduction is a material expense that companies need to fund. Indeed, our own empirical analysis supports these arguments, demonstrating that controlling for differences between companies' actual leakage and SELL has a statistically significant impact on companies' costs.

Ofwat's methods for setting base allowances do not fund the expenditure required to achieve its stretching leakage reduction targets. These will allow companies to fund a level of leakage reduction effort commensurate with the levels of leakage reduction achieved during the historical modeling period. Because average industry leakage reduction over this period was low on average, Ofwat's base allowances are unlikely to fund any material leakage reduction work at all.

As such, by only allowing enhancement expenditure for leakage reduction when companies exceed a target that itself exceeds the levels of leakage reduction achieved historically, Ofwat's funding package for leakage reduction is inconsistent with its targets.

By contrast, there was no such inconsistency in Ofwat's approach at PR14, as PCs for leakage reduction were set to reflect local conditions affecting leakage/SELL, with funding for companies stretching their performance beyond the PCs coming through ODIs. As discussed above, past regulatory determinations by Ofgem have also allowed companies to recover the costs of new regulatory requirements that trigger significant investment.

Change to Ofwat's funding package for leakage reduction is therefore required. One option would be to develop its cost assessment modelling tools, so that companies' base allowances better-reflect the growing need for work to reduce leakage. Alternatively, Ofwat could revise its "gated" approach to allowing companies' claims for enhancement expenditure to reduce leakage in a way that provides funding for them to bridge the gap between their proposed PCs and the levels of leakage reduction activity conducted historically.

71 Ofwat rejected enhancement expenditure for reducing leakage for Bristol Water, SES, Severn Trent, South East Water, South West Water, Southern Water, Wessex Water, Yorkshire Water. Source: Ofwat (2019), Action summary tables for each affected company.

72 Ofwat (January 2019), PR19 initial assessment of plans, Technical appendix 2: Securing cost efficiency, page. 18.

We have also shown that the marginal cost of leakage reduction rises as companies reduce leakage to lower levels than observed historically, which is another factor not accounted for by Ofwat's base expenditure modelling, or its allowances for enhancement expenditure for companies exceeding the target. We have also identified a number of other problems with the way Ofwat set its allowed unit costs, specifically related to the way it combined unit costs from its SDB modelling with information from companies' ODI incentive rates.

A possible solution to this problem could lie in modelling more thoroughly the unit cost of leakage reduction, as a function of the levels of leakage reduction companies target and other factors influencing the cost of leakage reduction. Essentially, we recommend that Ofwat considers improving on its approach of basing allowances on proposed ODI rates (which are in any event inappropriate as a guide to the cost of leakage reduction) and industry median unit costs.

Appendix A. Regression Analysis of Unit Costs and Leakage Reduction Targets

Table A.1 below set out the results of our regression analysis of the unit costs of leakage reduction in £m/Ml/day on the level of leakage targeted at the end of the AMP across all companies, excluding Thames Water.[73] We used the following variables:

- Regression 1, 2 and 3 rely on forecast leakage at the end of the AMP7 (i.e., 2024-25), measured in l/prop/day ("F_leakage_prop_2425") and m3/km/d ("F_leakage_km_2425") and a cross-product term ("F_product_2425).
- Regression 4, 5 and 6 rely on forecast 3-year average leakage positions in 2024-25 that companies have provided as part of their common performance commitments, measured in l/prop/day ("F_leakage_prop_avg") and m3/km/d ("F_leakage_km_avg") and a cross-product term ("F_product_avg").
- All regression models use unit cost (£m/Ml/day) as dependent variable.

Table A.1: Regression Analysis Results

Variables	(1)	(2)	(3)	(4)	(5)	(6)
F_leakage_km_2425	-0.549** (0.223)					
F_leakage_prop_2425		-0.0465* (0.0243)				
F_product_2425			-.00436** (0.00167)			
F_leakage_km_avg				-0.519** (0.209)		
F_leakage_prop_avg					-0.0440* (0.0227)	
F_product_avg						- 0.00377** (0.00148)
Constant	5.317*** (1.417)	5.742** (2.032)	4.194*** (0.934)			
Observations	14	14	14	14	14	14
R-square	0.337	0.234	0.361	0.339	0.238	0.351

*Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.*
Source: NERA analysis of Ofwat data.

[73] Data on unit costs for leakage reduction for HDD and NES is not available. We have therefore only included companies in the sample for which both unit cost and leakage data is available in the public domain.

Qualifications, assumptions and limiting conditions

NERA Economic Consulting ("NERA") was commissioned by SES Water to analyse proposals published by Ofwat for the funding of leakage reduction as part of the PR19 price control review process. The primary audience for this report includes Ofwat and other parties with an interest in the water industry.

NERA shall not have any liability to any third party in respect of this report or any actions taken or decisions made as a consequence of the results, advice or recommendations set forth herein.

The opinions expressed herein are valid only for the purpose stated herein and as of the date hereof. Information furnished by others, upon which all or portions of this report are based, is believed to be reliable but has not been verified. No warranty is given as to the accuracy of such information. Public information and industry and statistical data are from sources NERA deems to be reliable; however, NERA makes no representation as to the accuracy or completeness of such information and has accepted the information without further verification. No responsibility is taken for changes in market conditions or laws or regulations and no obligation is assumed to revise this report to reflect changes, events or conditions, which occur subsequent to the date hereof.

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Appendix AFW.CE.A1.18

Action ref AFW.CE.A1

Cost Allocation Paper

CE.A1.18 COST ALLOCATION
14 March Board Paper Appendix

1. INTRODUCTION

This memo sets out amendments that have been made to certain allocations in PR19 data tables to address Ofwat's concerns in relation to the allocation of costs between business units in our PR19 business plan submission set out in their 2018 company monitoring framework assessment report published in January 2019.

As presented in the paper to the Audit Committee on 20 February 2018, Ofwat also expressed concerns in relation to the cost assessment data submitted in the 2017/18 annual performance report ('APR') over the number of cost allocations still based on management estimate. Ofwat provides a hierarchy of cost drivers to be used in the Regulatory Accounting Guidelines ('RAGs') and utilisation of management estimates as a cost driver is permitted where information is unavailable to use the preferred cost driver. We are in the process of reviewing the seven references to management estimates in our 2017/18 accounting separation methodology statement as part of the 2018/19 APR preparation process, as any refinements to our methodology that can be made are not anticipated to materially change the allocation of costs between business units.

2. ALLOCATION OF METER READING COSTS

Following circulation of the final 2017/18 APR industry datashare in November 2018, we benchmarked our meter reading costs for the Retail household business unit. We identified that we had the highest meter reading cost per measured customer in 2017/18 across the industry (£3.98 per measured customer compared to an average across the rest of the industry of £2.22 per measured customer). We were even more of an outlier when compared with other water only companies (the average meter reading cost per measured customer for other water only companies in 2017/18 was £1.72).

On reviewing the accounting separation methodology statements for other companies as part of a process to understand further why we were an outlier, we identified that companies procuring meter reading services from other companies within the industry are including the commission paid for these services in their operating expenditure for their Retail household business units. We bill and collect charges in respect of sewerage and infrastructure within our supply area on behalf of Thames Water and Anglian Water, which includes reading the meters of their measured customers. The commission that we receive is allocated to our non-appointed business in line with the RAGs. However, we have not been allocating any of our meter reading costs to our non-appointed business to reflect the treatment of the associated commission, thereby leading to an overstatement of meter reading costs relating to our appointed business and therefore across the industry as a whole.

2. ALLOCATION OF METER READING COSTS (CONTINUED)

To address this issue, a proportion of meter reading costs has been allocated from Retail household to non-appointed operating costs using property numbers as a cost driver to reflect the element of sewerage commission received that relates to reading meters. The below table summarises the impact of this methodology change on Retail household meter reading costs since 2012/13:

	2012/13 £m	2013/14 £m	2014/15 £m	2015/16 £m	2016/17 £m	2017/18 £m	2018/19 £m	2019/20 £m	2020/21 £m	2021/22 £m	2022/23 £m	2023/24 £m	2024/25 £m
Meter reading costs per original PR19 submission	2.990	2.834	3.245	2.876	2.880	2.894	2.929	2.874	2.907	3.051	3.191	3.335	3.484
Meter reading costs per revised PR19 submission	1.858	1.786	2.016	1.808	1.810	1.469	1.457	1.423	1.439	1.515	1.589	1.665	1.744
Change	1.132	1.048	1.229	1.068	1.070	1.425	1.472	1.451	1.468	1.536	1.602	1.669	1.740
Change (%)	37.9%	37.0%	37.9%	37.2%	37.1%	49.2%	50.3%	50.5%	50.5%	50.3%	50.2%	50.1%	49.9%

The proportion of meter reading costs relating to properties billed by the company for both water and wastewater services has been calculated using property numbers with this cost then allocated 50%:50% between our Retail household and non-appointed business units.

This methodology change brings meter reading costs per customer more in line with industry averages (for 2017/18 the restated cost per measured customer is £1.96) and reduces Retail household total expenditure for AMP7 by £7.953m. This also decreases our tax in relation to the appointed business, and increases our return on regulatory equity ('RORE'), proportion of dividends allocated to the appointed business and total shareholder return reported in the 2017/18 financial flows data submission (there is no impact on retained value figures reported in this submission). These figures will be restated in the PR19 data tables, together with AMP6 average data for RORE and financial flows included in our 2018/19 APR (see below the impact on previously reported RORE for AMP6).

	2015/16	2016/17	2017/18
RORE per 2017/18 APR	4.13%	5.74%	6.95%
Restated RORE	4.53%	6.14%	7.27%
% change	0.40%	0.40%	0.32%

3. RECHARGES FROM WHOLESALE TO RETAIL HOUSEHOLD

We have re-assessed recharges made from Wholesale to Retail household for the shared use of fixed assets principally used by Wholesale following a benchmarking exercise of the value of Wholesale to Retail household recharges in 2017/18, which indicated that our recharges per customer were above industry average (£1.40 per customer compared to a rest of industry average of £1.06 per customer and other water only company average of £0.64).

On reviewing the assets identified as shared use assets from our fixed asset register to understand further why we were an outlier when compared to water only companies in particular, we identified a few assets that are not being used by the Retail household business unit. These assets included costs capitalised in relation to market reform, our new fieldwork management system and IT assets associated with the delivery of our Water Saving Programme, for which, following the company's exit of the non-household retail market in 2017 there is now greater clarity that these assets are entirely used by the Wholesale business unit.

3. RECHARGES FROM WHOLESALE TO RETAIL HOUSEHOLD (CONTINUED)

These assets have now been removed from the calculation, reducing the recharges from Wholesale to Retail household and bringing these more in line with industry averages (for 2017/18 the restated recharge per customer is £0.64, which would have been the sixth lowest in the industry with two companies reporting nil recharges from Wholesale to Retail household). The below table summarises the impact of this methodology change on recharges from Wholesale to Retail household since the start of AMP6:

	2015/16 £m	2016/17 £m	2017/18 £m	2018/19 £m	2019/20 £m	2020/21 £m	2021/22 £m	2022/23 £m	2023/24 £m	2024/25 £m
Recharges per original PR19 submission	1.406	1.028	1.914	2.016	2.261	2.608	2.991	2.41	2.496	2.777
Recharges per revised PR19 submission	1.406	1.028	0.871	0.748	0.424	0.335	0.337	0.207	0.231	0.252
Change	-	-	-1.043	-1.268	-1.837	-2.273	-2.654	-2.203	-2.265	-2.525
Change (%)	0%	0%	-54%	-63%	-81%	-87%	-89%	-91%	-91%	-91%

We note that we have not changed our methodology of calculating recharges once shared use assets have been identified but have just revisited the assets identified as shared use assets. This reassessment of shared use assets does not impact on our Retail cost to serve, as we understand that these recharges are excluded. However this reduces Retail household total expenditure for AMP7 by £11.920m. Wholesale total expenditure is not impacted, as the cost of shared use assets are included entirely within Wholesale total expenditure.

4. CONCLUSION

The changes to cost allocation between business units result in an overall £19.873m reduction to Retail household total expenditure for AMP7. Commentary for the impacted resubmitted tables will include detail justifying these changes, as detailed in this memo. This detail will also be included in our 2018/19 accounting separation methodology statement.

Appendix AFW.CE.A2.1

Action ref AFW.CE.A2

All Company Working Group (ACWG). Joint statement on strategic regional solution development

Joint statement on strategic regional solution development

Affinity Water, Anglian Water, Severn Trent Water, Southern Water, Thames Water, United Utilities and Water Resources South East

25 March 2019

During February and March Affinity Water, Anglian Water, Severn Trent Water, Southern Water, Thames Water and United Utilities have worked together to develop a set of proposals that seek to address the potential challenges associated with the promotion of strategic regional solutions as set out in Ofwat's initial assessment of plans.

The group of companies have collaborated to develop a set of principles, working documents and discussion papers which demonstrate how the gated process would work for the promotion of a regional scheme.

Further work has been identified which the companies will continue to work together to address.

1 Executive summary

This document sets out the work that has been jointly undertaken by the six water companies. These companies are Affinity Water, Anglian Water, Severn Trent Water, Southern Water, Thames Water, and United Utilities, with the support of Water Resources South East (WRSE). We have jointly assessed, reviewed and provided constructive comments back on the proposal for developing regional strategic solutions as set out by Ofwat in its initial assessment of companies' business plans ("IAP").

The companies have worked together over the last two months, observed and supported by Ofwat and the Environment Agency, to develop the following aspects:

- **In conjunction with the other companies involved, jointly propose methods for collaborative working including setting up the joint working group for individual schemes, and how consistent assumptions and decisions will be made within these groups and between them.**
    - A terms of reference for working collaboratively across all of the companies;
    - The principle of the scheme working groups, the requirement for specific Terms of Reference;
- **Provide more detail on the gated process, the deliverables, timings and expenditure allocations at each gate.**

  - A proposal to modify the timing of the gateways based on whether the schemes are required to obtain a development consent order (DCO);
  - Increased detail of the work between the proposed gates to allow an improved understanding of the funding required per stage to be undertaken, and to confirm the overall sum to complete all gates;
  - The requirement and principles of a change protocol to manage specific changes to schemes in the proposal and to change the current list of schemes when required;
  - Gateway acceptance criteria to be confirmed using the improved detail per gate**;**
- **Propose ODI-type mechanisms to allow allocated funding to be recovered by customers in the event of the scheme not progressing through each gate and for the non-delivery or late delivery of outputs**
  - Development of the principles of an ODI type mechanism;

The group have also agreed a forward-looking plan for further work.

This document covers the joint understanding between the 6 water companies of the above subjects. Each company may also submit further information building on this work in response to their individual IAP feedback from Ofwat.

Whilst the companies have worked through a lot of detail in a relatively short period of time, a forward-looking plan has also been incorporated into the document which sets out the additional information that will be worked on by the companies, for submission to Ofwat by the middle of May 2019 to allow it to take account of these proposals in its draft determination process.

We hope that Ofwat, and other regulators, will collaborate with the water companies and contribute to the ongoing development of the strategic water resource programme.

Contents

2 Ofwat's key questions

In their initial assessment of business plans Ofwat set out some very specific questions regarding the strategic regional solution development. These were set out as below, including preamble. Key references have been put in to indicate where answers to these questions can be found:

> **Strategic regional solution development - We have identified from the plans that at least one strategic supply solution is required over the next 5-15 years to secure drought resilience in the south-east. The strategic regional solution development allocation is to allow the delivery of consistent and transparent investigations, planning and development of strategic options with the overall aim of optimum solutions being construction ready by 2025.**
>
> **The company's allocation is made on the basis of having clear deliverables and customer protection for the gated delivery of the development of an eastern regional solution/transfer. The following actions are required to ensure the efficient delivery of this development programme.**

- **In conjunction with the other companies involved, jointly propose methods for collaborative working including setting up the joint working group for individual schemes, and how consistent assumptions and decisions will be made within these groups and between them.**
  - A terms of reference for working collaboratively both across all of the companies and also on specific schemes;
  - The principle of the scheme working groups, the requirement for specific ToR's, with the need for NDAs to be established as appropriate to each scheme;

  Refer to section 6.1; Section 10 (appendix B) and Section 11 (appendix C)

- **Provide more detail on the gated process, the deliverables, timings and expenditure allocations at each gate.**
  - A proposal to modify the timing of the gateways based on whether the schemes are required to obtain a development consent order (DCO);
  - Increased detail of the work between the proposed gates to allow an improved understanding of the funding required per stage to be undertaken, and to confirm the overall sum to complete all gates;
  - The requirement and principles of a change protocol to manage specific changes to schemes in the proposal and to change the current list of schemes when required;
  - Gateway acceptance criteria to be confirmed using the improved detail per gate

  Please refer to section 6.2, 6.3 and Section 12 (Appendix D)

- **Propose ODI-type mechanisms to allow allocated funding to be recovered by customers in the event of the scheme not progressing through each gate and for the non-delivery or late delivery of outputs.**

- Development of the principles of an ODI type mechanism;

Please refer to sections 6.5, 6.6 and Section 13 (Appendix E)

3 Introduction

As part of the initial assessment of companies business plans (IAP) Ofwat introduced proposals to support the delivery of strategic regional solutions to support drought resilience in the south east over the next 5 to 15 years. The proposals allocate funding and describe an associated gated process for the co-ordination and development of a consistent set of strategic water resource schemes. This proposal affects six companies, these being: Affinity Water, Anglian Water, Severn Trent Water, Southern Water, Thames Water and United Utilities. This group of companies form the **All Company Working Group** (ACWG).

Each of these companies received an action that they are required to respond to questions set out in the IAP by 1 April as part of the PR19 process. This document sets out the joint response of the six companies to this specific IAP actions and should be read alongside any individual company submissions which may provide further information building on this work.

Following the publication of the IAP, the ACWG have met several times in order to establish a common approach to implementing the proposals set out by Ofwat. WRSE has provided assistance in this process, including drawing this document together, which seeks to summarise the work undertaken to date by the six companies in agreeing a set of processes and enhancements to the proposed gated process.

The document also highlights potential enhancements to the process at a generic level. In some circumstances companies will also submit their own individual response to Ofwat's proposals to make specific representations around the scheme list, allocations or the requirements of the gated process to meet their own specific requirements.

One of the key principles the ACWG have adopted is to ensure this process aligns with the process to develop statutory Water Resources Management Plans (WRMP). This will ensure that any potential unintended consequences are avoided.

4 Document structure

This document is structured in a way that sets out the work that the companies have completed to date, which includes:

- Agreed terms of reference;
- The proposed overall joint working group and the specific scheme working groups;
- Revised timelines for the gated processes depending on whether the scheme will require a Development Consent Order (DCO);
- In principle the need for a change control process to change aspects of the current schemes but also to allow current schemes to be changed or new schemes introduced;
- The principles of an ODI with some worked examples.

The document sections are:

1) Background setting out a summary of Ofwat's proposals;

2) Proposed enhancements to the Ofwat gated process for the development of the strategic regional solutions;
3) Proposed work plan; and a
4) Summary.

5 Background: Initial assessment of business plans

Water companies have proposed various assessment programmes to meet their supply demand balance challenges in the future to ensure resilient supplies, during severe and extreme droughts. These challenges will only increase due to climate change, population growth, environmental requirements and societal expectations.

Ofwat have reviewed the various proposed investment plans to meet these challenges as part of the initial assessment of business plans (IAP). In response to their assessment they have proposed a new process which will allocate up to £358m to consistently investigate, plan and develop several strategic regional solutions (reservoir, effluent reuse, transfers, desalination) in order to identify the regional optimum solutions and ensure they are construction ready by 2025. The term ‘construction ready’ has still to be defined, but the group have set out criteria in section 6.3 as part of the proposals. Customers will be protected as investment will be returned if an activity is not required or deliverables are not met.

5.1 Strategic schemes that have been referred to in the IAP

Whilst there have been many national water resource investigations across England and Wales, the schemes that have been included in the Ofwat IAP are those found in company business plan submissions that were considered to be of a suitable scale to be strategically important.

Since the publication of the IAP, it has been recognised by Ofwat that the proposed list of schemes is not necessarily complete and therefore this represents an initial list. This initial list of schemes and the water companies associated with investigating them are set out in Figure 1, below:

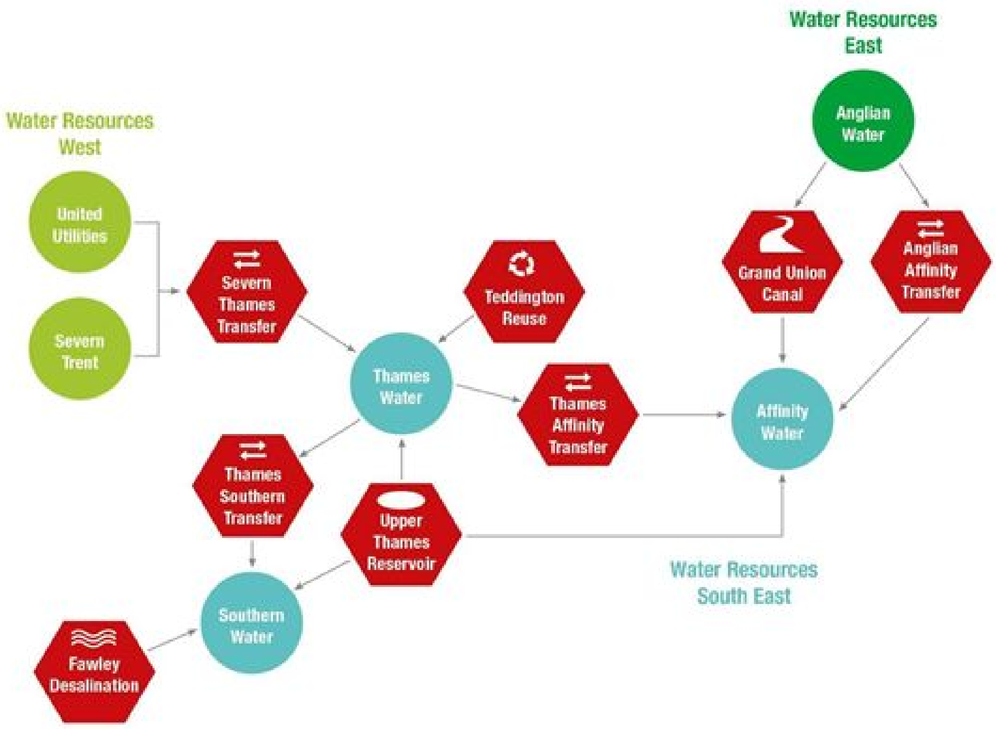


Figure 19: Regional strategic schemes as outlined in the IAP

Details of Ofwat's proposed funding of the schemes to take them through the gated process and the allocation of money between the water companies is set out in Appendix A.

The purpose of the gated process is to advance and achieve a given level of consistency between the regional schemes to allow informed decisions to be taken.

6 Proposed enhancements to the Ofwat gated process

During February and March the six water companies have been working together to go through Ofwat's proposals and the potential changes that could be introduced to enhance the Ofwat process.

The following subsections set the companies proposals for:

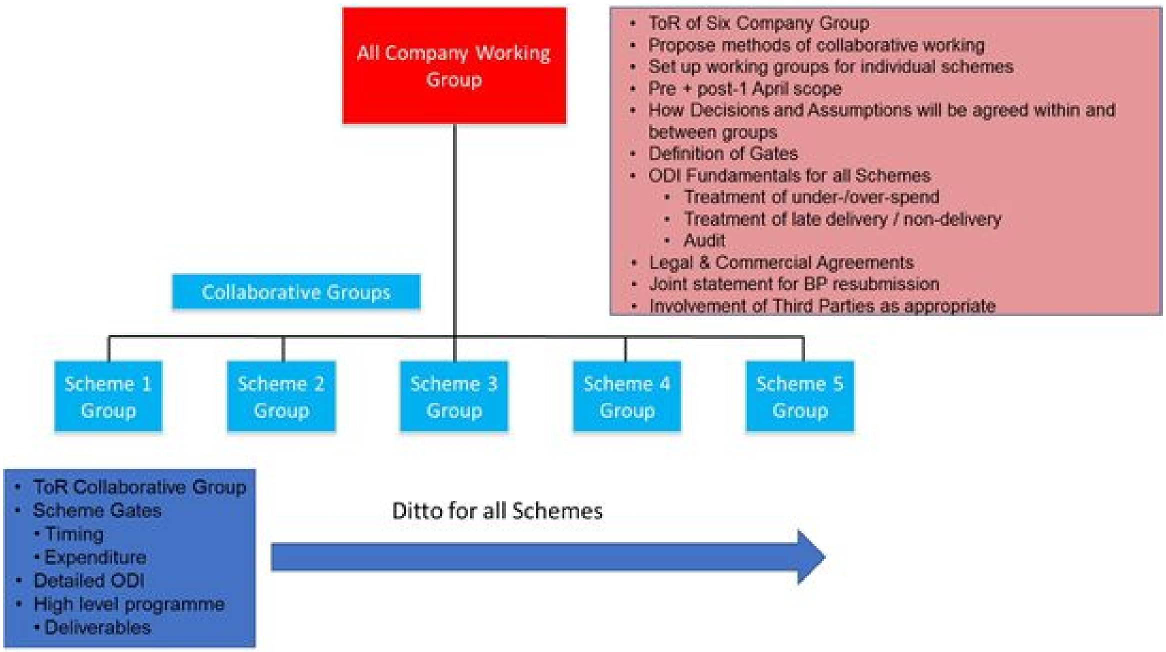
- Working groups: covering all company working group and project steering groups;
- Timing, gateways and governance; surrounding the progression of each of the schemes whilst still aligning it with the WRMP process;
- The principles of an ODI mechanism with an example.

It is hoped that this additional level of detail could be used to strengthen Ofwats proposals.

6.1 Working groups

It is proposed to develop two working group arrangements for the progression of the regional strategic schemes. This is set out in the diagram below:

Figure 20: Proposed structure of the ACWG and the scheme working groups



The ACWG (made up of the six companies and chaired by WRSE) is proposed to ensure that there is a consistent and collaborative approach adopted by each of the companies. It will also facilitate knowledge sharing about options for collaborative working for individual schemes. The high level working group will include those involved in the options, including the water companies, the regional groups and also with EA, Ofwat and Defra invited to attend. This membership may change due to changes in the options being considered. The key driver of this group is to manage consistency of approach across the options, including in costing and environmental benefits, proposing standard methodologies for the gated process and options for development of each option (e.g. the need for a Joint Venture).

Below this group will be a series of Scheme Working Groups. In some cases there is one company involved (e.g. Teddington Re-Use) and in others there will be at least three developing multiple options (e.g. Affinity Water, Southern Water and Thames Water developing the SESRO, the transfer to Affinity Water and the transfer to Southern Water).

The Scheme Working Groups will utilise the standards and methodologies to help inform the best approach for each option. The decision and progression of each group through the gated process will be a matter for each of the working groups. Any challenges or opportunities to improve will be fed back through the ACWG to allow review, learning and agreement on any proposed changes to approaches. The scheme specific working groups will set up their own legal and commercial agreements.

These groups will be set up and utilised up to Final Determination (FD) in December 2019. It is expected the shape of these groups will be reviewed again at this stage to confirm if they are still required.

Once the proposed Regulatory Alliance has been formed and its role defined the role of the ACWG will also be reviewed and re-aligned, if it is still required. For example the ACWG might become a review body that supports consistency of approaches across the scheme working groups.

A terms of reference for the current working group has been developed and is included in appendix B. The review of the process has highlighted some areas which could be enhanced if the amendments set out below could be made.

Appendix C sets out draft options for joint working at a scheme level which will continued to be developed by the companies as they set up the appropriate working level groups.

6.2 Timelines, Gateways and governance

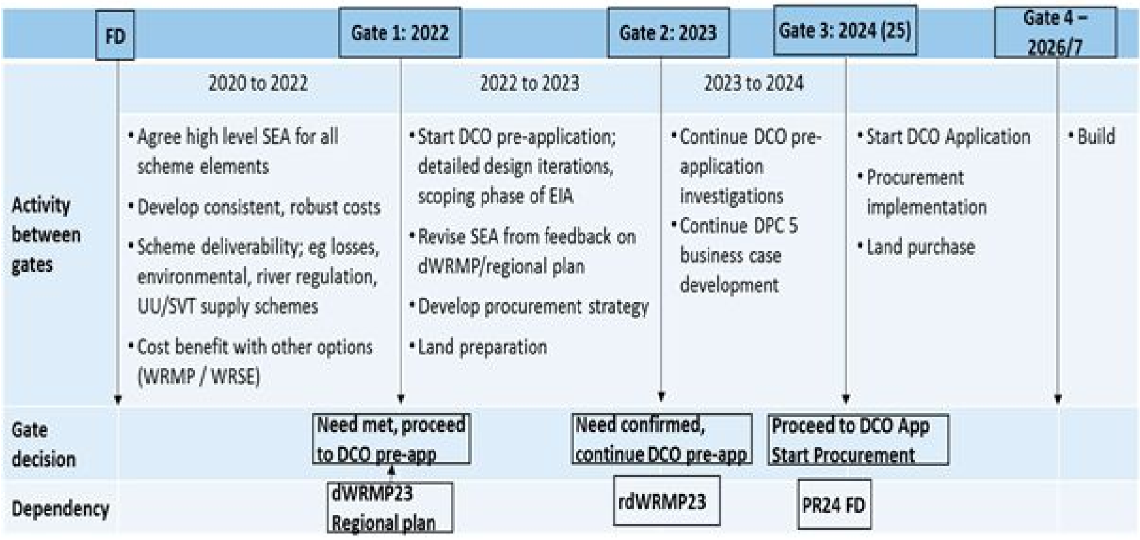
The gateway process that Ofwat have put forward provides a good way forward to develop strategic solutions, which can also inform the National Framework study. Some alterations to proposed process are set out below, but it is hoped that in completing this work it will help ensure that this process aligns with the development of the regional plans and company WRMPs; provides flexibility on the development of schemes in order to meet regulatory deadlines and ensures a consistency of approach.

- **Flexibility in the timing of the gateways:** By aligning the dates of the gateways with specific milestones for the development of the next company-specific or Regional WRMPs it will allow a better integration of the two processes, with clear outputs aligned.
- **Break gateway three into two gateways (DCO pathway only):** Gateway three is scheme specific as different schemes will require different levels of consents to build and operate them. Likewise, each scheme will have its own level of environmental and water quality considerations to investigate first in order to determine the final design. It is thought that instead of having one final gateway that this is broken down into two elements for schemes progressing down a DCO route and remain with three gates for a non-DCO scheme, these are highlighted in the proposal below.

6.3 Potential enhancement to the timing of the gates and the number of **gates**

A generic revised gated process and timings is shown in Figure 3 below (this example is for a large scheme following the DCO route). A more detailed activity breakdown of the activities to gate 4 is included in appendix D for reference:

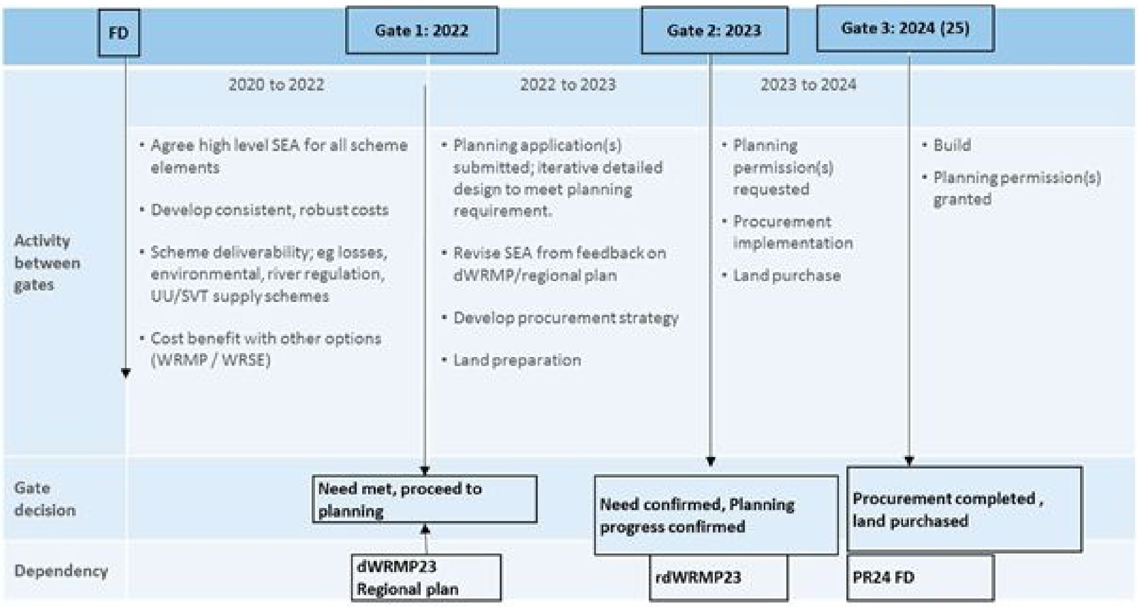
Figure 3: Example of gated process for a scheme requiring a DCO, using STT as an example



[1] A Development Consent Order (DCO) is the means of obtaining permission for developments categorised as Nationally Significant Infrastructure Projects (NSIP)

An equivalent timeline for a scheme that was not progressing through a DCO route is shown below.

Figure 4: Example of gated process for a scheme not requiring a DCO, using STT as an example



Whilst the Ofwat proposed timelines for the gateways is welcomed the following adjustments to each of the gates are set out below:

6.3.1 *Gate 1:*

This has been moved back one year to allow robust development of options aimed at the same need during Stage 1, for example, completing the EA work programme for the Severn Thames

Transfer (STT) to compare to the South East Strategic Resilience Option (SESRO). Work will also be completed on commercial and legal alignment between companies for joint working beyond Gate1, and any initial work for planning stages.

This timing of Gate 1 aligns with the publishing of the draft WRMP23, which will confirm any draft change in the need for water in the South East, and whether one or more of these options is required to continue.

Sign off at Gate 1 will be for robust options against a known need for continuation into Stage 2. [NB: A scheme can only request a Development Consent Order (DCO) if the Secretary of State has signed off the revised draft WRMP].

6.3.2 Gate 2:

During Stage 2 we propose the initiation of planning, either local planning or pre-application of the DCO, depending on the size of the option. As this stage requires access to land the company may require assistance from the Secretary of State to obtain permissions to enter land if land owners refuse access.

Also, initiation of the procurement strategy to align with the Direct Procurement for Customers (DPC), and any land preparation work.

This Gate allows review against the published revised draft WRMP24, the regional WRSE, Water Resources West (WRW) and Water Resources East (WRE) plans.

Sign off at Gate 2 will be for options completing required DCO and DPC activities, and also proving the need from WRMP and regional plans.

6.3.3 Gate 3:

During Stage 3 we propose to complete either planning phase for non DCO, or pre-application phase for a DCO option. Also, the DPC procurement strategy will be completed, ready for implementation. Any further land preparation activity or early purchase can be considered.

Sign off at Gate 3 is achieved for DCO with a completed planning, pre-application, and DPC plan. A non-DCO option will be ready for the build stage.

6.3.4 Gate 4 (DCO only):

During Stage 4 the option will request permission from the Secretary of State to move to the Application phase of the DCO. The procurement strategy for DPC will be implemented, and land will be purchased, using compulsory powers if needed.

Sign off at Gate 4 will include a consent order from the DCO examination, completed procurement of investment provider(s) and the land purchased.

For each Gate the actual sign off mechanism and body is still in discussion. It is expected that the existing statutory powers for regulators and government will apply. Therefore, the EA /NRW will review the option in line with the statutory WRMP process and associated guidelines, including environmental protection and proving the need for further water. If the option is successful, then Ofwat will sign off the economic best value of the option against other robust options. The Secretary of State will also be required to sign off at some points to align with the

WRMP sign off process, and also the Water National Policy Statement and associated DCO process. Other bodies, such as Natural England and DWI, may also be required to sign off. We are expecting the development of the Regulatory Alliance will be aligned with the National Framework.

Ofwat has provided funding using an averaged 6.4% of the overall investment within various published documents or tables, and splitting the funding 15%, 25% and 65% over 3 Gates. Companies may need further time to carry out an initial bottom-up exercise per scheme to determine the activities per stage, risks and opportunities, and therefore required funding. This may change the funding need per stage.

6.4 Change control process

The document has highlighted some proposed changes to the gated process above. During the discussions between the companies it has also been recognised that during the course of the next 5 years some of these schemes might change, be modified or substituted. It is recognised that there are other regional schemes that might be investigated by companies and or regions in the future. Therefore companies will include any new schemes in their specific company submissions by the middle of May (see forward plan) and then use the change control process to add or change schemes to the list from April 2020.

The three principles of this process should include:

- Specifying what the proposed changes to the scheme is / are. E.g. whether the scheme is stopping; being modified (scope or cost); or substituted.
- How will this will impact on any of the gateways and / or other regional schemes;
- Ensure that the proposed changes align with relevant statutory processes and the regulatory alliance governance process

We recognise that further work is required on this particular aspect but it will need to align with the proposed governance processes of the proposed Regulatory Alliance. Therefore the change control process is an interim mechanism until the proposed Regulatory Alliance has been formed and its role defined. If a change control mechanisms is still required then its purpose and role will align with the other processes set out by the Regulatory Alliance.

6.5 Development of an ODI type mechanism for customer protection

6.5.1 Introduction

In this section we set out key issues in the development of an ODI mechanism to allow allocated funding to be recovered by customers in the event of the scheme not progressing through each gate and for the non-delivery or late delivery of outputs.

This joint paper by six companies and WRSE does not propose a single specific ODI mechanism, but explores the issues and sets out some examples. This is intended to inform the development of specific ODIs by the companies and to provide a contribution to support development of Ofwat's thinking on the matter.

In developing an ODI mechanism we are making the following assumptions:

- We are currently pre-Gate 0, and Gate 0 starts at FD (December 2019).
- All options are assumed to be valid at the beginning of the process. Also, a programme of work will be defined to enable option validity to be developed / understood and decided at subsequent gates.
- Government and regulators have different roles:
    - Governments (the Secretary of State in England and Welsh Minister for the Environment, Energy and Rural Affairs in Wales) have a statutory role in approving WRMPs which select schemes to meet supply demand needs;
    - Environmental regulators have a role in providing advice to governments on WRMPs;
    - Environmental regulators have statutory role in approving consents for schemes that require impoundment or abstraction of water;
    - The economic regulator has statutory role in setting price limits which include an allocation for efficient expenditure for schemes;
    - The proposed Regulatory Alliance may have a role in coordinating input from regulators but at this stage is not thought to have a statutory authority and hence it cannot displace individual roles or responsibilities.
- Each gate is a checkpoint in the overall process where the need to continue scheme development can be assessed and a decision can be taken to continue with the recognition of development expenditure in price limits. Each gate occurs at the end of a stage of activity.
- Decisions should be taken in recognition that the gate process does not replace existing statutory processes, such as the Water Resources Management Plan. Decisions made at the gate review will affect the inclusion of development expenditure in price limits but will not be binding on other regulatory mechanisms or statutory processes.
- Stages (and their associated gates) will need to be defined carefully, in terms of either
    - a specific period of time in which to complete as much activity as possible, or
    - by a list of project outputs necessary to decide whether a project should continue, to be completed in whatever time is necessary.

6.5.2 Questions to consider:

There are a number of high level structural questions to consider about the ODI mechanism. These are set out below with some initial thoughts, which are then translated in to some principles in the following section.

6.5.2.1 What is the purpose of the ODI mechanism?

There is a recognised supply-demand need in the south east that needs to be met via one or more strategic options, but there is uncertainty about what the right option or options is / are for meeting that need. This uncertainty means we need a mechanism that enables the following approaches:

- To protect customers from incurring unnecessary expenditure by appointees when developing options to meet a defined supply-demand need.
- We may define "unnecessary" as expenditure that is not needed in the future because an option has been shown / agreed to be no longer valid, or was undertaken inefficiently in the past. Expenditure that was efficiently undertaken in good faith on an option that is subsequently dropped is not "unnecessary".
- To allow appointees to recover expenditure efficiently incurred in developing strategic options for consideration, including additional expenditure due to scope or risk change.
- To provide an incentive on companies to avoid delays in delivering outputs, by the application of a financial penalty if outputs are delayed or not delivered. This will require careful definition of the triggers for penalties to be applied, including whether there are mitigating circumstances that would avoid a penalty being applied (including a triviality threshold or force majeure-type circumstances).

6.5.2.2 What is the structure of the ODI mechanism?

There are a number of potential formulations of the ODI mechanism, but it should be based on the following considerations:

- Expenditure allocated to appointees but subsequently deemed "unnecessary" (see above) shall be returned to customers in the form of an end-of-AMP "true down" mechanism.
- The possible application of the totex sharing mechanism, where a portion of efficient underspend is retained by the company, or a portion of overspend is incurred by the company. (See question 8 below)
- There is potential for work outputs and associated expenditure allocated to each gate to move between gates as scope and desired outputs crystallise over time.
- The performance commitment metric can measure a number of different things:
    i. Allowed expenditure each year
    ii. Actual expenditure each year
    iii. Project milestones achieved each year
    iv. A percentage of total allowed expenditure/actual expenditure/milestones in each year
    v. Any of these could be measured annually or cumulatively over the period
- Penalty rates can be calculated in different ways:
    vi. A simple proportion of scheme stage expenditure allowance
    vii. A simple proportion of scheme total expenditure allowance
    viii. Proportion of annualised benefit lost due to the delayed output
    ix. Other?
- Are deadbands, caps and collars necessary to protect customers?
- The ODI structure should be relatively simple to aid the understanding of the measure by customers and stakeholders

6.5.2.3 What decision is made at each gate?

Ultimately, each gate should ensure that a decision can be taken to continue with the recognition of development expenditure in price limits. It therefore needs to consider:

- Whether work agreed at start of stage has been completed…
- …and whether expenditure on work carried out and completed was spent efficiently (with or without sharing of any savings).
- Whether there is a need for the scheme to proceed to next stage of development or is closed down (with or without amendment of scope of future work).
- Whether we need to change dates for future gates, and confirm scope and expected cost of future stage activities with element of risk / uncertainty, based on experience to date.

Note this requires the careful definition of the scope of activity within each stage, along with any dependencies (E.g. whether modelling work by appointees relies on activity by the EA in data gathering). Completing all work in a stage is likely to be necessary but not sufficient for a scheme to be approved to continue to the next stage (with the exception of work originally agreed as necessary but subsequently agreed in-stage not to be necessary to reach the gate decision).

It may be prudent to plan stage expenditure to include element of uncertainty / contingency; later stages have higher levels of contingency which reduces as gate approaches.

6.5.2.4 Who makes decisions at each gate?

Achieving clear, well evidenced and timely decisions at each gate will be critical for the successful functioning of the ODI mechanism. The decision making therefore needs to include the following factors:

- Each of the following regulators needs to be involved in the gateway decision: Ofwat, Environment Agency, Drinking Water Inspectorate, Natural England, Natural Resources Wales (for schemes which have components in Wales), Defra, Welsh government (for schemes which have components in Wales).
- All parties listed above can input to discussion / debate on whether the scheme need to goes ahead or is closed to further development.
- Given schemes are undertaken in order to meet supply-demand need as approved in WRMP, EA/NRW (and potentially DWI or Natural England) have a final say on whether scheme goes ahead by providing advice to government on WRMPs.
- Decisions on whether development expenditure should continue to be reflected in customers' bills will fall to Ofwat.
- Given there are environmental and economic decisions to be taken, it seems prudent to recognise all the varied aspects in the decision-making.

6.5.2.5 What criteria are decisions based on?

Decision making at gates should be based on a set of defined criteria to ensure an objective approach to decision making. Important considerations are:

- Appointees should put forward an assessment of the criteria and a proposal as to whether the scheme needs to progress through the gate and development continue to be funded by customers. This should be supported by evidence provided by the appointees and derived from the work programme to date with forecasts of likely future needs if relevant.
- Criteria for decisions at each i.e. gate should be agreed no later than the start of the relevant stage.
- Decision making could be based on a set of strict criteria assigned to individual regulators (E.g. the Environment Agency in relation to scheme selection based on their likely advice to the Secretary of State). Alternatively, a collective decision could be taken in the round based on an assessment of all the criteria, acknowledging that some risks and uncertainties will remain at various gates. Given that there will be risks and uncertainties, a decision in the round would appear most appropriate, provided this is evidence based and taken in customers' best interests.
- If a decision is to be taken in the round, ideally this would be by a collective decision by all the participants in the gateway. However, consideration should be given as to what happens if a collective decision can't be reached. Ofwat could chair the gateway review and make the final decision based on input and advice from the other organisations. This may be appropriate because the decision at a gateway will affect the prices paid by customers, but will not be binding on other statutory processes including the WRMP.

6.5.2.6 Is there an appeal process for the appointees?

Decisions taken need to be consistent and compatible with existing statutory processes. The ODI mechanism and the development of strategic options must be in parallel to and consistent with the statutory WRMP process. No additional appeal mechanism is or should be available that would be incompatible with existing statutory provisions.

6.5.2.7 Duration of gates

Clarity is needed on the timing and duration of gates. Important considerations are:

- When do gates start and finish? Do they overlap with stages of work or are they in between? Any work undertaken while a gate process is undertaken could be at risk if the gate decision is to stop work. However, it would not be efficient to pause work on a scheme while a gate decision is reached as this could lead to delays or increased costs.
- How long will be allowed for decisions to be taken? A relatively short gate process which allows for timely decisions would mitigate the concerns above.
- The need for a prolonged assessment period at each gate will be mitigated by the companies working closely with the regulators, facilitated by the proposed Regulatory Alliance (also known as the Shared Infrastructure Development Unit). Outputs of work, e.g. environmental investigations, will be shared as the work progresses and therefore it is unlikely that any new information will be revealed at a formal gate.

- A formal gateway review meeting may not be required for every scheme at every gate. Ofwat could decide in consultation with the regulators (or the proposed Regulatory Alliance could agree) if a review meeting is required. With the mitigation noted above, it seems possible for a review meeting, if required, to be held within one month of the date of submission, and if it is deemed not to be required a decision provided within one month of the date of submission. Similarly, a decision could be provided to the companies within two weeks of the date of the review meeting.

6.5.2.8 Interaction with efficiency incentives

It is still to be determined whether an efficiency incentive should be applied to companies' expenditure. On the one hand, companies should be incentivised to spend efficiently. On the other hand, companies should be incentivised not to over-populate scope or cost of activity so as to make a return. Factors to consider are:

- One approach would be to retain the normal cost efficiency incentives as per the PR19 methodology (i.e. the totex incentive), which incentivises accurate forecasting as well as efficient delivery. An ex-ante approach to setting or adjusting expenditure allowances through the ODI at each gateway would naturally preserve the totex incentive. It would also give the companies sufficient confidence to incur the necessary development expenditure.
- A second approach would be to regard expenditure incurred in developing strategic resources as outside the totex sharing mechanism, in the form of a cost pass-through mechanism with an economic purchasing obligation. Any underspend could be fully returned to customers, and any efficient overspend could be fully recovered from customers, not including penalties incurred. This would involve the companies reporting actual expenditure on the scheme during the period, with Ofwat confirming at regular points that there is nothing to indicate to them that expenditure to date has not been efficiently incurred. Then, at the end of the regulatory period, Ofwat could apply a revenue adjustment to offset the impact of the totex incentive on any over/under-spend against the ex-ante allowance. Such an approach would be appropriate when the expenditure requirements are particularly uncertain at the time of setting price limits. The risk with this approach is that it could result in decisions being made with the benefit of hindsight and therefore not allow companies to recover costs which were incurred in good faith. Such potential might act as a disincentive for companies to participate in scheme development.
- If totex incentives are retained, what rate should apply? Companies will ordinarily have different rates for the incentive. Should a common rate apply? One consideration is to whether the incentives relating to all the participants in a joint scheme are aligned. Using the same totex sharing rate for expenditure by all partners in a joint scheme would help to align incentives. This would require such expenditure to be reported separately and subject to a different totex rate than the rest of the company's expenditure.

6.6 Key Principles for the ODI type mechanism

Based on the above questions, and in the light of there being two possible approaches to efficiency, we consider the following principles should be adopted to ensure the ODI is designed to protect customers:

- Customers should not pay for expenditure to develop options beyond the point at which it is decided that options are not required;
- Companies should have confidence that efficient expenditure needed to develop options can be recovered from customers, otherwise there is a risk that options will not be developed by the time they are needed to supply customers;
- Companies should be incentivised to accurately forecast expenditure and to spend money efficiently;
- Companies should be incentivised to deliver outputs to sufficient time and quality to allow timely decisions to be made on the options;
- Where there are multiple beneficiaries of a shared option the risks should be shared proportionally between them, because to otherwise could place different incentives on the participants to the detriment of the option development;
- In any large infrastructure project there are risks and uncertainties which change over time. Sufficient flexibility should be retain to always allow decisions at each stage of development to be taken in the customers best interest, taking into account such risks and uncertainties understood at the time of the decision;
- A relatively simple formulation of the ODI should be adopted to aid transparency for customers and stakeholders, with a degree of consistency across schemes and companies;
- All relevant regulators should be involved in a timely decision making process aimed at taking an evidence based decision in customers' best interests;
- Each gate represents a decision point about whether development expenditure is to be reflected in prices paid by customers. It is important to recognise that this is separate from the statutory WRMP process which determines the content of WRMPs. Of course decisions on expenditure and prices should be made in the context of the developing WRMPs, but gate decisions should not be considered in any way binding on the WRMP.

These principles have been adopted in an example ODI which we set out in appendix E. This example demonstrates how an ODI might function, but does not constitute a single recommended approach by the six companies. Rather, it is intended to inform the development of specific ODIs by the companies and to provide a contribution to support development of Ofwat's thinking on the matter.

7 Proposed work plan

The working group has met and agreed a lot of information to develop this common approach to the proposed gated process. Whilst this has answered many questions there are still some outstanding issues that will be required to be resolved, these are listed in the table below The following programme below is set out in order to meet the regulatory timescales and the future gated process:

Set out a formal change control mechanism, which can also be used to record the decisions for stopping schemes and potentially substituting new schemes if required or is appropriate. This mechanism will come into force from the 1St April 2020.	16th May 19
Set out the dates for each of the gates on a scheme by scheme basis, accepting that gate 1&2 (with the possible exception of SWS) should align with the proposed WRMP process for the next plan.	16th May 19
An ODI for each scheme at working group level will be agreed and submitted to Ofwat	16th May 19
Expenditure for each scheme gate will be agreed between the relevant parties and submitted to Ofwat.	16th May 19

8 Summary

The proposed gateway process proposed by Ofwat is a positive step forward and provides a good mechanism to allow the selection and scheduling of the next key strategic options for the regions.

Whilst this process has been proposed by Ofwat the companies have worked together to propose some enhancements that would help with the identification of nationally significant schemes for water resources. The proposed plan of provides a series of deadlines to agree key activities which should help to inform the draft determination.

Good progress has been made to date including agreement on:

- A terms of reference for working collaboratively both across all of the companies and also on specific schemes;
- The principle of the scheme working groups, the requirement for specific ToR's, with the need for NDAs to be established as appropriate to each scheme;
- A proposal to modify the timing of the gateways based on whether the schemes are required to obtain a development consent order (DCO);
- Increased detail of the work between the proposed gates to allow an improved understanding of the funding required per stage to be undertaken, and to confirm the overall sum to complete all gates;
- The requirement and principles of a change protocol to manage specific changes to schemes in the proposal and to change the current list of schemes when required;
- Gateway acceptance criteria to be confirmed using the improved detail per gate
- Development of the principles of an ODI type mechanism;
- A forward-looking plan for further work for these actions is also included.

Appendix A: Ofwat's initial assessment of the costs per gateway per scheme from the IAP.

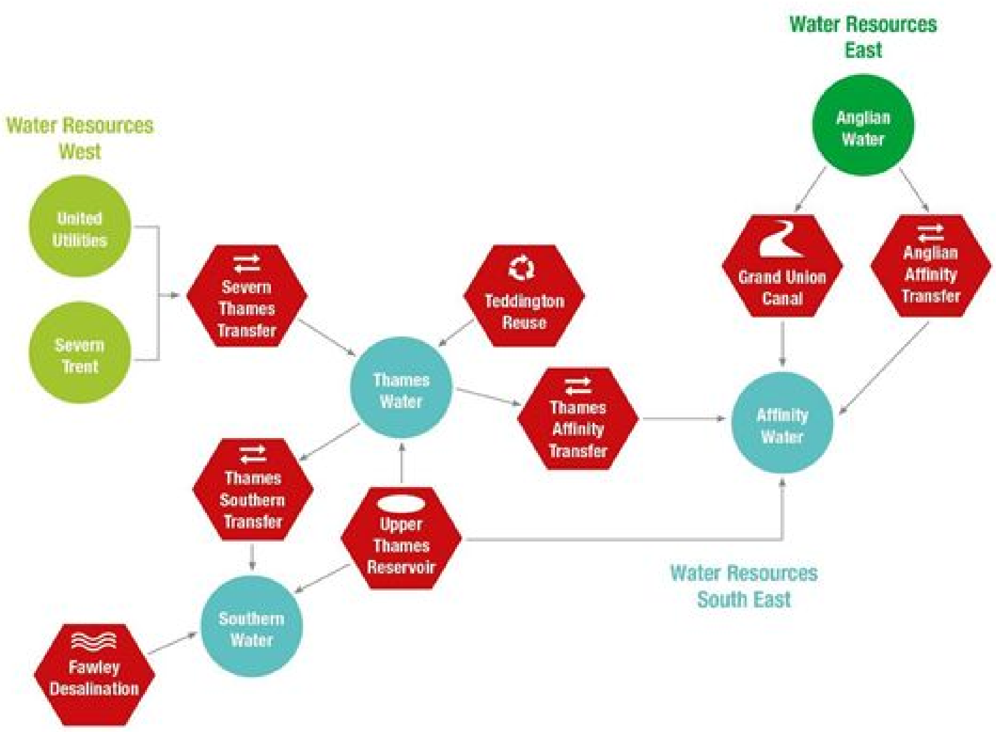
Water companies have proposed various assessment programmes to meet their supply demand balance challenges in the future to ensure resilient supplies, during severe and extreme droughts. These challenges will only increase due to climate change, population growth, environmental requirements and societal expectations.

Ofwat have reviewed the various proposed investment plans to meet these challenges as part of the initial assessment of business plans (IAP). In response to their assessment they have proposed a new process which will allocate up to £358m to consistently investigate, plan and develop several strategic regional solutions (reservoir, effluent reuse, transfers, desalination) in order to identify the regional optimum solutions and ensure they are construction ready by 2025. The term ‘construction ready’ has still to be defined, but the group have set out criteria in section 6.3 as part of the proposals. Customers will be protected as investment will be returned if an activity is not required or deliverables are not met.

A.1 Strategic schemes that have been referred to in the IAP

Whilst there have been many national water resource investigations across England and Wales, the schemes that have been included in the Ofwat IAP are those found in company business plan submissions that were considered to be of a suitable scale to be strategically important. Since the publication of the IAP Ofwat has recognised that this list of schemes is an initial list and that there are potentially other schemes that could be proposed. As such it will be for the water companies to make put forward other schemes.

The initial list of schemes and the water companies associated with investigating each of the schemes is set out in the figure below. The schematic layout of the IAP Water Resources schemes is subject to revision and is based on the initial view set out by Ofwat.



Details of Ofwats proposed funding of the schemes to take them through the gated process and the allocation of money between the water companies is set out in table 1 below.

Table 1: Water resource schemes outlined in the IAP.

10.16
14.69
10.52
40.88
31.45
77.11
64.17
109.44
358.41

The maximum development fund is based on 6.4% of the total scheme cost of the overall scheme (after making some efficiency adjustments). The 6.4% should equate to the development of the scheme option and its successful promotion to obtain the consents required to build and operate it. Therefore, the remaining 93.4% of the costs would be required to construct and commission the scheme. The data Ofwat analysed to derive the 6.4% was based on a range of different types of schemes that were included in the business plan, each of which have a different estimate of the cost required to develop the option and obtain the necessary consents required to build and operate it. It might therefore be more reasonable to use an agreed percentage allocation for the scheme type according to how difficult it will be to cost and gain consents for schemes.

Whilst the table refers to a maximum development allocation fund, companies will have to complete work to go through a gated process in order to retain funds. Any funds which have not been achieved by completing one of the gates would have to be returned to customer. The breakdown of costs per gateway is set out in table 2 below:

Table 2: percentage allocation of costs per gateway in the IAP

0.00%	15.00%	20.00%	65.00%

By combining tables one and two you can appreciate the level of funding that would be achieved, and the risks associated if they were not achieved. This breakdown is highlighted in the table below which also shows that the funding of these schemes is spread between all parties in a scheme, whether donors or recipient of water, in an equal measure. This statement does not comment on the cost estimates or allocation of costs, at this stage cost is a matter for those companies or groups promoting the individual schemes.

Upper Thames	36.48	0.00	5.47	7.30	23.71

Regional Reservoir (Abingdon - 2 sizes)					
Regional transfer from Thames to Southern	10.48	0.00	1.57	2.10	6.81
Regional transfer from Thames to Affinity	13.63	0.00	2.04	2.73	8.86
Anglian to Affinity Transfer	5.08	0.00	0.76	1.02	3.30
Grand Union Canal	5.26	0.00	0.79	1.05	3.42
Upper Thames Regional Reservoir (Abingdon - 2 sizes)	36.48	0.00	5.47	7.30	23.71
River Severn-River Thames transfer (pipeline and canal)	25.70	0.00	3.86	5.14	16.71
Teddington effluent reuse	64.17	0.00	9.62	12.83	41.71
Regional transfer from Thames to Southern	10.48	0.00	1.57	2.10	6.81
Regional transfer from Thames to Affinity	13.63	0.00	2.04	2.73	8.86
Upper Thames Regional Reservoir (Abingdon - 2 sizes)	36.48	0.00	5.47	7.30	23.71
Regional transfer from Thames to Southern	10.48	0.00	1.57	2.10	6.81
Regional transfer	13.63	0.00	2.04	2.73	8.86

from Thames to Affinity					
Fawley desalination	14.69	0.00	2.20	2.94	9.55
Anglian to Affinity Transfer	5.08	0.00	0.76	1.02	3.30
Grand Union Canal	5.26	0.00	0.79	1.05	3.42
River Severn-River Thames transfer (pipeline and canal)	25.70	0.00	3.86	5.14	16.71
River Severn-River Thames transfer (pipeline and canal)	25.70	0.00	3.86	5.14	16.71
Total	358.41	0.00	53.76	71.68	232.97

The purpose of the each of the gateways is to advance and achieve a given level of consistency of between the schemes to allow an informed decision to be taken to select which of the schemes to take forward. Table 3 below summarises to various gateways and when Ofwat have set out when they might be achieved.

Table 3: Ofwat's initial definition of the gateways in the IAP

Gateway 1 by 2021: Investigations and preliminary work to determine consistent inputs to decision making and designs, including: baseline and drought condition availability of water; environmental constraints; environmental, social and economic benefits; cost models and assumptions •Initial design work of schemes to specification required for initial decision making stage •Initial design work completed (using agreed consistent assumptions) and decision-making outputs presented and selected schemes carried forward
Gateway 2 by 2022: Detailed design work completed with outputs of decision-making presented and selected schemes carried forward
Gateway 3 by 2024: Planning permission granted for schemes and 'construction-ready'

The gateway process set out above defines a process which one gate must be reached before the next gateway can proceed. Overall the approach set out by Ofwat provides a mechanism through which strategic schemes can be developed on a consistent basis and allow a sub set of these schemes to be selected and taken forward to obtain the necessary permissions to build and operate the schemes.

Appendix B: Draft terms of reference for the All Company Working Group

Terms of Reference

- Group Tenure
  - To Final Determination (Dec 2019)
  - Post December 2019 the Group shall continue to meet in a facilitatory capacity to support and enable progress. The meetings will be quarterly.
- Membership
  - Affinity, Severn Trent, United Utilities, Thames, Southern, Anglian
  - Invites extended to Ofwat, EA, Defra, Third Parties (as appropriate)
- Secretariat
  - Chaired and facilitated by WRSE, with WRSE acting as the regional link to other regional groups as required
- Meeting Frequency
  - Every 2-3 weeks – for a period to end May 2019, then monthly to Final Determination
- Objectives of the group
  - To coordinate the delivery of the IAP actions relating to the development of the regional strategic options – as set out in the IAP by Ofwat (January 2019)
    - Agree methods of collaborative working within and between groups, facilitate and oversee joint proposals for schemes
    - Set out the review of the IAP scheme allocation and establishment of Schemes
    - ·Agree the principles of the Outcome Delivery Incentive
    - ·Publish minutes of meetings on web sites

    Note: Whilst the Group will facilitate and expedite timely progress of the work by setting out the initial framework, it does not carry the work out nor collectively organise the working groups (which will be performed at working group level), nor does this group carry a decision-making authority to decide on which schemes to be progressed or developed
  - To coordinate and align the changes required to the IAP gated process to fit with the wider planning process and deliver workable outcomes
  - Agree the modelling and technical linkages between the strategic schemes working groups and regional groups in relation to drought and costs assumptions

    Note: There is an important link with the regional planning level, where the list of schemes may be changed in time, as an output from the regional options assessments. That work will be performed in a consistent manner using methodologies that will meet regulator expectations. It is important that this group is cognisant of that work and should a change mechanism be required will have developed that mechanism in timely fashion with Ofwat
- Outputs
  - In time for companies re-submission by 1st April

    - A milestone timeline for the outputs of the Group to 1st April, Draft Determination (DD) and Final Determination (FD)
    - An agreed definition of Gates that can be used for Schemes at Gate 0 (FD)
    - Agreed assumptions on drought scenarios and cost modelling
    - The principles of the associated ODI that the individual Scheme Groups will use.
    - A Joint Statement from the Six Companies providing commitment to the working of the Strategic Solution Development
- In time for Draft Determination (e.g. middle/end May)
    - Suggested Schemes for Gate 0 with expenditure at each gate and associated ODI
    - The interaction of the Gates with a Regulatory timeline
- For Final Determination (Dec)
    - Final set of Schemes, with Gates and Expenditure, and associated ODI

Appendix C: Discussion document setting out some draft options for working groups

C.1 DRAFT OPTIONS FOR JOINT WORKING

C1.1 Introduction

In its IAP feedback, Ofwat identified that appointees will need to work together on developing strategic resources. Ofwat wants companies to:

> "jointly propose methods for collaborative working including setting up the joint working group for individual schemes, and how consistent assumptions and decisions will be made within these groups and between them."

This appendix is a discussion paper setting out high-level options for the joint working arrangements for individual schemes. Specifically, it looks at options for governance arrangements and allocation of funding between the appointees, and compares each option with the others.

The proposals set out below are based on the following assumptions:

- Several of the appointees operate within a whole business securitisation framework ("WBS"). The WBS prescribes the financing and operating activities of the regulated companies, and restricts the types of transactions they can undertake. In return, the appointees can maintain a higher level of gearing than they could if they were not operating under a WBS;
- Different approaches to joint working may be adopted, either across AMP7 or by different companies working on different schemes;
- For companies involved in more than one scheme, it may make sense for them to adopt the same approach to each scheme they are involved in;
- This note does not consider any relevant accounting (regulatory or otherwise), competition law or tax considerations or implications;
- We need to be aware of competition law requirements – the approach to joint working will need to be reviewed regularly; and
- Other joint working arrangements may exist which are not yet captured in this draft note.

C.2 Options for joint working

The options we are currently considering are summarised as follows (in increasing order of formality):

C.2.1 Simple Memorandum of Understanding Model ("MoU 1")

Appointees could use a simple MoU to agree the approach to joint working, including an agreed scope of work projects they would each have to do, who would carry out the work and how totex would be expended, including any potential redistribution of the existing equal-shares allocation. Each appointee would use its existing employees and internal governance arrangements, including Executive and Board, but would need to agree monitoring and governance arrangements for shared reporting of progress and delivery of shared objective.

C2.2 More Detailed Memorandum of Understanding Model ("MoU 2") – similarities to current WRSE model

The Water Resources in the South East ("WRSE") Group is a voluntary alliance of 6 appointees and 5 other stakeholders (including the Environment Agency). It works to develop long term plans for securing water supplies for south east England. It is funded by individual contributions from each appointee (and from the Environment Agency), pro-rated according to the relative size of each appointee's customer base. Individual appointees carry out work for the good of all WRSE members according to a scope of work agreed by all. Technical work is carried out by external contractors, procured through competitive tender by a single appointee acting on behalf of all members. Quality of work is reviewed by WRSE groups. Levels of governance include a CEO-level group, a Senior Leadership Team and a Project Management Board, comprising staff from appointees. The WRSE model could be replicated (broadly) for these schemes.

C.2.3 Contractual Joint Venture/Contractual Consortium/Contractual Collaboration Model ("Contractual JV")

A non-incorporated, contractual only joint venture between the parties could be considered which would effectively be a commercial arrangement between two or more or more of the companies as economically independent entities. Resourcing and governance of the JV would need to be agreed between the parties as part of the contractual arrangement but would likely be similar to the MoU 2 Model.

C.2.4 Incorporated Joint Venture Company ("JVCo")

Appointees could create a JVCo, funded by each with their share (all or a proportion) of the totex allowance. The JVCo would have its own staff (seconded from the appointees or employed separately) and governance arrangement, including Executive and Board and agreed reporting and accounting procedures. The investor-appointees would agree the role, purpose and business plan of the JVCo, including scoping the work projects it would have to do and how much autonomy it held to change its agreed scope.

C.2.5 Comparison of options

Table 1 below sets out a non-exhaustive list of potential benefits and disbenefits of each option.

Table 1 – potential benefits and disbenefits of potential options for joint working

Option	Pros	Cons
MoU 1	• Easy to establish • Minimal set-up and on-going cost • Companies already regulated by EA and Ofwat, clear collective responsibility and direct control over appointees • Maximises flexible working and cost efficiency through use of in-house resources or consultants	• Separate companies retain own incentives / objectives, reduced integration and cooperation compared with Contractual JV or JVCo • Potential for less transparency than other options • Lacks clarity of accountability – priorities within companies can change and distract from single purpose, relies on cooperation between companies

		• Harder to track totex – managed by each company across internal and external resources (on individual and joint activities)
MoU 2	• Existing precedent, easy to establish • Creates more structure than MoU 1 but without need for separate legal entity – members agree on budget and program of work in advance • Maintains flexibility to change scope of works if agreed by members • Allows totex to be pooled and paid in stages • Use of consultants helps protect each company's commercially sensitive data • A competitive tender process helps to provide transparency	• No current basis for regulation or control by Ofwat / EA, less accountability than for MoU, but can establish decision membership levels for these organisations • Lacks a separate legal identity – can suffer from a lack of clear structure and identity, which may affect both internal operation and dealings with third parties • Likely use of consultants to complete work with supervision from companies may increase costs • Absence of commercial contract to do procuring may create problems in event of dispute about outputs
Contractual JV	• Clear scope of the venture • The obligations and commitments (including liability) of individual companies contractual in nature and clearly understood • Use of consultants helps protect each company's commercially sensitive data • Competitive tender process helps to provide transparency • Provisions covering the financing of the venture considered at the outset	• Significant set-up and ongoing costs, especially for securitised companies • Tax and competition law considerations would need to be considered and may defeat the plan • Securitised companies may have issues under their financing documents in relation to entering into 'joint ventures' • Strict governance required to ensure success • Likely use of consultants to complete work with supervision from companies may increase costs
JVCo	• Clear and compartmentalised scope , boundaries and responsibilities • Maximises transparency through separate, audited accounts • JVCo can be sold/transferred to CAP following DPC • Clear risk sharing • Allows totex shares to be pooled – upfront or each year • Use of consultants helps protects each company's commercially sensitive data • Competitive tender process helps to provide transparency	• Significant set-up and ongoing costs, especially for securitised companies • Tax and competition law considerations would need to be considered but likely a lesser challenge than the Contractual JV • No current basis for regulation or control by Ofwat / EA, less accountability than for MoU • Strict governance required to ensure success • Securitised companies may have issues under their financing documents in relation to entering into 'JVs' • Likely use of consultants to complete work with supervision from companies may increase costs

To consider which option might be better than the others requires a set of criteria against which to judge them. Companies are still in the early days of discussing an agreeing their proposed approach to joint working and therefore these criteria are yet to be finalised. However, it seems reasonable that the criteria might include:

- The ease by which the joint arrangement is set up and maintained, including governance arrangements and ways of working;
- How much it would cost to set up and maintain the joint approach, including staff and overheads;

- The degree to which the joint approach provides clarity of purpose and delivers outputs accordingly;
- How much transparency and accountability each model allows; and
- The level of commercial protection afforded to each member in the event of disputes about delivery of outputs.

Notwithstanding the above analysis, it is likely that the companies will consider utilising more than one model as the requirements of the scheme change and its definition evolves. It might be, for example that one of the less formal structures is utilised initially, with a view to considering whether a more formalised structure could be utilised further into the project.

C.3 Conclusions and next steps

Each of these options appears to have benefits and disbenefits, of varying scale, and hence further work will be needed to develop and assess each option and to compare them with each other. There may also be other options not yet captured in this model.

The 6-company working group has been discussing the approach to the programme of developing the schemes in recent weeks. It is clear from these discussions and from Ofwat's IAP feedback that the scope of activities and detail of totex allocations across each stage has yet to be defined precisely but there is a consensus that expenditure up to Gate 1 is likely to be small relative to expenditure across subsequent stages of the programme.

If this assumption continues to hold, it would seems to be a prudent and pragmatic option to agree a flexible way of working that is easy to set up, with minimal cost and with little in the way of risk or legal formality. Companies can continue to develop other options for joint working and can decide later – when expenditure is likely to be much bigger than for stage 1 – whether such an arrangement needs to be replaced, and if so, with what other option.

Appendix D: An example of some generic programme of activities potentially required to get to gate 4

To align with the gateway timeline and high level stage activities in Section 6.3, a more detailed programme of activities has been provided. This is planned to be used to provide an initial bottom up view of funding to ensure that each scheme has an improved view of funding per stage and as an overall sum. The diagram below provides a view of part of the output in Stage 2, post Gate 1, for a DCO option

Generic activities for strategic scheme delivery to Gate 4, assuming DCO and DPC - DRAFT FOR DISCUSSION

Task Name	Activity 0	Gate 0 (July 2019)	Activity 1	Gate 1 (SOBC) - Mid 2022	Activity 2	Gate 2 (OBC / Final WRMP24)- Q4 2023	Activity 3	Gate 3 (Ready to submit DCO/FBC) - Q1 2025	Activity 4	Gate 4 (contract Award) - Q4 2027
Pre-Application										
DCO Application										
Review baseline data					Y					
Non statutory public consultations					Y		Y			
Consultation Strategy					Y					
Prepare notification to Secretary of State					Y					
Notify Secretary of State of the application					Y					
Statement of Community Consultation					Y					
Prepare supporting documents					Y		Y			
BAT Study										
Statutory consultation							Y			
Consultation Report							Y			
Notification of intent to submit DCO (Section 48 Notice)							Y			
Final refinement and preparation of the application							Y			
EIA										
EIA scoping					Y					
EIA					Y		Y			
Prepare Preliminary Environmental Information					Y		Y			
Environmental Statement					Y		Y			
Land										
Land referencing					Y					
Land purchase (voluntary)					Y		Y			
Notices / access to land					Y					
Surveys										
Topo / bathymetric survey					Y					
Ground investigations					Y		Y			
Location of existing services					Y		Y			
Land drainage info			Y		Y		Y		Y	
Water quality sampling					Y		Y			
Archaeological and ecological investigations										
Archaeological investigation					Y					
Ecological investigation					Y					
Engagement with regulators and statutory authorities										

Appendix E: A discussion document setting out an example of an ODI type mechanism

In the ODI section above we listed some principles for the design of an ODI to protect customers. These principles have been adopted in an example ODI which we set out below. This example demonstrates how an ODI might function, but does not constitute a single recommended approach by the six companies. Rather, it is intended to inform the development of specific ODIs by the companies and to provide a contribution to support development of Ofwat's thinking on the matter.

E.1 Measure definition

This measure is aligned to the proportion of the development costs for a strategic water resources scheme expected to be incurred between gate reviews. There are four gateways proposed between 2020 and 2025. At each of these gateways there will be a formal review of the progress made in developing the scheme and the evidence available at the time, assessed against a pre-determined set of criteria. All relevant regulators will be involved in the gateway: Ofwat, Environment Agency, Drinking Water Inspectorate, Natural England, Defra (and if the scheme has components in Wales, Natural Resources Wales and Welsh government).

Evidence will be presented by the companies and considered in the round to reach a collective decision as to whether the project passes a gateway. This will determine the ODI reporting and therefore, if necessary trigger an adjustment to the prices paid by customers to reflect changes in the expenditure needed for the scheme development.

The ODI for each company will be measured as the percentage of the company's option development costs allowed in that company's price limits for each year.

The company will report performance annually, with 2020/21 being the first year of performance reporting. Performance reporting will be based on decisions taken at the gateways. The percentage performance reported in each year will designed to ensure the correct payments will apply to recompense customers for the development costs recognised in price limits.

If a collective decision is made that the scheme should not progress beyond a gateway then the company will report zero percent after that date. Alternatively, if a collective decision is made the scheme should progress to the next gateway then the company will report the ex-ante determined percentage up until the next gateway. In either case the company will report each year the percentage as agreed by the regulators at the preceding gateway.

This ex ante approach to agree the ODI reporting preserves the normal cost efficiency incentives as per the PR19 methodology (i.e. the totex incentive) in this example. However it also means that an additional element is needed to protect customers in the exceptional event that a company fails to deliver; this is set out in the mitigation/exceptions section below.

E.2 Mitigation/exceptions

Evidence will be presented by the companies and considered in the round to reach a collective decision as to whether the project passes a gateway. The overriding factor in the gateway decision will be whether the customers' best interests are served. In exceptional circumstances the gateway decision could commit the company to report a percentage other than zero or the ex-ante allocation.

For example, in the event that the company fails to deliver a necessary output for a particular gateway, a lower percentage would be agreed to ensure that customers do not pay for that output. To ensure the correct percentage is reported, the company will seek assurance on the costs associated with that output and the reasons for non-delivery. Companies should not be penalised for circumstances outside their control.

An alternative example may be that the gateway decision is to accelerate various aspects of the work programme. In this example it could be agreed that a higher percentage than the ex-ante assumption could be reported from that point on. This would also work symmetrically so that it could be agreed at a gateway that the work programme should proceed on a delayed schedule, for example to allow for further consultation or additional analysis.

In any of these exceptional cases the company would provide assurance on the costs and evidence that it is in the customers' interest and the gateway review would determine the percentage to be reported.

E.3 Incentive type

This is a financial incentive with "underperformance" and "outperformance" elements.

It provides a mechanism for the company to recover different levels of expenditure from customers following decisions by regulators at the gate reviews. The financial adjustments should therefore be regarded as a "reckoning up" of necessary costs and not reflecting actual company performance.

The inclusion of an "outperformance" element will allow gate review decisions to accommodate acceleration or increase in scope if new evidence justifies the need for this. It is not intended to be a reward mechanism for companies.

There are no deadbands, caps or collars associated with this measure because the decision making by regulators in in the gate decisions provides the necessary protection for customers.

E.4 Outperformance/underperformance incentive rate

As set out above the performance commitment is set for each company based on their contribution to the scheme during AMP7. Therefore there are separate incentive rates for each company. The rate will apply symmetrically for outperformance and underperformance.

In this example we calculate the rate based on the costs assumed for one company's contribution to the option ("company X"). The approach is:

- Take the total option costs allocated to company X, which is assumed to be £25.7m in this example
- Company X has a 50:50 totex incentive rate so the £25.7m cost is multiplied by 50% to allow for the totex sharing mechanism.
- Divide by 100 to give the value for 1% delay.

In this example the incentive rate for the company is therefore £128,500 for each per cent of the project.

E.5 Worked examples

Below we set out three examples to demonstrate how the ODI mechanism will work to protect customers. These examples use the example incentive rate from above, and the example performance commitment targets in the table below. Note that for simplicity of presentation these examples assume that gateways fall at the end of a financial reporting year, however alternative gateway dates can easily be accommodated in this mechanism.

	Unit	AMP6	AMP7				
			2020/21	2021/22	2022/23	2023/24	2024/25
Performance commitment (example)	%	N/A	**10%**	**15%**	**25%**	**25%**	**25%**

E.5.1 Example 1: project stops after gateway 1 in March 2022

Based on the draft/final determinations and gateway 1 decisions the scheme development progresses as planned until gateway 1 in March 2022. Evidence is reviewed against the criteria at gateway 1 and the regulators decide that there is no need to progress the scheme beyond that point. The company therefore reports zero for each subsequent year.

	Unit	AMP6	AMP7				
			2020/21	2021/22	2022/23	2023/24	2024/25
Performance commitment	%	N/A	**10%**	**15%**	**0%**	**0%**	**0%**

This will therefore trigger underperformance payments of:

- Year 2022/23: (25% - 0%) × £128,500 = £3,212,500
- Year 2023/24: (25% - 0%) × £128,500 = £3,212,500
- Year 2024/25: (25% - 0%) × £128,500 = £3,212,500
- Total = £9,637,500

It can be seen that price limits had assumed that 75% of the £25.7m would be spent in these years, i.e. £19,275,000. Through the totex sharing mechanism half of this, i.e. £9,637,500, will be returned to customers. The other half is returned to customers through the ODI as above. This ensures that customers do not pay for this expenditure which is not needed.

E.5.2 Example 2: company does not deliver output needed for gateway 1 in March 2022

In this example the company does not produce a necessary environmental assessment that is required for gateway 1. The company prepares audited evidence that the cost associated with the environmental assessment is £500,000 and notes that the reason for the absence of the assessment is not for reasons outside its control. This evidence is reviewed and at the gateway review it is decided to accept this evidence. It is also decided that, based on the range of other evidence that the scheme should progress with the environment assessment being delivered by the next gateway.

It is therefore agreed that the company will report a lower percentage in 2021/22 to ensure that customers don't pay in full for the £500,000 environmental assessment. This percentage is calculated as follows:

- Ex ante allowance for the year = 15%
- Environmental assessment as a proportion of ex ante scheme development cost = £500,000 / £25.7m = 1.95%
- Reported performance in 2020/21 = 15% - 1.95% = 13.05%
- Underperformance payment for 2021/22 = (15% - 13.05%) × £128,500 = £250,000

The company subsequently delivers the environment assessment and the scheme progresses through subsequent gateways.

	Unit	AMP6	AMP7				
			2020/21	2021/22	2022/23	2023/24	2024/25
Performance commitment	%	N/A	**10%**	**13.05%**	**25%**	**25%**	**25%**

Overall, because the company incurs the cost of carrying out the environment assessment and returns money to customers through the ODI there is a net penalty. The potential for such penalties incentivises the company to deliver its contribution to the scheme in a timely and robust way.

If the company needs to incur additional expenditure to complete the same environmental assessment then this would not be reflected in the ODI reporting and would be subject to the normal totex incentive. In this example with 50:50 totex sharing, if the company had to incur an additional £500,000 the total expenditure incurred by the company would be £1m and the total recoverable from customers would be the £500,000 cost of delivering the assessment once. The company is penalised by £500,000 because it has incurred this additional expenditure which it cannot recover from customers.

E.5.3 Example 3: Acceleration of scope

In this example the scheme progresses as planned up to gate 2 in March 2022. In the run-up to gate 2 it emerges through finalisation of WRMPs and engagement with the regulatory alliance that the need for the scheme is earlier than previously anticipated. The companies involved in the scheme consider whether the scheme can delivered earlier and share evidence with the regulators. The companies submit a proposal into the gate review evidencing the accelerated plan and expenditure requirements.

A decision is then taken at gate 2 that the scheme should be accelerated because the need arises earlier than anticipated and work up to that point has shown that the subsequent stages can be delivered earlier than previously thought. It is therefore agreed that the company requires an additional expenditure allowance of £2m for 2023/24 and (following gate 3) an additional £5m for 2024/25. The additional £5m is subsequently confirmed at gate 3 and across AMP7 the company therefore reports as follows.

For 2023/24:

- Additional expenditure required £2,000,000
- Multiply by 50% to account for the totex incentive rate
- Divide by incentive rate of £128,500 to give 7.8%
- Add this to the original target of 25% to give 32.8%

Applying the same mechanism for 2024/25 gives a figure to report of 44.5%.

	Unit	AMP6	AMP7				
			2020/21	2021/22	2022/23	2023/24	2024/25
Performance commitment	%	N/A	**10%**	**15%**	**25%**	**32.8%**	**44.5%**

This triggers an “outperformance” payments as follows:

- Year 2023/24: (32.8% - 25%) × £128,500 = £1,000,000
- Year 2024/25: (44.5% - 25%) × £128,500 = £2,500,000

It can be seen that this allows companies to recover 50% of the costs associated with the increased scope through the ODI. The other 50% is recovered through the totex incentive.

It can also be seen that normal totex incentives apply after the gate, so that if the company actually spends more than the £2m assessment of the efficient expenditure needed for 2023/24 it cannot recover all of that additional expenditure. Equally the company can retain a proportion of any underspend against this ex ante assessment. This ensures that the company is always incentivised to deliver the work in an efficient way.

The mechanism set out in example 3 would work symmetrically so that it could be agreed at a gateway that the work programme should proceed on a delayed schedule, for example to allow for further consultation or additional analysis.

E.6 Risks and issues

Principal risks relating to the performance commitment are external factors, for example weather conditions can limit the ability to undertake certain environmental surveys. There also risks associated with the number of parties involved in the scheme but this will be mitigated by clear terms of reference and joint venture agreement.

It should also be noted that there is no pre-determined expectation that this scheme will pass through all the gateways. The mechanism is designed to allow work to progress to create option value and to protect customers should it be subsequently determined that the work does not need to progress further. There are a number of other strategic options being considered for the water resources needs of South East England and not all of them are expected to progress through all gateways. If this option does not progress on the basis of the evidence considered at a gateway this should not be seen as a performance failure by the company.

Appendix AFW.CE.A2.2

Action ref AFW.CE.A2

Affinity Water Scheme Review

We have reviewed the Ofwat IAP inclusion of Affinity strategic regional options and can confirm that these schemes can be taken forward to ‘Gate 0’, pending the ongoing group work between now and May.

Our summary of the schemes that will be taken forward for ‘Gate 0’ are as follows along with a number of key notes to explain some minor aspects of

Table A1.2 Alignment between our rdWRMP19 and our BP for our regional strategic options

Scheme Name (rdWRMP19)	Scheme Name BP (IAP)	BP (IAP) Regional development partners	Included in our rdWRMP strategic assessment	Selected in our rdWRMP19 ‘Best Value Plan’	Taken forward for Gate 0 (April 2019)	Scheme Comments	DCO / non DCO
South East Strategic Reservoir and associated transfers	Abingdon Reservoir Regional Transfer from Thames to Affinity	Thames and Southern Water	Y	Y	Y	This scheme is referred to as the SESR option and there is a regional transfer from the River Thames to Affinity Central. Both of these are included within in our rdWRMP19 BVP and our BP	SESR is DCO The regional transfer is non DCO
Severn-Thames Transfer (STT)	Severn Thames Transfer	Thames, Severn Trent and UU	Y	N	Y	We have assessed the STT in our rdWRMP19 and we will continue to work with the regional development partners as part of the Regional Transfer scheme from Thames to Affinity Central.	N/A
South Lincolnshire Reservoir		Anglian Water	y	N	Y (Transfer only)	We have assessed the SLR and transfer to Affinity Central and will be	non DCO

and Anglian transfer to Affinity	Eastern Regional Transfers					working together with Anglian Water to continue to assess the feasibility of the scheme for Gate 0. The transfer element is included in Gate 0.	
Grand Union Canal Transfer		Canal & River Trust, Anglian and Severn Trent Water	Y	Y	Y	The GUC scheme is included within in our rdWRMP19 BVP and our BP. We are continuing with our work with CRT and the other regional development partners	non DCO

Key Notes:

- The Minworth Effluent Transfer (with Severn Trent Water) was assessed within our rdWRMP19 but was not selected in the BVP and is not included in the BP. We have requested that it be added to the long list of strategic options that could form alternatives that could be added to Gate 0 in the future

- The South Lincolnshire Reservoir element of the Eastern Regional Transfer scheme to Affinity from Anglian Water is subject to a review by Anglian Water in conjunction with Affinity Water. Currently we understand that the transfer element has been included within the IAP and we are working with Anglian Water to understand if the South Lincolnshire Reservoir will be added to the scheme for Gate 0.

We consider the only scheme at this time that would require a Development Consent Order would be the SESR scheme.

Appendix AFW.CE.A3.1

Action ref AFW.CE.A3

Amber WINEP Queries Response

AFW.CE.A3.1 (Q1), Supporting evidence table below to advise how the sustainability reductions and 28 river morphology projects referred to in section 10.19 of Appendix 10 map on to the 13 Amber schemes listed in WINEP3. In our revised Business Plan we have added a column to Table 4.3 in section 4.9 to show the link between Amber SR's and the 28 river morphology projects.

OFWAT Classification(s)	Scheme	Asset	Driver	Issue	Scheme Details	Relationship to 10.19 of Appendix 10	WINEP ID
WINEP Water Resources Implementation Morphological Mitigation	Ivel (US Henlow)	BOWR,FULR and BALD	WFD_IMP_WRFlow, INNS_ND and NERC_IMP1	Linked to WR AMP6 Options Appraisal work where river restoration will be conducted in combination with river support schemes	Implementation Scheme: Undertake river restoration to mitigate the effects of abstraction	This WINEP line equals £1.258m of the total cost £9.27m and accounts for 4no. Projects out of the total figure of 28 amber morphological projects.	EAN00384
WINEP Water Resources Implementation Morphological Mitigation	"Cam (Audley End to Stapleford) Cam (Newport to Audley End)"	NEWP, WEND, DEBD, UTTL and SPRF	WFD_IMP_WRFlow, INNS_ND and NERC_IMP1	Linked to WR AMP6 Options Appraisal work where river restoration will be conducted in combination with river support schemes	Implementation Scheme: Undertake river restoration to mitigate the effects of abstraction	"This WINEP line equals £1.258m of the total cost £9.27m and accounts for 4no. Projects out of the total figure of 28 amber morphological projects. Both EAN02412 and EAN02413 have been confirmed by the Environment Agency as Green WINEP measures."	"EAN00385 EAN02412 EAN02413"
WINEP Water Resources Implementation Morphological Mitigation	Upper Colne (Ver to Berrygrove gague)	NETH, BRIC, EAST and BERR	WFD_IMP_WRFlow, INNS_ND and NERC_IMP1	Abstraction mitigation under the AMP5 Investigation and options appraisal	Adaptive Management: Undertake river restoration projects and monitor the benefits.	This WINEP line equals £1.109m of the total cost £9.27m and accounts for 4no. Projects out of the total figure of 28 amber morphological projects.	"HNL00078 "
WINEP Water Resources Implementation Morphological Mitigation	Lower Colne (Confluence with Chess to River Thames)		WFD_IMP_WRFlow, INNS_ND and NERC_IMP1	Abstraction mitigation under the AMP5 Investigation and options appraisal	Adaptive Management: Undertake river restoration projects and monitor the benefits.	This WINEP line equals £1.475m of the total cost £9.27m and accounts for 4no. Projects out of the total figure of 28 amber morphological projects.	HNL00082
WINEP Water Resources Implementation Morphological Mitigation	Bulbourne	BERK	WFD_IMP_WRFlow, INNS_ND and NERC_IMP1	Abstraction mitigation under the AMP5 Investigation and options appraisal	Adaptive Management: Undertake river restoration projects and monitor the benefits.	This WINEP line equals £1.357m of the total cost £9.27m and accounts for 4no. Projects out of the total figure of 28 amber morphological projects.	HNL00079
WINEP Water Resources Implementation Morphological Mitigation	Chess	CHES and CHAR	WFD_IMP_WRFlow, INNS_ND and NERC_IMP1	Investigation ongoing and the solution unknown. The solution that will go through implementation will be determined through the investigation and options appraisal. River restoration works (if recommended) would be undertaken in pertnership with Thames Water.	Adaptive Management: Undertake river restoration projects and monitor the benefits.	This WINEP line equals £1.147m of the total cost £9.27m and accounts for 4no. Projects out of the total figure of 28 amber morphological projects.	HNL00080
WINEP Water Resources Implementation	Brett	HIGH, LATT, SHELL, STOK	WFD_IMP_WRFlow	To implement the conclusions of preceding Inv/OA in collaboration with Essex and Suffolk Water and Anglian: this is likely to involve	Adaptive Management: Undertake river restoration projects and monitor the benefits.	This WINEP line equals £1.303m of the total cost £9.27m and accounts for 4no. Projects out of the total figure of 28 amber morphological projects.	EAN00007

Morphological Mitigation				habitat restoration/compensation discharge to mitigate for reduction in flows, but could involve a sustainability reduction			
WINEP Restoring Sustainable Abstraction	Chess	CHES CHAR	WFD_IMP_WRFlow	Level of certainty - Amber	Sustainability reduction Average and peak	This relates to the Central - changes to zones where resources are lost investment line totalling £7.38m and an 'Amber' SR reduction of 6.38Ml/d.	"HNL00063 (Alma Road) HNL00066 (Chartridge)"
WINEP Restoring Sustainable Abstraction	Ivel	BOWR	WFD_IMP_WRFlow	Level of certainty - Amber	River Support scheme	n/a Environment Agency has now confirmed as a Green WINEP measure.	EAN02411
WINEP Restoring Sustainable Abstraction	Brett	SHEL HIGH LATT STOK	WRD_IMP_WRFlow	Level of certainty - Amber	Sustainability reduction Average and peak	This relates to the East - replace GI pipes to prevent discolouration allowing more use of Ardleigh water investment line totaling £8.7m and an abstraction reduction of 2.6Ml/d.	EAN02420

AFW.CE.A3.1 (Q2) response, Supporting evidence to provide a breakdown of the expenditure (capex and opex) allocated for these 13 schemes between lines in Tables WS2 we have provided a breakdown of expenditure per scheme on a copy of the WS2 table (scheme level expenditure detailed in red).

						2020-21					2021-22					2022-23					2023-24					2024-25				
Line description		WINEPID	Item reference	Units	DPs	Water resources	Raw water distribution	Water treatment	Treated water distribution	Total	Water resources	Raw water distribution	Water treatment	Treated water distribution	Total	Water resources	Raw water distribution	Water treatment	Treated water distribution	Total	Water resources	Raw water distribution	Water treatment	Treated water distribution	Total	Water resources	Raw water distribution	Water treatment	Treated water distribution	Total
Price base						2017-18 FYA (CPIH deflated)					2017-18 FYA (CPIH deflated)					2017-18 FYA (CPIH deflated)					2017-18 FYA (CPIH deflated)					2017-18 FYA (CPIH deflated)				
A	Enhancement expenditure by purpose ~ capital																													
1	WINEP / NEP ~ Making ecological improvements at abstractions (Habitats Directive, SSSI, NERC, BAPs)	NEP	See item	£m	3	2.557	0.000	0.000	0.000	2.557	4.587	0.000	0.000	0.000	4.587	4.252	0.000	0.000	0.000	4.252	5.938	0.000	0.000	0.000	5.938	3.810	0.000	0.000	0.000	3.810
	WINEP / NEP ~ Making ecological improvements at abstractions (Habitats Directive, SSSI, NERC, BAPs)	Morph works Upper Colne				0.116				0.116	0.243				0.243	0.224				0.224	0.325				0.325	0.201				0.201
	WINEP / NEP ~ Making ecological improvements at abstractions (Habitats Directive, SSSI, NERC, BAPs)	Morph works Bulbourne				0.142				0.142	0.297				0.297	0.274				0.274	0.398				0.398	0.246				0.246
	WINEP / NEP ~ Making ecological improvements at abstractions (Habitats Directive, SSSI, NERC, BAPs)	Morph works Chess				0.121				0.121	0.251				0.251	0.232				0.232	0.336				0.336	0.208				0.208
	WINEP / NEP ~ Making ecological improvements at abstractions (Habitats Directive, SSSI, NERC, BAPs)	Morph works Lower Colne				0.155				0.155	0.323				0.323	0.298				0.298	0.432				0.432	0.267				0.267
	WINEP / NEP ~ Making ecological improvements at abstractions (Habitats Directive, SSSI, NERC, BAPs)	Morph works Ivel				0.132				0.132	0.276				0.276	0.254				0.254	0.368				0.368	0.227				0.227
	WINEP / NEP ~ Making ecological improvements at abstractions (Habitats Directive, SSSI, NERC, BAPs)	Morph works Cam				0.132				0.132	0.275				0.275	0.254				0.254	0.368				0.368	0.227				0.227
	WINEP / NEP ~ Making ecological improvements at abstractions (Habitats Directive, SSSI, NERC, BAPs)	Morph works Brett				0.137				0.137	0.285				0.285	0.263				0.263	0.382				0.382	0.236				0.236
2	WINEP / NEP ~ Eels Regulations (measures at intakes)		references	£m	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	WINEP / NEP ~ Invasive non-native species		in columns	£m	3	0.091	0.000	0.000	0.000	0.091	0.079	0.000	0.000	0.000	0.079	0.076	0.000	0.000	0.000	0.076	0.076	0.000	0.000	0.000	0.076	0.068	0.000	0.000	0.000	0.068
1	WINEP / NEP ~ Drinking Water Protected Areas (schemes)			£m	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	WINEP / NEP ~ Water Framework Directive measures	SR		£m	3	6.599	0.000	0.386	0.856	7.841	15.468	0.000	0.759	4.269	20.496	15.320	0.000	0.761	4.271	20.352	12.969	0.000	0.075	0.075	13.119	3.182	0.000	0.000	0.000	3.182
	WINEP / NEP ~ Water Framework Directive measures - AMBER	SR - Chess				0.157				0.157	0.140				0.140					0.000					0.000					0.000
	WINEP / NEP ~ Water Framework Directive measures - AMBER	SR - Brett				0.572				0.572	2.179				2.179	2.179				2.179	2.179				2.179	2.179				2.179
3	WINEP / NEP ~ Investigations			£m	3	1.110	0.000	0.000	0.000	1.110	1.477	0.000	0.000	0.000	1.477	1.673	0.000	0.000	0.000	1.673	1.623	0.000	0.000	0.000	1.623	0.985	0.000	0.000	0.000	0.985
4	Improvements to river flows	Cam River support		£m	3	0.200	0.000	0.000	0.000	0.200	0.100	0.000	0.000	0.000	0.100	0.100	0.000	0.000	0.000	0.100	0.050	0.000	0.000	0.000	0.050	0.050	0.000	0.000	0.000	0.050
B	Enhancement expenditure by purpose ~ operating																													
40	WINEP / NEP ~ Making ecological improvements at abstractions (Habitats Directive, SSSI, NERC, BAPs)	NEP	See item	£m	3					0.000					0.000					0.000					0.000					0.000
41	WINEP / NEP ~ Eels Regulations (measures at intakes)		references	£m	3					0.000					0.000					0.000					0.000					0.000
42	WINEP / NEP ~ Invasive non-native species		in columns	£m	3					0.000					0.000					0.000					0.000					0.000
1	WINEP / NEP ~ Drinking Water Protected Areas (schemes)			£m	3					0.000					0.000					0.000					0.000					0.000
2	WINEP / NEP ~ Water Framework Directive measures	SR		£m	3	4.700				4.700	3.600				3.600	3.300				3.300	8.200				8.200	10.318				10.318
	WINEP / NEP ~ Water Framework Directive measures - AMBER	SR - Chess														0.001					0.001					0.001				
	WINEP / NEP ~ Water Framework Directive measures - AMBER	SR - Brett																												
3	WINEP / NEP ~ Investigations			£m	3					0.000					0.000					0.000					0.000					0.000
4	Improvements to river flows			£m	3					0.000					0.000					0.000					0.000					0.000

				20XX-XX				
Line description		Units	DPs	Water resources	Raw water distribution	Water treatment	Treated water distribution	Total
Price base				Outturn (nominal), 2017-18 FYA (CPIH deflated)				
A	Enhancement expenditure by purpose ~ capital							
1	WINEP / NEP ~ Making ecological improvements at abstractions (Habitats Directive, SSSI, NERC, BAPs)	£m	3	WS2001WR	WS2001RWD	WS2001WT	WS2001TWD	WS2001CAW
2	WINEP / NEP ~ Eels Regulations (measures at intakes)	£m	3	WS2002WR	WS2002RWD	WS2002WT	WS2002TWD	WS2002CAW
3	WINEP / NEP ~ Invasive non-native species	£m	3	WS2003WR	WS2003RWD	WS2003WT	WS2003TWD	WS2003CAW
1	WINEP / NEP ~ Drinking Water Protected Areas (schemes)	£m	3	WS2006WR	WS2006RWD	WS2006WT	WS2006TWD	WS2006CAW
2	WINEP / NEP ~ Water Framework Directive measures	£m	3	WS2007WR	WS2007RWD	WS2007WT	WS2007TWD	WS2007CAW
3	WINEP / NEP ~ Investigations	£m	3	WS2008WR	WS2008RWD	WS2008WT	WS2008TWD	WS2008CAW
4	Improvements to river flows	£m	3	W3027WR	W3027RWD	W3027WT	W3027TWD	W3027CAW
B	Enhancement expenditure by purpose ~ operating							
40	WINEP / NEP ~ Making ecological improvements at abstractions (Habitats Directive, SSSI, NERC, BAPs)	£m	3	WS2009WR	WS2009RWD	WS2009WT	WS2009TWD	WS2009CAW
41	WINEP / NEP ~ Eels Regulations (measures at intakes)	£m	3	WS2010WR	WS2010RWD	WS2010WT	WS2010TWD	WS2010CAW
42	WINEP / NEP ~ Invasive non-native species	£m	3	WS2011WR	WS2011RWD	WS2011WT	WS2011TWD	WS2011CAW
1	WINEP / NEP ~ Drinking Water Protected Areas (schemes)	£m	3	WS2025WR	WS2025RWD	WS2025WT	WS2025TWD	WS2025CAW
2	WINEP / NEP ~ Water Framework Directive measures	£m	3	WS2026WR	WS2026RWD	WS2026WT	WS2026TWD	WS2026CAW
3	WINEP / NEP ~ Investigations	£m	3	WS2027WR	WS2027RWD	WS2027WT	WS2027TWD	WS2027CAW
4	Improvements to river flows	£m	3	WS2028WR	WS2028RWD	WS2028WT	WS2028TWD	WS2028CAW

AFW.CE.A3.1 (Q3), Supporting evidence to provide clarity on how the volumes and costs set out in the tables in section 10.19.1 relate to the corresponding data in the table on p68 of Appendix 6 we have produced an additional table to clearly set out the green and amber SR's by volume and cost in the different areas (Central and East).

	Central		East		
LoC	Average Reduction (Ml/d)	Capex (£m)	Average Reduction (Ml/d)	Capex (£m)	Total Capex (£m)
Green	27.33	49.675	0	0	49.675
Amber	6.38	0.297	2.6	8.447	8.744
Total	33.71	49.972	2.6	8.447	58.419

AFW.CE.A3.1 (Q4) Supporting Evidence

We have reviewed the previously submitted single unit cost and feel that this number would be better presented as a single unit cost for supply side measures only. The demand side measures will therefore be removed.

We purpose to have a single unit cost for undertaking “amber” sustainability reductions supply side measures in our Central region and a separate single unit cost for undertaking “amber” sustainability reductions supply side measures in our East (Brett) region. The rationale behind having two separate rates being the cost differential between undertaking the “amber” sustainability reductions in the two regions is not consistent in terms of cost/Ml.

The unit cost of achieving sustainability reductions at each site is assessed from a combination of the cost of asset changes necessary to adapt our assets to replace the supplies lost at the location used have been calculated as follows

Existing:

Environmental Uncertainty Mechanism	Linked Outcome	Unit	Unit Cost Adjustment (£m)
WINEP 3 "amber" sustainability reductions not required	Making sure you have enough water, while leaving more water in the environment	Ml/d of deployable output reduced	-3.710
WINEP 3 "amber" river morphology projects not required	Making sure you have enough water, while leaving more water in the environment	Project unit	-0.331

Investment	Total Cost (£m)	Volume (Ml/d)	Unit Cost (£m/Ml/d)
Supply/asset side - cost of changing our assets to address loss of resource			
Central - changes to zones where resources are lost	49.72	33.71	1.47
East - replace lead pipes to prevent discolouration allowing more use of Ardleigh water	8.70	2.60	3.35
Cost of adapting assets to address lost resource	**58.42**	**36.31**	**1.61**
Replacement water (demand side or strategic			
Baseline metering	69.35	26.06	2.66
Water efficiency and behavioural change	70.88	33.55	2.11
Leakage reduction	35.00	24.30	1.44
Strategic transfer of water	36.67	17.00	2.16
Total	**211.89**	**100.91**	**2.10**
Total			**3.71**

Investment	Total Cost (£m)	Number of Projects	Unit Cost (£m)
River morphology projects	9.27	28	0.331

Uncertainty	Linked Outcome	Unit	Indicative Unit Cost Adjustment (£m)
Sustainability reduction not on WINEP3 in Brett Region (from 2.6 Ml/d to 3.7 Ml/d)	Making sure you have enough water, while leaving more water in the environment	Ml/d of deployable output reduced	3.35
Sustainability reduction not on WINEP3 in Brett Region (from 3.7Ml/d to 20.0 Ml/d)	Making sure you have enough water, while leaving more water in the environment	Ml/d of deployable output reduced	6.67

Proposed change

Environmental Uncertainty Mechanism	Linked Outcome	Unit	Unit Cost Adjustment (£m)
WINEP 3 "amber" sustainability reductions not required **Central region**	Making sure you have enough water, while leaving more water in the environment	Ml/d of deployable output reduced	-0.042
WINEP 3 "amber" sustainability reductions not required **East region**	Making sure you have enough water, while leaving more water in the environment	Ml/d of deployable output reduced	-3.260
WINEP 3 "amber" river morphology projects not required	Making sure you have enough water, while leaving more water in the environment	Project unit	-0.331

Investment	Total Cost (£m)	Volume (Ml/d)	Unit Cost (£m/Ml/d)
Supply/asset side - cost of changing our assets to address loss of resource			
Central - changes to zones where resources listed as "amber" are lost	0.27	6.38	0.042
East - replace Galvanised Iron pipes to prevent discolouration allowing more use of Ardleigh water	8.45	2.60	3.26
~~**Cost of adapting assets to address lost resource**~~	~~**58.42**~~	~~**36.31**~~	~~**1.61**~~
~~**Replacement water (demand side or strategic**~~			
~~Baseline metering~~	~~69.35~~	~~26.06~~	~~2.66~~
~~Water efficiency and behavioural change~~	~~70.88~~	~~33.55~~	~~2.11~~
~~Leakage reduction~~	~~35.00~~	~~24.30~~	~~1.44~~
~~Strategic transfer of water~~	~~36.67~~	~~17.00~~	~~2.16~~
~~**Total**~~	~~**211.89**~~	~~**100.91**~~	~~**2.10**~~
~~**Total**~~			~~**3.71**~~

Investment	Total Cost (£m)	Number of Projects	Unit Cost (£m)
River morphology projects	9.27	28	0.331

Uncertainty	Linked Outcome	Unit	Indicative Unit Cost Adjustment (£m)	Indicative Total Cost (£m)
Sustainability reduction not on WINEP3 in Brett Region (from 2.6 Ml/d to 4.6 Ml/d)	Making sure you have enough water, while leaving more water in the environment	Ml/d of deployable output reduced	3.26	6.52
Sustainability reduction not on WINEP3 in Brett Region (from 4.6Ml/d to 20.0 Ml/d)	Making sure you have enough water, while leaving more water in the environment	Ml/d of deployable output reduced	6.67	102.72

Appendix AFW.CE.A4.1

Action ref AFW.CE.A4

DWI Letter CED

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

Enquiries: 030 0068 6400

E-mail: DWI.Enquiries@defra.gov.uk
DWI Website: http://www.dwi.gov.uk

guardians of drinking water quality

21 December 2018

Information Letter 03/2018

To: Board Level and Day to Day contacts of Water and Sewerage Companies and Water Companies in England and Wales

Dear Sir/Madam

METALDEHYDE – Recent developments and actions required

Purpose

This letter is to inform all water companies of the outcome of a recent review of authorisations for the use of metaldehyde products.

It updates my letter of 6 March 2018 to those companies with catchment management Undertakings for metaldehyde. It sets out arrangements for the management and delivery of those Undertakings; and comments on some wider implications for arrangements for drinking water supplies.

Background

On 19 December 2018, the Environment Secretary announced a ban on the outdoor use of metaldehyde, to be introduced across Great Britain. A copy of the press release is attached as Annex a.

In brief, the key elements most relevant to drinking water quality matters are:

- The reauthorisation process has determined that, on the basis of the impact on small birds and mammals, only metaldehyde used in greenhouses will be permitted;
- There will be a transition period of 18 months to allow suppliers and pesticide users to use up their stocks of metaldehyde;
- This means that, by the spring of 2020, the risk of metaldehyde contaminating drinking water is likely to be significantly reduced. Therefore we will no longer need to consult on an additional targeted ban to further protect drinking water sources;

- We expect water companies to continue their important work investing in catchment activities during this transition period, and beyond, to maximise the prospect of full compliance with the drinking water standard for metaldehyde.

This letter will enable water companies to review and confirm the provisions they have made in business plans for activities to achieve and maintain compliance. This may be directly, through improvement programmes resulting from enforcement action by the Inspectorate, or indirectly, through schemes (mainly catchment management activities) agreed with the Environment Agency or Natural Resources Wales.

Additionally, companies may wish to review the provisions that they have made for mitigating metaldehyde contamination in relation to transfers, bulk supplies, and other arrangements for their contingency planning, and within their draft water resource management plans.

Arrangements for existing Undertakings for metaldehyde

As mentioned in my previous letter, we have reviewed the continuing fitness for purpose of the current Undertakings for metaldehyde following this re-authorisation.

These Undertakings are bespoke, some cover metaldehyde issues only, whereas others include other pesticides. They incorporate differing solutions; catchment management, treatment and operational measures; some relate to bulk supplies and transfers; and some companies have draft Undertakings in preparation following recent enforcement action.

The outcome of our review is that the existing catchment management Undertakings are no longer fit for purpose due to the change of circumstances described above, and need to be updated.

Consequently, we propose to write individually to the affected companies, early in the New Year, to initiate submission of revised Undertakings. We propose no changes to the guidance provided previously, i.e. the revised Undertakings may:

- extend completion in achieving compliance beyond the current end date of 2020, to no later than 2025.
- cover metaldehyde only; for Undertakings including other parameters (apart from total pesticides), revised Undertakings or completion reports for the other parameters will be requested;
- cover the same water supply zones as existing Undertakings. Any extension of the geographical area covered requires justification and individual discussion with the Inspectorate;
- include steps to manage metaldehyde contamination of raw water in conjunction with other stakeholders through the processes required to implement the reauthorisation;
- include an annual progress reporting step each January starting in January 2020; It is our expectation that the revised Undertakings will focus primarily on catchment management and operational activities to achieve compliance and mitigate risk. We expect these measures to continue during and beyond the transition period, until evidence is available to close the Undertakings.

Our letters to individual companies in the New Year will address the evidence requirements for closure, and will provide a revised template for companies to use for submission of draft Undertakings.

I would like to take this opportunity to emphasise that our source to tap approach to risk mitigation is not altered by this decision about one substance. Water companies are expected to develop and maintain comprehensive catchment management activities to deal with the ongoing, challenges from climate change, land use and other causes of raw water deterioration.

Other consequences of these changes

The changes outlined above do not alter the current guidance provided by the Inspectorate to companies on matters relating to wholesomeness; acceptability to consumers; long term planning; contingency planning; and the risk of deterioration of supplies due to transfers and bulk supplies.

Copies of this letter are being sent to:

- Michael Roberts, Chief Executive, Water UK;
- Margaret Read, Water Services, Department of Environment and Rural Affairs
- Richard Coles, Jan Dixon, Kirstin Green; Water Quality, Department of Environment and Rural Affairs
- Eifiona Williams, Water Management Team, Welsh Government;
- Sue Petch, Drinking Water Quality Regulator for Scotland;
- Catriona Davis, David O'Neill, Drinking Water Inspectorate for Northern Ireland;
- Tony Smith and Chairs of the Regional Consumer Council for Water;
- Kevin Ridout, Paul Martin, Ofwat;
- Helen Wakeham, Deputy Director, Water Quality, Groundwater and Land Contamination, Environment Agency
- Geraint Weber; Water Strategy Advisor, Natural Resources Wales
- Grant Stark; Health and Safety Executive
- Benedict Duncan, Food Standards Agency;
- David Williams; Chemicals Pesticides and Hazardous, Department of Environment and Rural Affairs
- Stephen Robjohns and Ovnair Sepai at Public Health England.

This letter is being sent electronically to Board Level and day to day contacts. Hard copies are not being sent but the letter may be freely copied.

Any enquiries about the letter should be addressed directly to Caroline Knight caroline.Knight@defra.gov.uk.

Yours sincerely

Milo Purcell.

Milo Purcell
Deputy Chief Inspector

Annex a: DEFRA press release: 19 December 2018

Department
for Environment
Food & Rural Affairs

PRESS RELEASE: FOR IMMEDIATE RELEASE 19 DECEMBER

Restrictions on the use of metaldehyde to protect wildlife

A ban on the outdoor use of metaldehyde, a pesticide used to control slugs in a range of crops and in gardens, is to be introduced across Great Britain from Spring 2020, the Environment Secretary announced today (19 December).

The decision to prohibit the use of metaldehyde, except in permanent greenhouses, follows advice from the UK Expert Committee on Pesticides (ECP) and the Health and Safety Executive (HSE) that metaldehyde poses an unacceptable risk to birds and mammals.

Slugs can cause significant damage to plants and crops, particularly potatoes, cereals and oil seed rape. However, there are other ways to mitigate their impact through soil preparation. For example, sowing the seed deeper into the soil may prevent the slugs from reaching them. There are also alternative pesticides containing ferric phosphate which provide effective control of slugs and snails without carrying the same risks to wildlife.

> **Environment Secretary Michael Gove said:**
>
> "I recognise that significant effort has been put into encouraging growers and gardeners to use this pesticide responsibly by the Metaldehyde Stewardship Group. However, the advice is clear that the risks to wildlife are simply too great – and we must all play our part in helping to protect the environment.
>
> "I encourage companies and growers to look at the alternatives, such as ferric phosphate, which is authorised and does not carry similar risks."

The outdoor use of metaldehyde will be phased out over 18 months to give growers time to adjust to other methods of slug control. It will be legal to sell metaldehyde products for outdoor use for the next six months, with use of the products then allowed for a further 12 months.

The new restrictions on metaldehyde will also reduce the possibility of the pesticide contaminating drinking water sources. Although this was not a factor in the advice from ECP and HSE, the restrictions will help water companies continue to meet our robust drinking water standards.

ENDS

Notes to editors:

- For further information please contact Defra press office on 020 8225 7317 or out of hours on 0345 051 8486

Appendix AFW.CE.A4.2

Action ref AFW.CE.A4

DWI Metaldehyde Letter

guardians of drinking water quality

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

Enquiries: 030 0068 6400

E-mail: caroline.knight@defra.gov.uk
DWI Website: http://www.dwi.gov.uk

9 January 2019

Ms Pauline Walsh
Chief Executive Officer
Affinity Water
Tamblin Way
Hatfield
Hertfordshire
AL10 9EZ

Dear Ms Pauline Walsh

METALDEHYDE – Revision of undertakings

Further to Information Letter 03/2018, this letter is to inform you of our approach for the revision of your undertakings for metaldehyde.

As you are aware the reauthorisation process for metaldehyde has now concluded. It has determined that, on the basis of the impact on small birds and mammals, only metaldehyde used in greenhouses will be permitted. There will be a transition period of 18 months to allow suppliers and pesticide users to use up their stocks of metaldehyde.

We have reviewed the continuing fitness for purpose of the current undertakings for metaldehyde following this reauthorisation. The outcome of our review is that the existing catchment management undertakings are no longer fit for purpose due to the change of circumstances described above, and need to be updated.

You currently have four undertakings for metaldehyde in place as follows:

1. AFW3325: catchment management undertaking for metaldehyde only
2. AFW3324: catchment management undertaking for metaldehyde and chlopyralid
3. AFW3389: bulk supply undertaking for metaldehyde only
4. AFW3322: treatment/blending undertaking for metaldehyde only at North Mymms The

process for revision is described below;

AFW3325: catchment management undertaking for metaldehyde only

As indicated in Information Letter 03/2018, revised catchment management undertakings for metaldehyde will:

- extend completion in achieving compliance, to no later than 2025;

- cover metaldehyde only;
- cover the same water supply zones as existing undertakings. Any extension of the geographical area covered requires justification and individual discussion with the Inspectorate;
- include steps to manage metaldehyde contamination of raw water in conjunction with other stakeholders through the processes required to implement the reauthorisation;
- include an annual progress reporting step each January starting in January 2020

It is our expectation that the revised undertakings will focus primarily on catchment management and operational activities, in conjunction with other stakeholders, to achieve compliance and mitigate risk. We expect these measures to continue during and beyond the transition period, until evidence is available to close the undertakings.

I attach a template for a legal instrument for metaldehyde indicating the actions that we consider may be appropriate. I would be grateful if you could review and return a completed template to DWI_Improvement_Programmes@defra.gov.uk by **31 March 2019.**

AFW3324: catchment management undertaking for metaldehyde and chlopyralid

Your undertaking AFW3324 includes catchment management measures for both metaldehyde and clopyralid, we require that you now submit separate undertakings for these pesticides. Thus:

for **metaldehyde** we require, by **31 March 2019**

- a revised undertaking using the template attached for the zones covered by this undertaking. If it is appropriate (i.e. steps are identical) we would allow the inclusion of the zones covered in this undertaking in the revision of undertaking AFW3325 above.

and for **chlopyralid** we require, by **31 March 2019** either:

- a draft revised undertaking for clopyralid, for continued mitigation actions. Note any extension of the geographical area or time period covered requires justification and individual discussion with the Inspectorate; or
- if you have suitable evidence that the risk has been mitigated, a closure report for the current undertaking in respect to clopyralid.

Please submit the appropriate documentation to DWI_Improvement_Programmes@defra.gov.uk by **31 March 2019**

We encourage companies to close their undertakings as early as possible. Companies should submit a completion report, for all undertakings, when sufficient evidence is available to demonstrate suitable mitigation of the risk. For catchment management mitigation, we believe that sufficient evidence would be a period of 3 years of compliance and evidence of stable or decreasing raw water trends.

AFW3389: bulk supply undertaking for metaldehyde only

As your undertaking AFW3389 relates to bulk supplies from other companies, it will be updated after completion of the revision of the relevant source company undertakings. We expect that this will be an administrative change to ensure that the completion date matches that of the relevant source company revised undertaking.

Therefore we require that you send a request for administrative change to this effect, to DWI_Improvement_Programmes@defra.gov.uk, by **30 April 2019**. Note that any extension of the geographical area covered requires justification and individual discussion with the Inspectorate.

AFW3322: treatment/blending undertaking for metaldehyde only at North Mymms

In the light of this reauthorisation you may determine that your proposed actions included in your undertaking at North Mymms (AFW3322) are no longer appropriate. We acknowledge that you have submitted a change request for this undertaking in October 2016. We are minded to support this proposed change but have been awaiting the outcome of the reauthorisation decision.

Please would you let us know whether you wish to proceed with the current change application or, if you wish to make further changes, please send us a revised change application, by **31 March 2019**.

Finally, we do not envisage that this reauthorisation will impact on your undertaking AFW3281 for the oil seed rape pesticides. Any changes to this undertaking should be submitted to us in the usual way.

Copies of this letter are being sent to:

- Richard Coles; Water Quality, Department of Environment and Rural Affairs
- Paul Martin, Ofwat;
- Helen Wakeham, Deputy Director, Water Quality, Groundwater and Land Contamination, Environment Agency

This letter is being sent electronically. Hard copies are not being sent. Please contact Caroline Knight (Caroline.Knight@defra.gsi.gov.uk or phone 07990 623355) if you have any queries on this letter.

Yours sincerely

Milo Purcell.

Milo Purcell
Deputy Chief Inspector

Enc: Schedule of works template for revised metaldehyde undertaking