Section 11

Preferred plan

Table of contents

Figures

Tables

Section 11.

Preferred plan

A. Overview

11.1 In this section the preferred planning water management programmes for the plan period for each WRZ are presented and discussed. These programmes are referred to collectively as the preferred plan.

11.2 Our preferred plan represents the long term best value balance of water management schemes for the Thames Water area and the wider South East region. It takes into account the need to address and resolve the predicted water supply/demand deficit in the plan period whilst having regard to affordability, the preferences of our customers, impacts on the environment, the need for flexibility in managing a range of risks including a 1:200 year drought, best value planning of water supply in south east England and uncertainties, and the need to facilitate sustainable development.

11.3 There are alternative plans that, compared with our preferred plan, show higher and lower costs and risks. However, as shown in this section, our preferred plan is towards the lower end of the cost range whilst achieving sustainable water resource management. This gives our plan a different risk profile from previous water resource plans which we consider strikes the most appropriate water management balance throughout the planning period. In striking that balance, we have ranked affordability in providing an economical system of water supply as one of the major factors to be weighed in deriving our preferred plan.

11.4 The starting point for building preferred water management programmes for our six WRZs has been the least cost plan (Section 10: Programme appraisal and scenario testing). From this common base we used the programme appraisal approach described in Section 10 to develop the long term best value plan which has become our preferred plan.

11.5 For London, our preferred plan follows the theme of striking a balance between the least cost plan and incorporating the benefits to be obtained from optimising against the other six decision metrics we set out in Section 10. The preferred plan focuses first on demand management, water trading and the introduction of small resource schemes in the early stages of the planning period. This allows for the construction of larger resource options for the medium and long-term period from 2030 onwards.

11.6 For the Thames Valley WRZs, we have identified demand management as the key building block for the maintenance of a long-term and sustainable approach to future water resource management over the planning period.

11.7 As the Henley and Kennet Valley WRZs have no forecast supply-demand deficit and are already resilient to a 1 in 200 year severe drought event, the proposed investment in this zone is minimal. A demand management programme for both zones is included in our preferred plan to make equitable provision across all of our supply areas in terms of customers paying for water used on a measured tariff.

11.8 In this section we first describe the preferred plan for each WRZ and then list the components of the plan in detail together with an overview of the environmental assessment of the preferred plan. We then provide a broader company level overview of the demand management programme we intend to deliver over the first 25 years of the planning period, and describe the greenhouse gas emissions and carbon accounting attributable to the preferred plan.

11.9 The charts and tables summarising the preferred plan for each WRZ exclude the treatment and conveyance elements associated with the supply options. This is because this information is not used to differentiate the merits of the preferred plan from alternatives during programme appraisal as the requirement for these elements is common and thus their inclusion does not provide a reason to prefer one water management programme over another. We have chosen to reduce the information presented by excluding these elements to improve transparency, in circumstances where the summary tables already contain a large volume of information.

11.10 It is important to note that whilst we have not listed these option elements as components of the options chosen, their delivery does have costs and in some cases benefits attached. These costs and benefits are included in the EBSD+[1] run and are also included in the summary performance metrics for each run referenced throughout our plan.

11.11 From 2030 in London the delivery of the combined demand reduction programme and smaller water resource supply options provides an improvement in drought resilience from 1% p.a. in any given year (1 in 100 year) to 0.5% p.a. (1 in 200 year), achieving risk composition 3 status[2]. The demand management programme in the Thames Valley achieves a similar outcome for those zones which are not already resilient to 1 in 200 year severe drought events.

11.12 Strategic network reinforcement is not included in the table of options selected nor is it reflected in the decision metric scores. This is because the EBSD+ model does not currently have the capability to perform the complex intra-zonal hydraulic modelling that would be required to facilitate scheduling of such options. Essentially these types of options account for perturbations in the future distribution of demand and treatment within a WRZ.

11.13 The plan is adaptive with alternative options available to the preferred schemes should any of the latter subsequently prove to be infeasible. During the first five years of the plan we will continue to undertake parallel investigations of the preferred options and the most likely alternative schemes as part of our adaptive pathway approach. For example, a reuse scheme at Beckton will continue to be investigated alongside the Deephams reuse scheme and the Severn Thames Transfer scheme will continue to be investigated in parallel with the SESRO. We will work with other companies as part of a development programme introduced by Ofwat in its feedback in January 2019 on its initial assessment of companies PR19 business plans[3]. The companies are Affinity Water, Anglian Water, Severn Trent Water, Southern Water and United Utilities. The results of these investigations will inform a definitive decision point in 2022/23 on which schemes should be promoted to maintain security of supply throughout the planning period. This date facilitates the schemes' delivery within their respective lead times and it also aligns with a similar decision point in Affinity Water's WRMP19.

[1] A modelling method that combines Economics of Balancing Supply and Demand (EBSD) and MGA (Modelling to Generate Alternatives)
[2] UKWIR (2016) WRMP 2019 methods - risk based planning (Report Ref. No. 16/WR/02/11).
[3] Ofwat Initial Assessment of Plans. Supply demand balance enhancement: feeder models summaries. Cost assessment team, January 2019

11.14 Details of the studies being undertaken to facilitate the 2022/23 decision point are given, together with the monitoring and reporting mechanisms which will be put in place to enable continued stakeholder involvement and keep them informed of progress. Stakeholder engagement and input to the decision point will be secured through the consultation process for regional WRMPs which will occur during 2022/23.

B. London

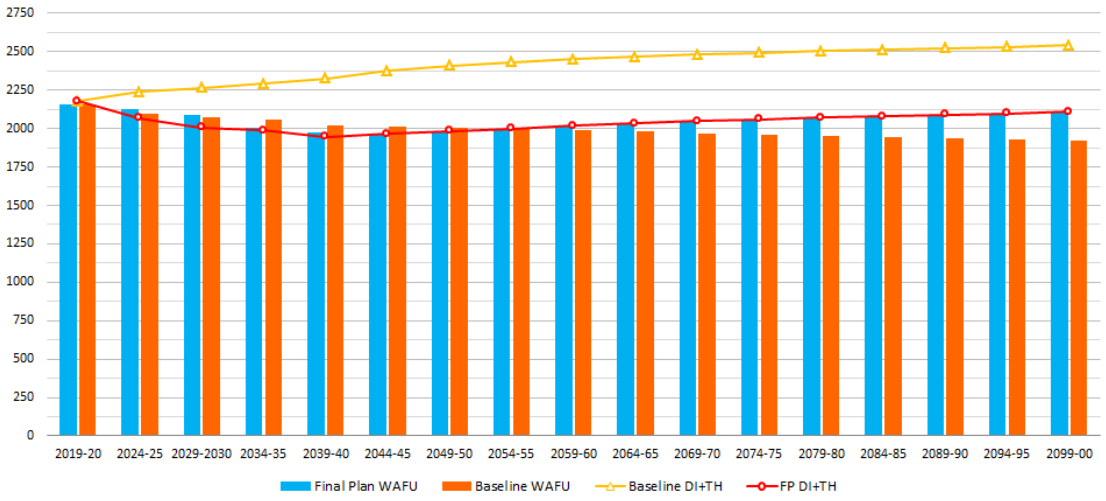
The preferred plan for London

11.15 The baseline forecasts in Figure 11-1 show that there is a significant supply-demand deficit against the dry year annual average (DYAA) demand (plus target headroom) in London throughout the planning period. Inclusion of target headroom in the forecast is the agreed industry procedure to allow for uncertainty in the baseline data. Without investment, security of supply would not be maintained in this zone.

11.16 The deficit is largely driven by the combination of population growth and reductions in raw water availability due to the impacts of climate change.

11.17 By the implementation of our preferred plan (combining demand management and resource development), the supply/demand deficit will be removed in AMP7 and the supply and demand for water will remain in balance throughout the remainder of the planning period.

Figure 11-1: London supply-demand balance (DYAA) over 80-year planning horizon



11.18 Table 11-1 to Table 11-6 set out the detail of the preferred plan for the London WRZ. The key features of the preferred plan are:

Short-term (2020/21-2024/25) - demand management

- Continue our progressive metering programme (PMP) with 365,007 household meters being installed in AMP7, achieving total household meter penetration of 59%

by the end of AMP7. We will continue using smart meter technology, the policy we introduced in WRMP14.

- Reduce leakage by 122.4 Ml/d from 2020-2024. A combination of DMA enhancement, customer side leakage reduction, pressure management, mains replacement and AMP6 Leakage Reduction Carry Over will achieve a 99.1 Ml/d reduction. The remainder, 23.3 Ml/d, will be achieved from AMP6 activity deferral.
- Continue to promote water efficiency activity to help customers use water wisely by undertaking 350,000 Smarter Home Visits and 50,000 'Leaky Loo' repairs to promote behavioural change that will stem the underlying increase in water use shown in our baseline forecast. Further detail relating to these programmes is provided in Appendix O: Water efficiency.
- Introduction of a reward based incentive scheme in AMP7 to promote water efficiency.

Short-term plan (2020/21-2024/25) – water resource development

- Water trading agreement with RWE NPower to use the abstraction licence surplus created by the closure of Didcot A coal fired power station to provide a deployable output (DO) gain of 18 Ml/d from 2020 to 2025.
- Release of network constraints and groundwater development providing approximately 16 Ml/d additional water available for use by 2024.

Medium-term plan (2025-2045) - demand management

- Continue to roll out our PMP to deliver over 680,000 meter installations by the end of AMP8 (2025/29), achieving 73% of individual household meter penetration in the London WRZ.
- Implement a financial incentive based tariff scheme from 2035 when household meter penetration is widespread. The scheme will incentivise lower household consumption and is expected to deliver a 5% reduction in usage.
- Deliver a further 76 Ml/d leakage reduction in London across AMP8 and AMP9 through a combination of customer-side leakage reduction, pressure management, DMA Enhancement and mains rehabilitation.
- Continue to promote water efficiency activity to help customers use water wisely to promote behavioural change that will stem the underlying increase in water use shown in our baseline forecast.

Medium-term plan (2025-2045) – water resource development

- Delivery of further innovative groundwater schemes, the Deephams wastewater reuse scheme, Oxford Canal raw water transfer and release of network constraints in South London, providing more than 75 Ml/d additional supply in London from 2030 onwards.
- Extension of the existing water import trade with Essex and Suffolk Water, due to expire in 2035, until 2060.
- The SESRO 150Mm^3 scheme in 2037/38 to secure long-term resilience. This solution allows us to maintain supply resilience and be able to support 100 Ml/d of regional

raw water demand from Affinity Water, as well as supporting flows and levels in the Oxford watercourses through abstraction reduction at Farmoor.

- Reduce existing abstraction at Waddon, North Orpington and New Gauge to improve flows in the River Wandle, River Cray and River Lee (Amwell Magna reach), respectively.

Long-term plan (2045-2099) – water resource development

- From the 2080s delivery of the supported Severn Thames Transfer to improve long-term resilience in the face of ongoing growth, the forecast impacts of climate change on available water resources, any additional loss of existing resources due to environmental requirements associated with the Water Framework Directive, and any further WRSE regional water requirements.

Plan description

11.19 Our supply-demand balance is in deficit as early as the first year of AMP7 (2020/21) and grows rapidly thereafter. In line with our twin-track approach we will use demand management as much as possible to resolve the deficit, but we will require new water supply resources in due course.

11.20 In AMP7, we will continue to deliver our integrated demand management approach by rolling out the PMP that was established in AMP6, aiming to install 365,007 household meters by the end of AMP7. In addition, a comprehensive water efficiency programme, including 350,000 Smarter Home Visits to engage and enable customers to reduce water usage will be an integral part of delivering the benefits. We anticipate that significant behavioural change will result from a high profile metering and water efficiency campaign. This is accompanied by a mains rehabilitation programme, and pressure management and DMA Enhancement for leakage reduction. At the end of AMP7, meter penetration in London will have increased to 59% of individual household properties. The demand management programme will continue across London beyond AMP7 with a combination of interventions that will provide benefits of reduced usage as well as leakage reduction.

11.21 Asset Health mains rehabilitation activity is not covered in this WRMP19, but it has benefits for daily network maintenance activity. We will look for synergies between our WRMP19 Enhancement Programme and the Asset Health Programme in the PR19 Business Plan to achieve holistic benefits for our customers.

11.22 Water resource development in the first five-year period (2020/21-2024/25) is dominated by groundwater schemes and the RWE Npower water trading scheme. Construction will commence on options which provide higher resilience such as the Deephams wastewater reuse scheme. This scheme has been jointly reviewed with the Environment Agency and the findings can be found in Appendix L: Water Reuse. The Oxford Canal raw water transfer and the SESRO will also be available in the medium to long-term period (2030-2040).

11.23 As shown in Table 11-7, the preferred plan is £0.5 billion NPV higher than the least cost plan by reason of its delivery of significantly greater benefits when assessed against a number of additional relevant metrics, whilst affording the same value in terms of customer preference. The preferred plan is more flexible, makes a better contribution to sustainable development and is better aligned to customers' priorities and Government objectives, for only a small cost

premium compared with the least cost plan. In our view this is a good example of how we spend our customers' money wisely and sustainably, to produce a best value plan.

Performance of the preferred plan

11.24 The preferred plan for London ensures that security of supply is maintained throughout the 80-year planning period and removes the supply-demand deficit in the baseline forecast shown in Figure 11-2. The waterfall diagram Figure 11-1 illustrates how the interventions from both the demand management programme and resource schemes come together to remove the deficit.

11.25 The plan is adaptive with alternative options available to the preferred schemes should any of the latter subsequently prove to be infeasible. During the first five years of the plan we will continue to undertake parallel investigations of the preferred options and the most likely alternative schemes in conjunction with other companies and our regulators. For example, a reuse scheme at Beckton will continue to be investigated alongside the Deephams reuse scheme and the Severn Thames Transfer scheme and further reuse options will continue to be investigated in parallel with the SESRO. The results of these investigations will inform a definitive decision point in 2022/23 to determine which schemes should be promoted to maintain security of supply throughout the planning period. This date facilitates the schemes' delivery within their respective lead times and it also aligns with a similar decision point in Affinity Water's WRMP19.

11.26 The requirement for a large supply resource in the 2030s provides flexibility in the WRMP planning process to clarify and accommodate future uncertainties with respect to population growth, requirements of the Water Framework Directive, regional requirements for water from WRSE water companies (e.g. Affinity Water) and enhancement of our growing understanding of the implications and timing of climate change on water available for use.

Table 11-1: London preferred plan – Overall plan (DYAA) for demand management

	London	Delivery date and ongoing supply demand benefit (Ml/d)							
		AMP7	AMP8	AMP9	AMP10	AMP11	AMP12	AMP13	AMP14-AMP22
		2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049	2050-2054	2055-2100
Total benefit from DMP		**177.2**	**93.7**	**49.4**	**84.8**	**29.8**	**15.0**	**7.5**	**Benefits maintained**
Leakage reduction	**Total leakage reduction**	**122.4**	**46.8**	**29.4**	**40.8**	**24.8**	**10.0**	**7.5**	**Benefits maintained**
	AMP6 Leakage reduction carry over	31.6							
	Household metering customer side leakage (CSL)	22.7	9.7						
	Bulk metering CSL								
	AMP7: 36,001 meters	3.0							
	AMP8: 122,081 meters		15.4						
	AMP9: 0 meters			0.0					
	AMP10: 87,505 meters				6.0				
	Replacement metering CSL	3.5	3.5	3.5					
	Mains replacement	6.1	0.9	21.1	30.0	20.0	10.0	7.5	
	Pressure management	6.2							
	Innovation			4.8	4.8	4.8			
	DMA enhancement	26.0	17.3						
	AMP6 activity deferral	23.3							
Usage reduction	**Total usage reduction**	**54.8**	**46.9**	**20.0**	**44.0**	**5.0**	**5.0**	**Benefits maintained**	
	Household metering								
	AMP7: 365,007 meters	28.7							
	AMP8: 319,793 meters		28.1						
	AMP9: 0 meters			2.4					
	Water efficiency	24.8	18.1	16.9	5.0	5.0	5.0		
	Incentive scheme	0.8	0.2	0.2	0.2				
	Non-potable water	0.5	0.5	0.5	0.5				

Innovative tariffs	38.3

Table 11-2: London preferred plan – Overall plan (DYAA) for resource management

London	Delivery date and ongoing supply demand benefit (Ml/d)												
	AMP7	AMP8	AMP9	AMP10	AMP11	AMP12	AMP13	AMP14	AMP15	AMP19	AMP20	AMP21	AMP22
	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049	2050-2054	2055-2059	2060-2064	2080-2084	2085-2089	2090-2094	2095-2099
Groundwater schemes													
Network constraint removal New River Head	3	3	3	3	3	3	3	3	3	3	3	3	3
Aquifer storage and recovery – Horton Kirby	5	5	5	5	5	5	5	5	5	5	5	5	5
Groundwater Southfleet/ Greenhithe	8	8	8	8	8	8	8	8	8	8	8	8	8
Groundwater Addington			1	1	1	1	1	1	1	1	1	1	1
Groundwater Merton			2	2	2	2	2	2	2	2	2	2	2
Network constraint removal Epsom			2	2	2	2	2	2	2	2	2	2	2
Artificial recharge – Kidbrooke (SLARS1)			7	7	7	7	7	7	7	7	7	7	7
Artificial recharge – Merton (SLARS3)			5	5	5	5	5	5	5	5	5	5	5
Aquifer storage and recovery – South East London (Addington)			3	3	3	3	3	3	3	3	3	3	3
Raw water purchase schemes													
RWE Didcot	18												
Oxford Canal			11	11	11	11	11	11	11	11	11	11	11
Reduced raw water export													
Chingford				20	20	20	20	20					
Indirect potable reuse													

London	Delivery date and ongoing supply demand benefit (Ml/d)												
	AMP7	AMP8	AMP9	AMP10	AMP11	AMP12	AMP13	AMP14	AMP15	AMP19	AMP20	AMP21	AMP22
	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049	2050-2054	2055-2059	2060-2064	2080-2084	2085-2089	2090-2094	2095-2099
Deephams reuse			45	45	45	45	45	45	45	45	45	45	45
Strategic Options													
SESRO 150Mm^3 transfer from SWOX to London						22.2	46.6	75.3	119.8	194	194	194	194
Severn Thames Transfer										4.2	22.4	51.9	60.3
Total additional water resource	**34**	**16**	**92**	**112**	**112.0**	**134.1**	**158.6**	**187.2**	**211.9**	**290.2**	**308.4**	**337.9**	**346.3**
Baseline deficit	-142.6	-195.2	-236.2	-305.8	-362.3	-403.2	-434.7	-463.4	-489.0	-530.6	-567.3	-604.0	-623.4
Additional reduction in DO													
1:200 drought resilience			-140	-140	-140	-140	-140	-140	-140	-140	-140	-140	-140
Vulnerable chalk stream reductions (Waddon and North Orpington)				-15.97	-15.97	-15.97	-15.97	-15.97	-15.97	-15.97	-15.97	-15.97	-15.97
Raw water transfer to WRSE[4]				-100	-100	-100	-100	-100	-100	-100	-100	-100	-100

[4] In its preferred plan, Affinity Water has requested a 100 Ml/d supply from the SESRO to be available by summer 2038. The transfer and treatment elements of the scheme are then developed in two 50 Ml/d stages by Affinity Water, in 2038 and 2053, respectively. Under an alternative scenario where the 100 Ml/d supply is considered as two separate 50 Ml/d supply requirements in 2038 and 2053, respectively, the SESRO is still selected in 2038 in the EBSD+ modelling (see Appendix X, Table X-29). This scenario allowed sensitivity checking of how sensitive the plan is to different year 1 requirements from Affinity Water. In both sets of requirements the SESRO is still selected in the first instance by 2038.

Table 11-3: London preferred plan – Water resource schemes (delivery year in chronological order)

Resource schemes	DYAA yield (Ml/d)	Delivery year
Raw water purchase RWE Didcot	18	2020
Removal of network constraint New River Head	3	2020
ASR Horton Kirby	5	2024
Groundwater Southfleet/ Greenhithe	8	2024
Groundwater Addington	1	2030
Groundwater Merton	2	2030
Indirect potable reuse Deephams	45	2030
Removal of network constraint Epsom	2	2030
Raw water purchase Oxford Canal to Cropredy	11	2030
AR Kidbrooke (SLARS1)	7	2030
AR Merton (SLARS3)	5	2031
ASR East London (Addington)	3	2031
Reduced raw water export Chingford (E&S)	20	2035
SESRO 150Mm^3 transfer from SWOX to London	294	2037
Severn Thames Transfer – Vyrnwy	110	2083
Severn Trent Mythe licence transfer	12	2089
Severn Thames Transfer – United Utilities/ Severn Trent Option B	21	2092
Severn Thames Transfer – Netheridge	18	2096

Table 11-4: London preferred plan – Annual average leakage forecast

London	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Average leakage forecast (Ml/d)	531	408	361	332	291	266

Table 11-5: London preferred plan – Meter penetration (including voids)

London	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11	End AMP22
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45	2099/2100
Household meter penetration (%) (incl. voids)	42	59	73	74	75	76	82

Table 11-6: London preferred plan – Per capita consumption (PCC) (DYAA)

London	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11	End AMP22
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45	2099/2100
PCC (l/h/d)	142	136	131	129	124	124	121

Figure 11-2: London final plan over the 80-year planning horizon

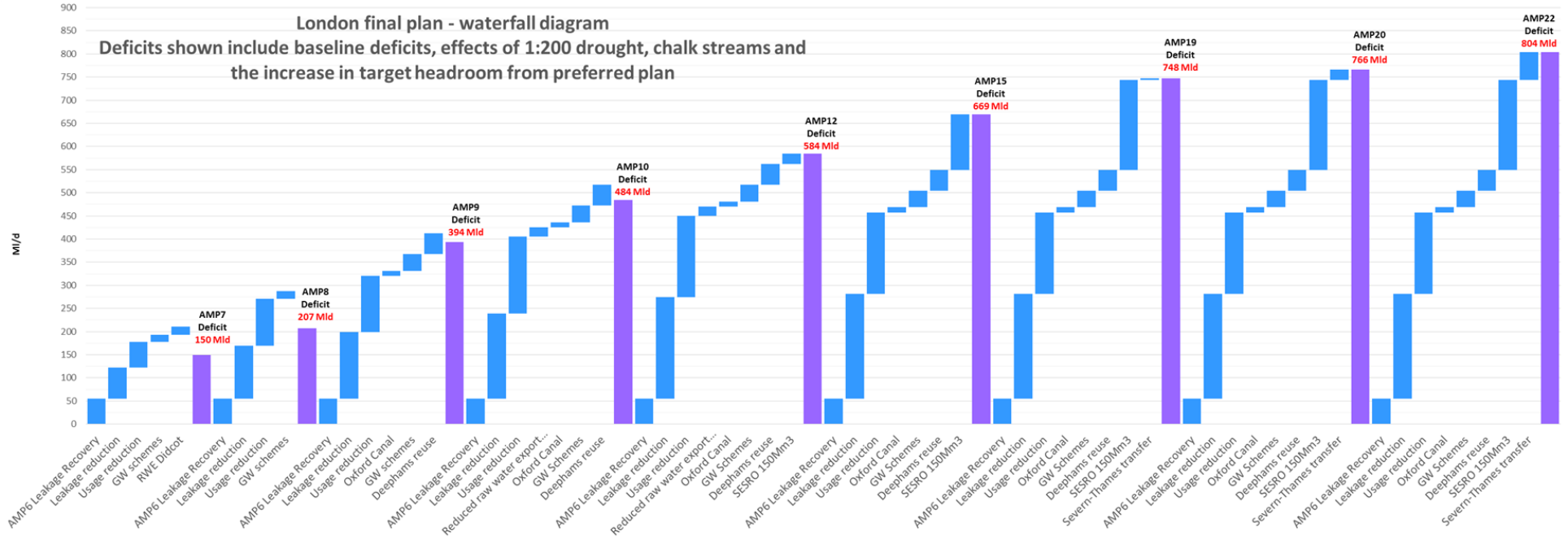


Table 11-7: Programme appraisal metric scores[5]

Metrics / Programme	Cost (£bn NPV)	Resilience	Deliver-ability	Environ. benefit	Environ. adverse	Customer Preference	IGEQ
Least cost[6]	4.105	0.84	1.00	70	81	4.41	11.33
Preferred	4.628	0.88	0.95	81	77	4.42	11.19

Selection of the preferred plan

11.27 In selecting our preferred plan we had regard to the results and learning from the programme appraisal process reported in Section 10: Programme appraisal and scenario testing, feedback from our Customer Challenge Group, feedback from stakeholders and interested parties, guidance from our expert panel members, and the outputs of environmental assessments including the Strategic Environmental Assessment (SEA).

11.28 We presented our analysis of our programme appraisals and explained the emergence of our preferred plan to the Thames Water Executive and Board between April 2017 and August 2018. We held a series of detailed technical sessions with individual Board members to describe our recommended preferred plan and highlighted the risks and costs of the plan. We also discussed the interactions of the plan with the Thames Water Price Review 2019 (PR19) Business Plan to ensure we would be securing long term best value for our customers.

11.29 We have summarised the decision making process in Section 10: Programme appraisal and scenario testing, with the programmes evaluated shown in Appendix X: Programme appraisal outputs.

11.30 Our preferred plan is considered the long term best value plan for the 80 year plan period when compared with other candidate plans; it is more resilient, makes an overall greater contribution to intergenerational equity and is more closely aligned to the achievement of Government objectives contained in guidance and to relevant outcomes of our customer research than any other plan.

11.31 To improve resilience to a 1 in 200 year drought, water resource schemes with relatively short lead times are required in the medium term. The primary contending options were a combination of schemes comprising small groundwater sources, the Oxford Canal raw water transfer and the Deephams re-use scheme versus a single larger desalination or reuse scheme at Beckton. The combination of small schemes is selected as preferred because it is cheaper and more flexible than one larger scheme, retaining option value to bring in some schemes sooner or later if advantageous; the total NPV of the preferred plan is £0.087 million NPV lower than that comprising a single large desalination or reuse option. The ongoing opex running costs of the combined scheme are also lower. Should either the Deephams reuse option or the Oxford Canal prove to be infeasible, a larger reuse scheme at Beckton (or a potential West London reuse option) is likely to be promoted instead, depending on the outcomes of the environmental studies that are being undertaken in the period to 2022/23. Subsection M:

[5] London, SWOX and SWA WRZ are modelled together, so these scores are for the combined zone.
[6] For the preferred "Baseline + Drought + WRSE" baseline scenario.

Adaptive alternative options approach gives further details of the investigations that are being undertaken.

11.32 The output of the programme appraisal process reported in Section 10 shows that our preferred plan:

- Meets customer expectations for continuous reduction in leakage, and builds resilience against extreme weather with greater focus on the sustainable use of water resources
- Aligns well to Government policy objectives set out in the Water Resources Planning Guideline (WRPG)[7] and Defra's 25 Year Plan[8]
- Is flexible in so far as the plan has a spread of 'no regrets' water supply options which can be adapted as required
- Reduces the demand for water and also supports present and emerging south east regional raw water requirements
- Given the higher cost and performance uncertainties of a large indirect potable water reuse or desalination scheme, together with the wider environmental sustainability constraints in our supply zones as well as in the South East region, the outputs indicate that the SESRO is to be preferred as a sustainable water resource scheme to provide resilience against climate change and an increasing regional demand from WRSE

11.33 As discussed above, the long-term leading strategic option selected through the programme appraisal process for supply to the London WRZ is the SESRO in south west Oxfordshire. The option is located to the west of London and therefore is able to supply the SWOX and SWA WRZs as well as use the River Thames as a natural conveyance route to transfer raw water to London. The option is also able to supply the WRSE raw water needs of Affinity Water (100 Ml/d by summer 2038) and potentially South East Water if required in the future; both companies having existing intakes on the River Thames. The SESRO has been selected in Affinity Water's WRMP19 separate programme appraisal process as the best value long-term strategic option for its customers, assuming a joint promotion with Thames Water. The SESRO also has potential to supply Southern Water via a transfer pipeline to its Hampshire South zone.

11.34 Affinity Water has identified the SESRO as its preferred best value long-term strategic supply option which it intends to develop jointly with Thames Water and it will contribute sufficient investment to reserve 100Ml/d out of the full 294Ml/d yield of the scheme (Table 11-2). It requires the reservoir by summer 2038 under its 'Challenging' Future and proposes to develop the associated transfer and treatment elements of the scheme in two 50Ml/d stages. In the first stage Affinity Water will develop an abstraction on the River Thames and transfer the new supply to a new treatment works located near its existing Iver works. In the second stage it will extend the transfer through to Harefield and a second 50Ml/d works in that location. This is set out in paragraphs 6.3.6 and 6.3.7 of its main WRMP19 (page 109).

11.35 Affinity Water has included two 50Ml/d stages for the scheme within its WRMP tables, as this represents the timing when it would use the water for supply purposes (i.e. the 'deployable output' becomes available). However, it plans to contribute to the development of the reservoir

[7] Environment Agency and Natural Resources Wales, Water Resources Planning Guideline: Interim Update July 2018
[8] H M Government 2018 A Green Future: Our 25 Year Plan to Improve the Environment

itself to reserve raw water availability of 100Ml/d at the time of construction – i.e. by summer 2038, which is entirely consistent with our understanding.

11.36 Affinity Water considers that developing the SESRO scheme in two phases represents 'best value' for its customers as the staged development is preferred in terms of economics and flexibility. It checked that the solution (100Ml/d reservoir followed by two 50Ml/d transfer and treatment developments) is economic, by constraining its EBSD model so that it could only chose either one 50Ml/d option or the full 100Ml/d option – in that case it selected the 100Ml/d option as the preferred development. This is consistent with the separate EBSD+ modelling we undertook whereby we tested the reverse of the position, with Affinity Water's requirement being introduced in two separate 50Ml/d stages (Table 11-2). The 150 Mm3 SESRO was again selected as the preferred option to be available by summer 2038.

11.37 Based on the collaborative modelling between our two companies' plans it is clear that the proposed approach, where the full 294Ml/d capacity reservoir is developed in 2038, and Affinity Water constructs the treatment and transfer elements in two 50Ml/d stages, represents a common 'best value' approach. Our two companies' plans are fully aligned with regard to the timing and development of the SESRO.

11.38 Were the SESRO not to be a feasible option, the alternative water supply option selected through the programme appraisal process is the supported Severn Thames Transfer. There is regulatory support for the transfer as it has potential to increase regional connectivity, increasing the size of a catchment from which water resources can be drawn. Development can also be undertaken in a phased approach. Both options have potential to supply similar volumes of water and could be delivered in combination, but the results of our programme appraisal process demonstrate that the reservoir is preferred to be delivered first on the basis of least cost, higher reliability and the fact that the transfer option in isolation does not provide the increased supply resilience sought by Affinity Water. The lack of resilience of the transfer as an isolated option has also been identified by WRSE.

11.39 Ongoing opex associated with the reservoir is also significantly lower than the Severn Thames Transfer which is an important aspect for Affinity Water given the company's dependence on direct river abstraction to maintain security of supply for its customers. Given its low opex, the SESRO also supports usage in non-drought conditions to enable (with new connectivity) reduced abstraction from existing sources perceived to be putting hydrological pressure on vulnerable chalk streams and water courses. The opex cost ratio of the transfer in comparison to the reservoir (at 50% probability (P50) cost confidence) is approximately 3.3 to 1 which illustrates the significantly higher running costs of the transfer option in isolation.

11.40 As set out in Section 10: Programme appraisal and scenario testing, to meet the future supply demand challenges in our London, SWOX and SWA WRZs, and the wider South East region, multiple strategic water resource options will be required. It is not a question of which single option is best, it is which option is needed when. Our programme appraisal process has selected the SESRO as the first strategic option to promote for the WRSE area, in advance of the Severn Thames Transfer.

11.41 The strengths and weaknesses of the two options are set out in Table 11-8 to facilitate consideration of relevant factors other than cost, namely resilience, environmental impacts, intergenerational equity, customer preference, deliverability and adaptability (see Section 10 for details). The studies that we have undertaken to date on both options have demonstrated

that the reservoir consistently performs much better as the first strategic regional water supply option to promote, in advance of the transfer. Our WRMP19 customer research revealed that customers' top three criteria for devising Thames Water's WRMP are cost, type of option and reducing risk of severe water use restrictions. The reservoir scores higher marks against each of these water resource management considerations than does the supported Severn Thames Transfer, as shown in Table 11-8.

Table 11-8: Strengths and weaknesses of the South East strategic reservoir and supported Severn Thames Transfer options

South East strategic reservoir	Supported Severn Thames Transfer
Advantages	**Advantages**
Least cost, reliable and proven option selected through EBSD+ programme appraisal analysis with potential for significant recreational benefits. Storage and transfer hub for the South East region. Independently selected by Affinity Water as its preferred best value strategic supply option.	Supports inter-basin transfers and increases size of catchment from which water resources can be drawn. Development can be undertaken in a phased approach.
Low ongoing running costs which facilitates reduced abstraction from environmentally sensitive sources during normal years without incurring extra cost. Significantly lower opex costs for Affinity Water than alternative options.	No loss of agricultural land
Facilitates unplanned and routine maintenance of existing raw water storage reservoirs, without incurring additional cost.	
Offers opportunities for secondary activities, including recreation and biodiversity gains.	
Disadvantages	**Disadvantages**
Loss of agricultural land and displacement of 20 households and businesses. Strong opposition from local pressure group.	Environment Agency (EA) hands-off flow (HoF) on lower Severn creates risk of non-availability of water for abstraction at times of low flow. The EA's recently updated Severn Corridor Abstraction Licensing Strategy (March 2019) is expected to increase the HoF at Deerhurst by 800 Ml/d. This will substantially reduce the amount of water available for transfer from the River Severn. Increasing risk of coincident drought affecting both the South East and West areas, as occurred during the drought of 1976. As part of the MaRIUS project, CEH Wallingford found that droughts in the Thames and Severn regions are going to be more coincident in the future as a result of climate change. A major drought in both the Severn and Thames catchments at the same time is projected to increase by 56% in the near future (2022-2049) and 135% in the far future (2072-2099).
Eight year construction period with disruption to local residents and potential impacts on air quality and greenhouse gas emissions	Long conveyance route increases risk associated with pollution.
Loss and disturbance to heritage assets and archaeological remains	Phosphorous from agricultural lower Severn catchment contributes to high algal loading, which risks changing the characteristics of the upper Thames. Transfer could potentially further increase Thames Water's exposure to this risk, to which we are particularly vulnerable because of our reliance on surface water abstraction (80% in London and 40% in SWOX WRZs).
Potential impacts on the setting of the North Wessex Downs AONB	Potential opposition from stakeholders against water transfer to England. Disruption to Cotswolds AONB during construction period.

South East strategic reservoir	Supported Severn Thames Transfer
	Customers' least favoured option and no opportunities for recreational benefits linked to the pipeline.
	Requires alternative resource development in donor area to free up water resources for transfer with potential for WFD deterioration.
	Cost used in EBSD+ analysis is for a single pipeline only, which is at higher risk than a dual pipeline.

11.42 The supported Severn Thames Transfer supports inter basin transfers between water companies, albeit United Utilities and Severn Trent Water would both need to develop new water resources in their own supply areas to facilitate a large transfer and, therefore, resource development would still be required. The long conveyance route of the option would in its own right constitute a substantial capital investment project (for the pipeline section). The long route is also at risk of pollution events in the rivers Severn and Vyrnwy and, as such, it can be considered less resilient than the South East strategic reservoir option, which is located within the Thames catchment. On the other hand, it is acknowledged that inter-basin transfer increases the size of the catchment from which water resources can be drawn, which could have a positive effect on resilience, due to the lower probability of there being a coincident drought across several companies' regions compared with a drought in one region, although coincident droughts are forecast to become more frequent. Professor Jim Hall (Oxford University) was funded by NERC to look at drought risk under climate change (the MaRIUS[9] project). As part of that work, CEH Wallingford found that droughts in the River Thames and River Severn catchments are forecast to be more coincident in the future as a result of climate change[10]. The likelihood of the occurrence of a major drought in both the Severn and Thames catchments at the same time is projected to increase by 56% in the near future (2022-2049) and 135% in the far future (2072-2099).

11.43 The Environment Agency has indicated that in order to protect the Severn Estuary Special Area of Conservation it will impose a hands off flow constraint on any abstraction licence from the lower Severn. This effectively means that there is no guarantee that water released from Vyrnwy reservoir will be available for abstraction in the lower Severn when required for supply to the South East and, as such, the risk to security of supply associated with this option is significantly increased. The scheme falls under the jurisdiction of Natural Resources Wales and will require support from the Welsh Government.

11.44 There are no opportunities for recreational benefits and environmental enhancements associated with the pipeline transfer of raw water from the River Severn.

11.45 The South East strategic reservoir option is more flexible with regard to water supply and cheaper than the Severn Thames Transfer option. It would provide additional raw water storage, which improves resilience in the South East and enables other Thames Water raw water storage reservoirs to be taken out of service for routine and unplanned maintenance. The transfer option in isolation does not provide the increased supply resilience sought by Affinity Water which is already vulnerable to loss of surface water supplies given the company's high

[9] **Ma**naging the **R**isks, **I**mpacts and **U**ncertainties of drought and water **S**carcity, NERC funded research project
[10] Rudd A.C., Bell V.A. and Davies H.N., Severn Thames Transfer Study Final Report July 2018, Centre for Ecology & Hydrology 2018

reliance on direct river abstraction to maintain security of supply. A number of Thames Water's existing raw water storage reservoirs are more than 100 years old. Work undertaken by engineering consultants W S Atkins and AECOM has identified that there is an increasing risk that these assets will need to be taken out of supply in response to unplanned maintenance requirements. If the volume of the existing raw water storage capacity is reduced the yield of the Severn Thames Transfer will be lower, because there is reduced capacity to store the water that is transferred and increasing reliance is placed on the remaining storage reservoirs.

11.46 Both adverse and beneficial effects can arise during construction and operation but the main disadvantages with the reservoir option are that its development will require the loss of agricultural land, as well as the displacement of approximately 20 households and businesses currently on the site. The construction period would be approximately eight years and during this time there is a need to use large volumes of materials. During this construction period there is the potential to cause disruption and adverse effects on air quality, archaeological remains, the landscape and heritage assets as well as adverse impacts on the visual amenities of nearby residents, in particular, the inhabitants of the villages of Steventon, Drayton, Marcham and East Hanney. Such construction activities including the routing of construction traffic would need to be carefully managed with mitigation measures put in place. Due to the construction and operation of the reservoir permanent effects on the landscape, historic character and archaeological remains will result. Further meetings will be held with Historic England and Oxfordshire County Council to confirm mitigation measures to address potential impacts on archaeological remains and heritage assets as part of the detailed design process. Archaeological mitigation measures will include review of previous desk based and field studies, further targeted field evaluations and targeted excavations alongside watching briefs during overburden stripping where archaeology has been identified. As part of any future application for consent further studies would also be commissioned including landscape, historic landscape character and visual impact assessments to help inform the detail of mitigation measures and an environmental management plan, which will be developed to help monitor mitigation measures and effects.

11.47 Over the longer term and once the reservoir landscaping is fully established, the scheme has the potential to offer landscape benefits. Significant benefits from the option are also expected in terms of recreational opportunities, compensatory habitat provision as well as the provision of opportunities to reduce abstraction from environmentally sensitive chalk streams and water courses in the River Thames catchment.

11.48 The Severn Thames Transfer scheme is included in our preferred plan but is not called upon as a source of supply until the 2080s. The studies that we have undertaken to date on both options has demonstrated that the reservoir consistently performs better as an independent strategic regional water supply option for the South East and this is why it is selected first in the sequencing of options in our plan[11]. We are committed to further developing transfer options with third party suppliers, and with the support of government and regulators. Our 2019 Business Plan includes funding for further ongoing work to examine the feasibility of the transfer, most notably work on establishing the magnitude of water losses that could occur during transfer, environmental and water quality concerns and the changes that would be required to the hydraulic regulation of the River Severn. Details of this further work that is to be

[11] Paragraph 11.46 discusses the additive benefits of the South East Strategic Reservoir option to the Severn Thames Transfer scheme in that it enables the maximisation of transferable water from the River Severn.

undertaken on the Severn Thames Transfer are set out in Appendix J of our Statement of Response to the consultation on our draft WRMP19 and in subsection X below.

11.49 The relatively late timing of the Severn Thames Transfer in the WRMP19 is driven by growth, resilience to severe drought events, the forecast impacts of climate change and the proposed reductions in our abstractions from vulnerable chalk streams and water courses. Any addition to these needs, or if the promotion of the reservoir option was unsuccessful, or if increased resilience was required by Government for the WRSE water companies as recommended within the 2018 National Infrastructure Commission (NIC) study[12], would be likely to bring the timing of the transfer forward in the planning period. Our ongoing work on the feasibility of the transfer continues, accordingly, to be undertaken jointly with regulators (Natural Resources Wales, Environment Agency, Natural England, Ofwat and DWI) and other water companies, with the scope and funding requirements shared between all parties.

11.50 The issues associated with the higher cost and lower reliability of the Severn Thames Transfer option can be mitigated to a certain extent through the construction of the SESRO in the preferred plan. The SESRO will provide increased storage capacity to store surplus water during periods of high flow where algal ratings will be lower and thereby reduce the dependency on the need to take more expensive water from the River Severn during periods of drought and low flow. It also reduces the need to implement flow augmentation options to support the transfer which are likely to have a potential detrimental environmental impact within the River Severn catchment (e.g. Minworth effluent transfer to the upper reaches of the River Avon) since the total amount of water required from the transfer scheme will be lower. Furthermore, the increased storage capacity which the SESRO creates in the Thames catchment helps mitigate the growing risk of unplanned reservoir outage and the inability to store River Severn flows when they are available. Essentially given the risks, it is logical and pragmatic to increase existing storage capacity in the Thames catchment by the construction and operation of the SESRO before implementing a transfer so as to reduce financial and environmental costs and improve the reliability of the transfer scheme.

11.51 From the analysis undertaken within our WRMP it is clear that the storage and transfer capability of SESRO is the first choice strategic option. If SESRO was to be found to be robust, then the current next-best strategic option would be the Severn Thames Transfer. This next-best option therefore remains important to securing drought resilience in the future. Also, if the need for water increases further due to increased growth or drought protection then the transfer may be required to be built much earlier than the timing in our preferred plan.

11.52 The delivery of the SESRO in 2037/38 creates surplus in the supply / demand balance which can be used to facilitate a cost effective reduction in some of our existing London groundwater abstractions that have been shown to have an impact on vulnerable chalk streams and water courses. Our groundwater abstractions at Waddon (7.2 Ml/d) and North Orpington (8.8 Ml/d) are perceived to have a detrimental impact on the River Wandle and River Cray, respectively, but investigations undertaken to date have concluded that it is not cost beneficial to reduce abstraction at these sites. The SESRO with its low annual opex costs will help more cost effectively to reduce abstraction at these sites and thereby address the concerns.

[12] Preparing for a drier future, National Infrastructure Commission, April 2018

11.53 There is also an opportunity to reduce abstraction at New Gauge on the River Lee. This should not result in a loss of deployable output if infrastructure is built to subsequently capture and store the downstream increased river flow which would then become available.

11.54 In the River Lee, reduced abstractions at New Gauge could facilitate increased flow along the Amwell Magna reach. This water can be subsequently abstracted downstream into the Lee Valley reservoirs but will require a new tunnel to transfer the water back to the New River and Coppermills water treatment works if an adverse impact on deployable output is to be avoided. There is an important assumption here that water not abstracted at New Gauge is subsequently available for downstream abstraction. This assumption will need to be confirmed through field investigations.

Risks and uncertainties in the preferred plan

11.55 Although we are confident that our preferred plan is appropriate for the London WRZ, there are a number of risks and uncertainties which have been evaluated.

11.56 In line with the WRPG, these are described below.

Risk: demand management, including leakage reduction

11.57 The 143 Ml/d supply demand deficit in London in AMP7 is planned to be addressed through demand management interventions. However, we do not have full control with respect to the potential benefits that will be achieved through this activity. In particular, there is uncertainty relating to the performance of our ageing infrastructure network given its proven fragility to extreme climatic events. We have therefore included limited, cost effective resource development and water trading in AMP7 to help manage this risk and maintain a resilient supply system. This is an important risk management measure given the current supply system in London has been shown to be currently resilient only to a 1 in 100 year drought event.

11.58 Neighbouring water companies in the South East (e.g. South East Water) are also undertaking substantial demand management programmes which may release surplus water resources for trading. We have approached South East Water about the possibility of implementing a trade to buy any forecast surplus from them. At this early stage of the planning process they consider that such a trading approach is likely to have low resilience and high uncertainty and as such is not robust enough to enter into an agreement with us. We will continue to monitor and discuss such potential trading agreements with South East Water as they roll out their demand management programme.

11.59 We do not have full control over the benefits achievable through metering and the promotion of water efficiency. To mitigate these risks, in AMP6 we have set up a dedicated metering team to review the end-to-end delivery of the metering programme from supply-chain management to customer communications and queries. This is to be combined with a very proactive and ambitious water efficiency programme.

11.60 We are also working closely with stakeholders, such as the Greater London Authority, to ensure we have a consistent water conservation message across London.

Risk: metering and tariffs

11.61 The plan includes the introduction of a reward based incentive scheme in AMP7 as this has the potential to be highly cost-effective in reducing the long-term cost of water supply. The plan also includes financial tariffs from 2035 to penalise high water usage when household meter penetration is widespread. Our customer research has shown customers perceive such tariffs to be unfair without widespread penetration of household metering which is why the introduction of sophisticated financial tariffs is delayed until 2035. We have assumed a 5% saving associated with the financial tariff but it is possible that additional savings could be delivered through varying the financial incentives utilised. It should be recognised, however, that recent research by Howe[13] [14] indicates that demand is not sensitive to price.

Risk: long-term resilience and regional demand

11.62 On the balance of evidence, our forecasts point to a complex supply-demand problem in London that demand management and small scale resource schemes will not be enough to resolve on their own. We believe that long-term resilience can be secured through the introduction of the SESRO in south west Oxfordshire. This mitigation approach equips us to respond to regional demands for water as well as potential long-term sustainability reductions in supply. Early delivery of the scheme in the planning period also addresses risks posed by early reductions in water available for supply linked to climate change.

Uncertainty: long-term sustainability reductions and West Berkshire Groundwater Scheme

11.63 There remains uncertainty in the long-term level of potential sustainability reductions that could affect the London WRZ, as well as the ongoing reliability of output from the West Berkshire Groundwater Scheme (WBGS). Although publication of the Water Industry National Environment Programme (WINEP) in March 2018 gave clarity to the status of the Lee Valley reservoir abstractions, a number of our groundwater abstractions in north east and south east London are subject to ongoing investigation in AMP7. Furthermore, the ownership, operation and long-term viability of the WBGS remains uncertain and the Environment Agency has requested that we assess the impact of the scheme on our plan. We have tested the sensitivity of the preferred plan to uncertainty linked to the Water Framework Directive as part of our programme appraisal process and also a reduction in output from the WBGS (Section 10: Programme appraisal and scenario testing). Results from 'What-if' scenario testing in Table 10-20 show that the plan is robust to the further loss of resources linked to achieving Water Framework Directive compliance, as well as reductions in output from the WBGS.

11.64 To achieve the long term best value solution for supply resilience in London (and the South East region) we consider it is important to confirm any further potential sustainability reductions in the next five years so that efficient and cost effective planning can be undertaken in relation to the size and timing of the larger water resources options currently identified in the preferred plan.

[13] Howe, C.W and Linaweaver, F.P. (1967) The impact of price on residential water demand and its relation to system design and price structure. Water Resources Research, 3, 13-32
[14] Howe, C.W. (2005) The functions, impacts and effectiveness of water pricing: Evidence from the United States and Canada, International Journal of Water Resources Development, 21:1, 43-53

Uncertainty: climate change

11.65 As shown in Section 5: Allowing for risk and uncertainty, climate change is likely to have a significant impact on water resource availability in London. This is due to a combination of the likely reduction in the availability of water resources and in the quality of water abstracted from surface water sources and stored in our raw water storage reservoirs.

11.66 Whilst we believe this change is manageable in the short-term, the potential large adverse impacts that substantial and more frequent drought events could have on the London water supply system means that it is important to plan ahead and look at long-term solutions to maintain resilience. HR Wallingford has completed sensitivity analysis for us, examining uncertainty in the timing of the impacts of climate change on available water resources[15]. This work has shown that there is significant uncertainty which presents a challenge to the scheduling of options and to anticipating the rate of the onset of climate change impacts. The degree of impact on system performance that might be considered very likely in the 2080s could be considered equally likely by the 2050s and quite likely by the 2030s. The work has demonstrated that the Environment Agency's assumption of linearity in climate change impacts back cast from the 2080s may not be a robust assumption and significant impacts could occur much sooner than forecast. This has implications for the timing of no regrets water resource options where it could be considered prudent to invest in them sooner.

11.67 We have undertaken further sensitivity analysis on the timing of climate change impacts and this is set out in Section 10: Programme appraisal and scenario testing. Both the 'What-if' scenario analysis and the adaptive pathways approach confirmed that the preferred programme is robust to changes in the timing of the impact of climate change on water availability.

11.68 The approach of combining demand management and the parallel introduction of large-scale water resource development helps to mitigate this long-term uncertainty.

London – preferred plan summary

11.69 The above paragraphs describe the content of the WRMP19 preferred plan for London. From the work we have undertaken we consider the preferred plan achieves the long term best value overall balance between demand management and resource development, in that it is affordable, takes account of relevant output of our customer research, is resilient, adaptable, and contributes to sustainable water supply/demand management in the South East over the plan period.

11.70 We believe the underlying strategy of reducing water losses from our network, being innovative to reduce overall water demand and to understand where and when water is being used is an appropriate short and medium-term management strategy if we are to meet the challenges of the forecast water supply / demand in the Thames Water area.

[15] HR Wallingford (2017) Thames Water MCS Support Trajectory of climate change impacts and scaling MAM8070-RT002-R1-00

C. Swindon and Oxfordshire

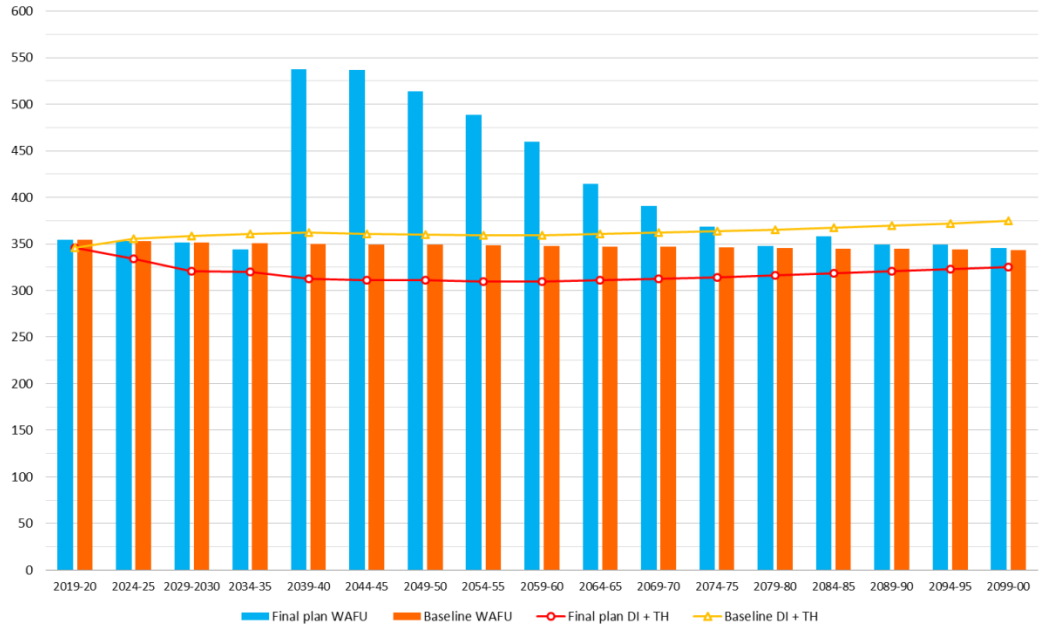
The preferred plan for SWOX

11.71 As illustrated in Figure 11-3, SWOX has a baseline supply/demand deficit in dry year critical period (DYCP) conditions starting from 2022/23 and growing throughout the planning period.

11.72 The deficit at peak demand is driven by a combination of population growth and the impact of climate change on available water for use.

11.73 Our preferred plan removes the supply-demand deficit in AMP7 and the zone will remain in balance throughout the planning period. The water supply/demand balance is maintained through demand reduction, including leakage reduction, and the implementation of a new strategic water resource scheme (SESRO) in 2037/38 which creates a surplus, providing resilience for the zone and facilitating the export of water to the London and SWA WRZs, as well as meeting WRSE regional water demands in the medium-term. The plan is presented in Table 11-9 to Table 11-15.

Figure 11-3: SWOX supply-demand balance (DYCP) over 80-year planning horizon



11.74 The key features of the preferred plan are:

Short term (2020/21-2024/25) demand management

11.75 From 2020 we will roll out our progressive metering programme (PMP). Our aim is to achieve total SWOX household meter penetration of 92% by 2030 with the installation of smart meters.

11.76 We will continue to promote water efficiency and metering to help customers use water wisely (in direct response to customer research findings). By the end of AMP7, we aim to deliver circa 8.8 Ml/d benefits through the water efficiency campaign.

Medium-term plan (2024-2040) demand management and water resource development

11.77 We will also include an incentive based financial tariff across the WRZ, commencing in 2035.

11.78 As set out in the preferred plan for our London WRZ, the SESRO will be available from 2037/38 to provide raw water benefits for SWOX, as well as facilitating transfer to the London and SWA WRZs and to Affinity Water.

11.79 The reservoir also creates an opportunity to reduce abstraction at Farmoor which should not result in a loss of deployable output if new infrastructure to facilitate the reduction is installed during construction of the scheme. The saved water from a reduction at Farmoor can be abstracted downstream through the reservoir intakes, stored, and then transferred back to Farmoor to be put into supply during periods of low flow. Reduced abstraction at Farmoor would enable greater flows through the Oxford watercourses.

Long-term plan (2040 to 2099) water resource management

11.80 An inter-zonal raw water transfer from SWOX to SWA WRZ via the River Thames and a new surface water intake at Medmenham enables transfer of surplus available water resources in SWOX by up to a maximum of 24 Ml/d and will help SWA to mitigate its long-term deficit from 2066 onwards.

11.81 Increased population projections associated with the planned Cambridge, Milton Keynes and Oxford (CaMKOx) growth corridor are not currently included in our baseline supply demand forecasts for the SWOX WRZ given that to date the additional housing has not been formally adopted within local plans. As such the forecast supply demand deficit in the SWOX WRZ from 2040 onwards should be considered to be relatively low and there is likely to be a requirement for additional supply sooner than currently allowed for within our preferred plan. The timing of the reservoir in the preferred plan allows for any further growth beyond that allowed for in the baseline forecasts.

Performance of the preferred plan

11.82 The preferred plan for SWOX ensures that security of supply is maintained through the planning period and removes the forecast baseline supply-demand deficit, as shown in Figure 11-3.

Table 11-9: SWOX preferred plan – Overall plan (DYCP) for demand management

	SWOX	Delivery date and ongoing supply demand benefit (Ml/d)				
		AMP7	AMP8	AMP9	AMP10	AMP11-AMP22
		2020-2024	2025-2029	2030-2034	2035-2039	2040-2100
Total benefit from DMP		**21.9**	**16.8**	**3.3**	**9.3**	**Benefits maintained**
Leakage reduction	**Total leakage reduction**	**9.8**	**6.7**	**0.6**	**Benefits maintained**	
	AMP6 Carry-over leakage	2.3				
	Household metering CSL	3.9	3.6			
	Bulk metering CSL					
	AMP7: 3,161 meters	0.3				
	AMP8: 5,526 meters		0.5			
	AMP9: 321 meters			0.03		
	Replacement metering CSL					
	Mains replacement		0.4	0.6		
	Pressure management					
	DMA enhancement	3.3	2.2			
Usage reduction	**Total usage reduction**	**12.1**	**10.1**	**2.7**	**9.3**	**Benefits maintained**
	Household metering					
	AMP7: 46,475 meters	3.3				
	AMP8: 44,708 meters		4.3			
	AMP9: 0 meters			0.7		
	Water efficiency	8.8	5.8	2.0		
	Incentive scheme					
	Non-potable water					
	Innovative tariffs				9.3	

Table 11-10: SWOX preferred plan – Overall plan (DYCP) for resource management

SWOX	Delivery date and ongoing supply demand benefit (Ml/d)									
	AMP7	AMP8	AMP9	AMP10	AMP11	AMP12	AMP14	AMP16	AMP18	AMP22
	2020-2024	2025-2029	2030-2034	2035-2039	2040-2044	2045-2050	2055-2059	2065-2069	2075-79	2095-2099
Strategic Options										
SESRO 150Mm³				294	294	294	294	294	294	294
Thames Water SESRO WAFU				194	194	194	194	194	194	194
Affinity SESRO WAFU				100	100	100	100	100	100	100
Severn-Thames Transfer										81
London export						-22.2	-75.3	-142.1	-180.3	-254.3
Inter-zonal transfer										
River Thames to Medmenham								-1.2	-4.4	-12.0
Total additional water resource				**294**	**294**	**272**	**219**	**128**	**90**	**16**
Baseline deficit	-2.2	-6.6	-10.0	-11.9	-11.3	-11.2	-11.3	-15.3	-19.9	-31.2
Additional reduction in DO										
1:200 Drought resilience			**-6.9**	**-6.9**	**-6.9**	**-6.9**	**-6.9**	**-6.9**	**-6.9**	**-6.9**

Table 11-11: SWOX preferred plan – Water resource schemes (delivery year in chronological order)

Resource schemes	DYCP yield (Ml/d)	Delivery year
SESRO 150Mm^3	294	2037

Table 11-12: SWOX preferred plan – Annual average leakage forecast

SWOX – DYAA	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Average leakage forecast (Ml/d)	63	54	47	46	46	46

Table 11-13: SWOX preferred plan – Meter penetration

SWOX	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11	End AMP22
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45	2099/2100
Household meter penetration (%) (incl. voids)	67	79	92	94	94	94	95

Table 11-14: SWOX preferred plan – PCC (DYAA)

SWOX	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11	End AMP22
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45	2099/2100
PCC (l/h/d)	136	128	121	118	112	110	99

Table 11-15: Programme appraisal metric scores[16]

Metrics / Programme	Cost (£bn NPV)	Resilience	Deliver-ability	Environ. benefit	Environ. adverse	Customer Preference	IGEQ
Least cost[17]	4.105	0.84	1.00	70	81	4.41	11.33
Preferred	4.628	0.88	0.95	81	77	4.42	11.19

[16] London, SWOX and SWA WRZ are modelled together, so these scores are for the combined zone.
[17] For the preferred "Baseline + Drought + WRSE" baseline scenario.

Building the preferred plan

11.83 We followed the same stakeholder and governance process outlined above for London in developing our preferred plan for the SWOX WRZ.

11.84 In order to have a holistic view of the supply-demand balance, we undertook the programme appraisal of SWOX together with the London and SWA WRZs because SWOX is the main resource donor to serve these other zones. Furthermore, the same best-value plan for SWOX aligns with that for London and SWA. The synergies have been described in the programme appraisal process set out in Section 10: Programme appraisal and scenario testing.

11.85 We consider that a plan primarily based on demand management in the short and medium term period with the introduction of the SESRO in 2037/38 is the most appropriate, balanced plan. Water transfers and trades will be developed later in the planning horizon to meet any increase in local demand for water. Whilst this plan is not least cost, it has considerable benefits beyond pure monetary value. This is the best value long-term plan because:

- It provides sufficient resilience to respond to population growth, the impacts of climate change as well as regional water demands.
- It has balanced environmental impacts.
- It aligns with customer research preference on demand management and resource development schemes.
- It has close alignment to the achievement of Government policy objectives outlined in the WRPG and Defra's Guiding Principles and the 25 year Plan to improve the environment[18].

11.86 These factors are discussed in the programme appraisal process (Section 10: Programme appraisal and scenario analysis), reflecting the fact that the preferred plan is higher cost than the least cost plan but delivers better overall value for customers.

11.87 It has been noted that the impact of climate change is forecast to increase the intensity and frequency of extreme drought events. Without additional resource development, the SWOX WRZ will be potentially heavily reliant on environmentally damaging drought permit options in the event of a drought of greater severity than has been experienced in the historic record. Large-scale resource options provide important benefits to manage future climate uncertainty and reduce reliance on drought permit options except in severe and extreme drought events.

11.88 A further benefit of our preferred plan for SWOX is the importance of communicating a clear message of water stress and the need to use water wisely in the South East region. We want to maintain a consistent message to our customers and rolling out our PMP outside London will help us to extend and provide clarity on our demand management policy. Having consistent communication is significant for our long-term sustainable development if better use of water resources is to be achieved.

11.89 Delivering the SESRO in the late-2030s helps to reserve groundwater schemes as contingency measures to help manage uncertainty.

[18] H M Government 2018 A Green Future: Our 25 Year Plan to Improve the Environment

Risks and uncertainties in the preferred plan

Risk: concern relating to the SESRO

11.90 We are very aware of the concerns expressed by members of the local community regarding construction of the SESRO, particularly concerning the change in land use and the adverse environmental impacts during construction. In describing the preferred plan for our London WRZ we have set out the advantages and disadvantages of the SESRO.

11.91 Our programme appraisal process has already reflected our position that we ranked adverse environmental impacts as a high priority during the decision making process. We determined through the programme appraisal process that the benefits brought about through implementing the reservoir as a sustainable water resource scheme for local supply as well as to supply the SWA and London WRZs and the wider South East region outweighed the temporary adverse impacts that would be caused during construction.

SWOX - preferred plan summary

11.92 The above section summarises the preferred plan for SWOX. From the work we have undertaken we consider the preferred plan has the right overall supply/demand balance, aligns to Government objectives, and has an optimum balance of metric scores when viewed from a holistic perspective of the overall plan.

11.93 We consider that the underlying strategy behind the plan, that is to reduce the overall demand for water and to best secure the long term water supply with the introduction of a large-scale strategic reservoir resource, the best value water management strategy for the plan period if we are to be able to accommodate future challenges created by growth, climate change and the need to protect the environment.

D. Slough, Wycombe and Aylesbury

The preferred plan for SWA

11.94 As illustrated in Figure 11-4 there is a baseline supply-demand deficit in DYCP.

11.95 However, there are no large scale local resource schemes within the SWA WRZ that can resolve the deficit and raw water imports into the zone are required.

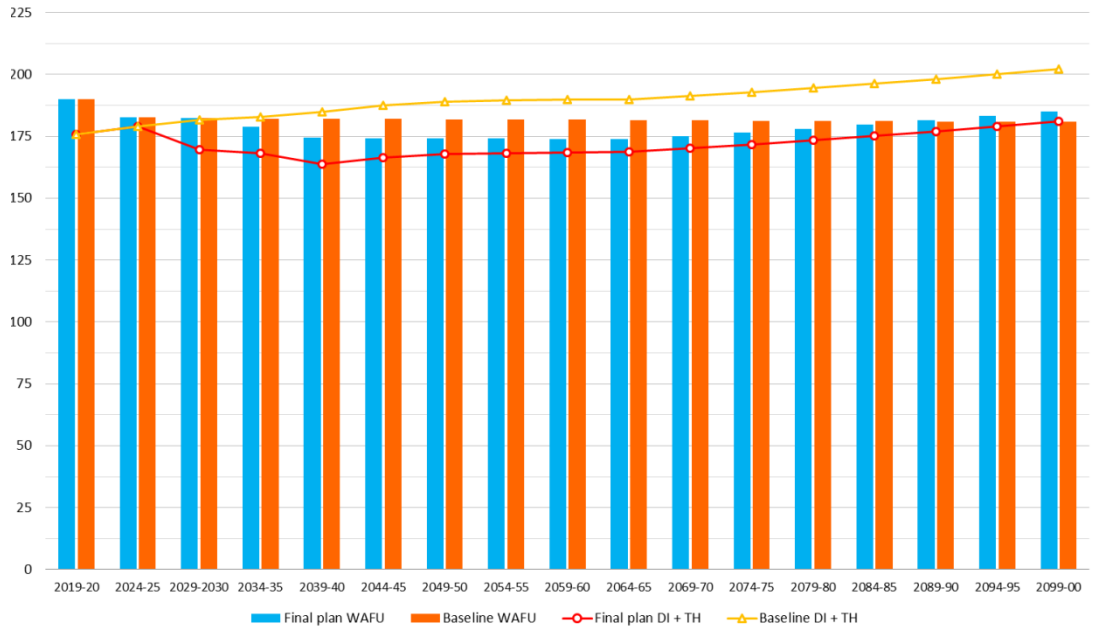
11.96 For DYCP, a deficit is observed from 2033/34. If no action is taken, the deficit during peak time in SWA would reach 21 Ml/d at the end of the 80-year planning period.

11.97 Our PMP is the core demand management strategy implemented from 2025 together with a proactive water efficiency campaign and mains replacement.

11.98 The preferred plan for the London-SWOX-SWA WRZs, as described earlier in Section 10: Programme appraisal and scenario testing, is to implement an inter-zonal raw water transfer from SWOX to SWA to meet the growing long-term deficit observed from 2066. This transfer is

facilitated by the South East strategic reservoir. A local groundwater scheme is available from 2038, which is forecast to provide a benefit of 5 Ml/d.

Figure 11-4: SWA supply-demand balance (DYCP)



11.99 The key features of the preferred plan are:

Medium to long-term (2025 – 2099)

11.100 Demand management for SWA will start in 2025 (AMP8). Smart meter penetration of individual household customers of 87% will be delivered by 2030.

11.101 The Datchet groundwater scheme in 2038 will provide 5 Ml/d to maintain security of supply until an inter-zonal transfer from SWOX is required in 2066 at times of peak demand which provides a maximum benefit up to 24 Ml/d to meet the needs in SWA.

11.102 The plan is presented in Table 11-16 to Table 11-22.

Plan description

11.103 SWA WRZ is forecast to remain in surplus until a DYCP supply-demand deficit is observed from 2033/34, driven primarily by population growth, together with the loss of existing water resources through a 9.8 Ml/d abstraction licence reduction at Hawridge in 2024, where our groundwater abstractions are perceived to impact the River Chess.

11.104 We aim to install 56,882 smart household meters by 2029/30 alongside water efficiency to deliver 10 Ml/d reduction in usage by the end of AMP9 (2034/35). In addition with leakage reduction activities and the introduction of tariffs, the integrated demand management programme is expected to achieve circa 22 Ml/d benefits by the end of AMP10 (2039/40).

11.105 One small resource development scheme plus a large inter-zonal transfer are required to maintain the medium and long-term supply demand balance once savings from demand management are substantially taken up.

11.106 The delivery of the SESRO in 2037/38 provides an opportunity to stop any remaining abstraction at the Pann Mill groundwater source (9.5 Ml/d), following on from the imposition of an initial 7.3 Ml/d sustainability reduction in 2020. The source is perceived to have a detrimental environmental impact on the River Wye. Previous investigations concluded that it was not cost beneficial to stop abstraction at this site. The SESRO with its low annual opex costs will help to more cost effectively stop using the remaining licence at Pann Mill and thereby help to address concerns voiced by environmental groups.

11.107 To stop all abstraction at Pann Mill will require the imposition of new infrastructure earlier than currently included in the preferred plan. The Medmenham intake on the River Thames would need to be brought forward from its current planned date of 2066 to 2037/38 and a new main would also need to be constructed to allow for the water to replace that currently provided by Pann Mill.

11.108 Development of the Datchet groundwater source is currently planned in 2038 and this would no longer be required if the Medmenham intake scheme is brought forward. The overall total cost of the preferred programme would increase by approximately £20 million NPV, but environmental impacts associated with the Datchet scheme and its supporting infrastructure would not be incurred. We welcome regulator and stakeholder views on this suggested amendment to the preferred plan.

Performance of the preferred plan

11.109 Figure 11-4 illustrates the supply-demand balance for SWA. The preferred plan for SWA ensures that security of supply is maintained throughout the planning period.

Table 11-16: SWA preferred plan – Overall plan (DYCP) for demand management

SWA		Delivery date and ongoing supply demand benefit (Ml/d)			
		AMP8	AMP9	AMP10	AMP11-AMP22
		2025-2029	2030-2034	2035-2039	2040-2100
Total benefit from DMP		**12.2**	**3.3**	**6.6**	**Benefits maintained**
Leakage reduction	**Total leakage reduction**	**4.7**	**0.7**	**1.1**	**Benefits maintained**
	Household metering CSL	4.2	0.0	0.0	
	Bulk metering CSL				
	AMP8: 5,783 meters	0.5			
	AMP9: 0 meters		0.0		
	AMP10: 0 meters			0.0	
	Replacement metering CSL				
	Mains replacement		0.7	1.1	
	Pressure management				
	DMA enhancement				
Usage reduction	**Total usage reduction**	**7.5**	**2.6**	**5.5**	**Benefits maintained**
	Household metering				
	AMP8: 56,882 meters	6.00			
	AMP9: 0 meters		0.9		
	AMP10: 0 meters			0.0	
	Water efficiency	1.5	1.7	0.9	
	Incentive scheme				
	Non-potable water				
	Innovative tariffs			4.6	

Table 11-17: SWA preferred plan – Overall plan (DYCP) for resource management

SWA	Delivery date and ongoing supply demand benefit (Ml/d)							
	AMP7	**AMP8**	**AMP9**	**AMP10**	**AMP11**	**AMP16**	**AMP17**	**AMP22**
	2020-2024	**2025-2029**	**2030-2034**	**2035-2039**	**2040-2044**	**2065-2069**	**2070-2074**	**2095-2099**
Groundwater								
Datchet				5.4	5.4	5.4	5.4	5.4
Inter-zonal transfer								
River Thames to Medmenham						24	24	24
Total additional water resource				**5.4**	**5.4**	**29.4**	**29.4**	**29.4**
Baseline supply demand balance	3.6	0.9	-0.6	-2.9	-5.5	-9.9	-11.5	-21.3
Additional reduction in DO								
1:200 Drought resilience			**-3.3**	**-3.3**	**-3.3**	**-3.3**	**-3.3**	**-3.3**
Vulnerable chalk stream (Pann Mill)				**-9.8**	**-9.8**	**-9.8**	**-9.8**	**-9.8**

Table 11-18: SWA preferred plan – Water resource schemes (delivery year in chronological order)

Resource schemes	DYCP yield (Ml/d)	Delivery year
Groundwater Datchet	5.4	2038
Inter-zonal transfer River Thames to Medmenham from SWOX	24	2066

Table 11-19: SWA preferred plan – Annual average leakage forecast

Slough Wycombe Aylesbury – DYAA	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Average leakage forecast (Ml/d)	37	37	33	32	31	31

Table 11-20: SWA preferred plan – Meter penetration

Slough Wycombe Aylesbury	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11	End AMP22
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45	2099/2100
Household meter penetration (%) (incl. voids)	57	64	87	91	92	92	94

Table 11-21: SWA preferred plan – PCC (DYAA)

Slough Wycombe Aylesbury	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11	End AMP22
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45	2099/2100
PCC (l/h/d)	138	136	126	122	114	113	102

Table 11-22: Programme appraisal metric scores[19]

Metrics / Programme	Cost (£bn NPV)	Resilience	Deliver-ability	Environ. benefit	Environ. adverse	Customer Preference	IGEQ
Least cost[20]	4.105	0.84	1.00	70	81	4.41	11.33
Preferred	4.628	0.88	0.95	81	77	4.42	11.19

[19] London, SWOX and SWA WRZ are modelled together, so these scores are for the combined zone.
[20] For the preferred "Baseline + Drought + WRSE" baseline scenario.

Building the preferred plan

11.110 Due to the high complexity of the supply / demand deficit problem in the London, SWOX and SWA WRZs we have undertaken a combined WRZ programme appraisal. This provides a holistic view and facilitates an efficient, best value investment programme.

11.111 The preferred plan resulting from this combined programme appraisal process is the best value plan for the London-SWOX-SWA WRZs in total.

11.112 We consider the preferred plan aligns to the achievement of Government policies and aspirations, has reduced environment impact and allows us to respond flexibly to future uncertainties to deliver long term best value for customers and the wider water environment.

11.113 In-line with other Thames Valley WRZs, we have taken an integrated approach to demand management with our PMP being the core of our strategy.

SWA – preferred plan summary

11.114 The preferred programme for SWA ensures that security of supply is maintained throughout the planning period.

11.115 The approach of focusing on demand management and groundwater development in the medium-term and implementing a large inter-zonal transfer later in the planning period facilitates mitigation of long-term uncertainty.

11.116 The above section summarises the preferred plan for the SWA WRZ. From the work we have undertaken we consider the preferred plan provides the long term best value balance of relevant water management considerations, including securing sufficient resilience against growing demand and climate change, and has less environmental adverse impacts compared with alternative programmes.

11.117 Other uncertainties include likely increasing demand for water supply from the South East region (e.g. South East Water) and more frequent and intense drought events. As discussed earlier, the combined London, SWOX and SWA preferred plan addresses and enables mitigation of these risks. Our stress testing approach set out in Section 10: Programme appraisal and scenario testing is similar to an adaptive pathways approach.

E. Kennet Valley

The preferred plan for Kennet Valley

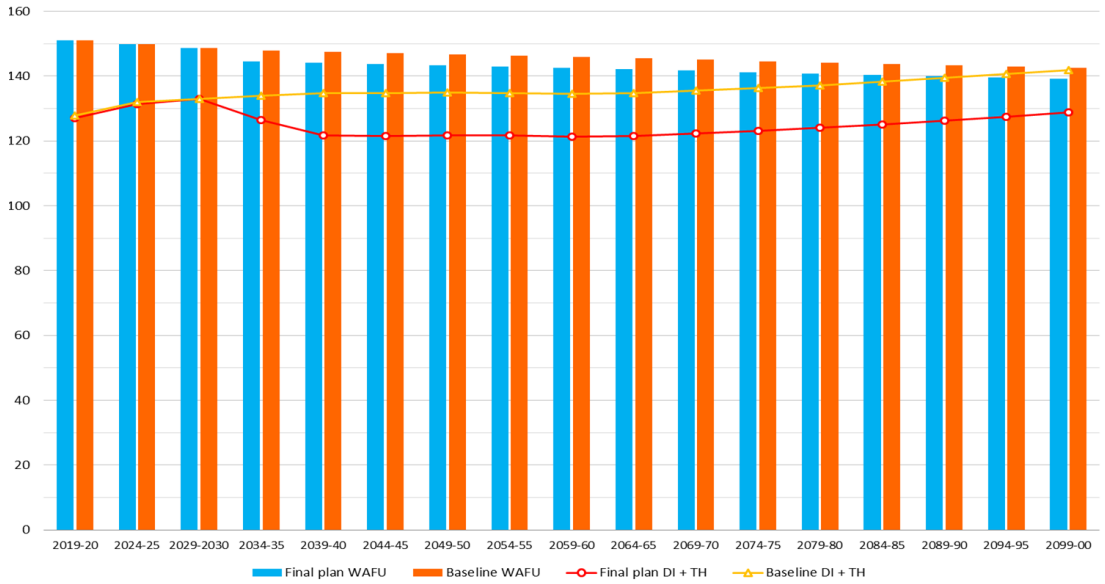
11.118 The Kennet Valley WRZ remains in surplus throughout the planning period in the baseline supply-demand balance forecast (Figure 11-5). However, the zone is not resilient to a 1 in 200 year severe drought event and as such requires investment to improve security of supply resilience. A deficit emerges at the end of the planning period in the 2090s.

11.119 The planning problem in Kennet Valley has been classified as being of low complexity and therefore Kennet Valley is following a least cost approach to close the deficit which emerges

when resilience to a severe drought is included. This has been explained in Section 10: Programme appraisal and scenario analysis.

11.120 The preferred plan is centred on demand management starting from AMP9. The strategy on demand management is consistent with other WRZs. We continue to focus on our PMP and proactive water efficiency, in addition to the introduction of an incentive based financial tariff. We expect to receive circa 13.7 Ml/d benefits by the end of AMP10 (2035/40) associated with our demand management activities.

Figure 11-5: Kennet Valley supply-demand balance (DYCP)



11.121 The key features of the preferred plan are:

Medium-term (2030-2040) demand management

11.122 Roll out of PMP and aim to achieve 95% household smart meter penetration by the end of AMP9 (2034/35).

11.123 The metering, a proactive water efficiency campaign and the introduction of financial tariffs is expected to deliver 10 Ml/d savings by 2039/40.

Plan description

11.124 Our preferred plan starts with an integrated demand management programme. Consistent with our other WRZs, Kennet Valley will roll out our PMP.

11.125 The demand management programme ensures resilience to a 1 in 200 year severe drought event.

11.126 Table 11-23 to Table 11-28 outline the details of the plan.

Table 11-23: Kennet Valley preferred plan – Overall plan (DYCP) for demand management

	Kennet Valley	Delivery date and ongoing supply demand benefit (Ml/d)			
		AMP9	AMP10	AMP11	AMP12-AMP22
		2030-2034	2035-2039	2040-2044	2045-2100
Total benefit from DMP		**8.5**	**5.1**	**Benefits maintained**	
Leakage reduction	**Total leakage reduction**	**3.7**		**Benefits maintained**	
	Household metering CSL	3.4	0.0	0	
	Bulk metering CSL AMP9: 4,332 meters AMP10: 0 meters AMP11: 0 meters	0.3			
	Replacement metering CSL				
	Mains replacement				
	Pressure management				
	Innovation				
	DMA enhancement				
Usage reduction	**Total usage reduction**	**4.8**	**5.1**	**Benefits maintained**	
	Household metering AMP9: 42,237 meters AMP10: 0 meters AMP11: 0 meters	3.3	0.6	0.0	
	Water efficiency	1.5	1.1	0.0	
	Incentive scheme				
	Non-potable water				
	Innovative tariffs		3.4		

Table 11-24: Kennet Valley preferred plan – Overall plan (DYCP) for resource management

Kennet Valley	Delivery date and ongoing supply demand benefit (Ml/d)							
	AMP7	**AMP8**	**AMP9**	**AMP10**	**AMP12**	**AMP17**	**AMP19**	**AMP22**
	2020-2024	**2025-2029**	**2030-2034**	**2035-2039**	**2045-2049**	**2070-2074**	**2080-2084**	**2095-2099**
Total additional water resource	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**
Baseline Supply Demand Balance	17.9	15.7	13.9	12.7	**11.7**	8.3	5.6	0.6
Additional reduction in DO								
1:200 Drought resilience			**-3.4**	**-3.4**	**-3.4**	**-3.4**	**-3.4**	**-3.4**

Table 11-25: Kennet Valley preferred plan – Annual average leakage forecast

Kennet Valley – DYAA	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Average leakage forecast (Ml/d)	26	26	26	22	22	22

Table 11-26: Kennet Valley preferred plan – Meter penetration

Kennet Valley	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11	End AMP22
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45	2099/2100
Household meter penetration (%) (incl. void)	58	63	68	95	95	95	96

Table 11-27: Kennet Valley preferred plan – PCC (DYAA)

Kennet Valley	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11	End AMP22
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45	2099/2100
PCC (l/h/d)	133	130	129	120	111	110	98

Table 11-28: Kennet Valley preferred plan – Programme appraisal metric scores

Metrics / Programme	Cost (£m NPV)	Resilience	Deliver-ability	Environ. benefit	Environ. adverse	IGEQ	Customer preference
Preferred	40.7	0.44	1	6	1	0.33	4.39

Building the preferred plan

11.127 Our preferred plan is built from the outcomes of our programme appraisal process and we have followed the same governance process as outlined above for the London, SWOX and SWA WRZs.

11.128 We consider that a preferred plan based on demand management is appropriate.

Risks and uncertainties in the preferred plan

11.129 The preferred plan for Kennet Valley ensures that security of supply is maintained throughout the planning period.

11.130 The main risk to the supply demand balance of the zone is the potential reduction of output from the Environment Agency's West Berkshire Groundwater Scheme. This scheme, where in

times of drought water is abstracted from underground aquifers in order to augment flows in the River Kennet, supports our abstraction at Fobney and further downstream in London.

11.131 The ownership, operation and long-term viability of these assets are unclear and the Environment Agency has requested we assess the potential impact of a reduction in outputs from the scheme on our plan.

11.132 The full scheme has a supply benefit of 43 Ml/d to the Kennet Valley WRZ. We believe that complete loss of the entire scheme benefit would be unlikely, so we have developed a scenario that reduces output by 27 Ml/d based on the contribution of sustainable drought sources in the confined chalk aquifer.

11.133 Currently there are insufficient options in the Kennet Valley to meet a reduction in supply of that scale and we would likely need to develop a new surface water intake on the River Thames near Reading in order to support Fobney. The additional abstraction from the River Thames would be made viable through release of water from the South East strategic reservoir following its completion in 2037/38. An earlier requirement would necessitate bringing forward the demand management programme from the current planned start of 2030.

Kennet Valley - preferred plan summary

11.134 The above sections summarise the preferred plan for Kennet Valley. We consider the preferred plan has the right overall balance, aligns to customer research and provides sufficient long-term resilience. The plan is resilient to any uncertainties associated with the continuing availability of the West Berkshire Groundwater Scheme.

F. Guildford

The preferred plan for Guildford

11.135 As indicated in Figure 11-6, there is a baseline DYCP supply-demand deficit in Guildford, starting as early as 2025/26 and increasing over the rest of the planning period.

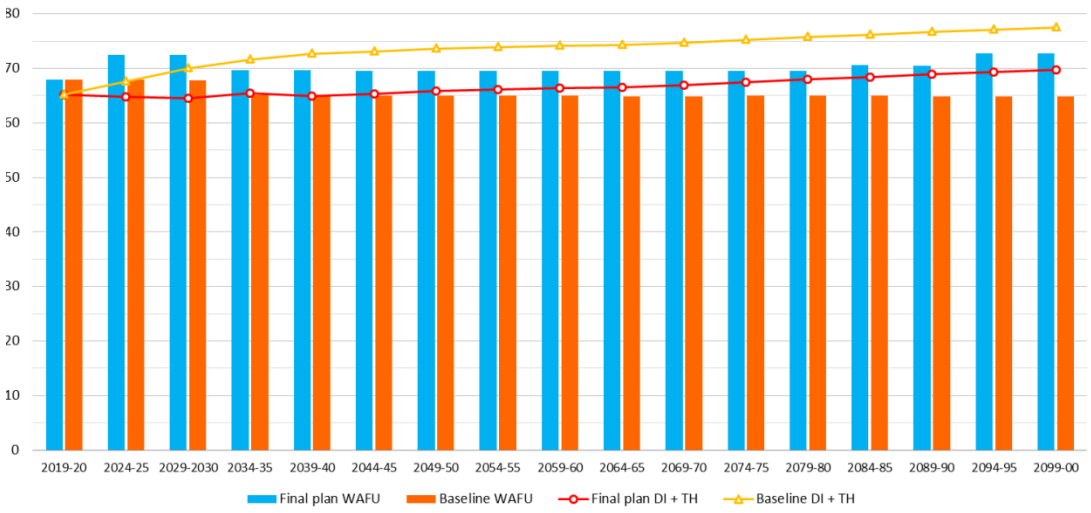
11.136 The problem characterisation of the Guildford WRZ has been classified as being of low complexity and we have followed a least cost approach for deriving Guildford's preferred plan because the supply-demand deficit can be balanced at this level of investment.

11.137 Similar to other WRZs, integrated demand management with focus on our PMP, water efficiency and DMA Enhancement is applied in Guildford together with the removal of a network constraint at Ladymead which provides an additional 4.6 Ml/d supply to Guildford in 2024.

11.138 A new main is required to transfer water from sources in the west of the zone to the east, where resource availability is limited and demand management activity will be insufficient in itself to meet the forecast growth in demand associated with new housing development.

11.139 The key features of the preferred plan are:

Figure 11-6: Guildford supply-demand balance (DYCP)



Short to medium-term (2020-2030) demand management

11.140 Implementing our PMP together with proactive promotion of water efficiency including 80,000 Smarter Home Visits and 1,000 'Leaky Loo' visits to help customers use water wisely.

11.141 Our PMP in Guildford will achieve over 88% individual household smart meter penetration by the end of 2030.

Short to long-term (2020 to 2099) water resource management

11.142 Removal of a network constraint at Ladymead allows an extra 4.6 Ml/d supply to Guildford from 2024.

11.143 A transfer main from Shalford water treatment works to Netley Mill in 2026 facilitates movement of water from the west of the resource zone to the east.

11.144 To maintain security of supply in the long-term requires removal of a network constraint at Dapdune in 2081 followed by development of a groundwater source at Dapdune in 2091.

Plan description

11.145 Our preferred plan includes a PMP with 9,259 household meters installed in AMP7, followed by 7,232 between 2025 and 2030.

11.146 A small resource scheme removing network constraints at Ladymeads is required as early as 2024 to support growth.

11.147 In the long-term, post 2080, another network constraint requires removal, together with further development of a small groundwater source.

11.148 Our preferred plan is listed in Table 11-29 to Table 11-35.

Performance of the preferred plan

11.149 The preferred plan for Guildford ensures that security of supply is maintained throughout the planning period. The WRZ is already resilient to a 1 in 200 year severe drought event.

Table 11-29: Guildford preferred plan – Overall plan (DYCP) for demand management

	GUI	Delivery date and ongoing supply demand benefit (Ml/d)				
		AMP7	AMP8	AMP9	AMP10	AMP11-AMP22
		2020-2024	2025-2029	2030-2034	2035-2039	2040-2100
Total benefit from DMP		**3.4**	**2.6**	**0.9**	**1.5**	**Benefits maintained**
Leakage reduction	**Total leakage reduction**	**2.1**	**1.5**	**0.5**	**Benefits maintained**	
	AMP6 Carry-over leakage	0.5				
	Household metering CSL	0.8	0.6	0.0	0.0	
	Bulk metering CSL	0.1				
	AMP7: 1,194 meters					
	AMP8: 1,194 meters		0.1			
	AMP9: 0 meters					
	Replacement metering CSL					
	Mains replacement		0.3	0.5		
	Pressure management					
	Innovation					
	DMA enhancement	0.7	0.5			
Usage reduction	**Total usage reduction**	**1.3**	**1.1**	**0.4**	**1.5**	**Benefits maintained**
	Household metering					
	AMP7: 9,259 meters	0.8				
	AMP8: 7,232 meters		0.9			
	AMP9: 0 meters			0.1		
	Water efficiency	0.5	0.2	0.3		
	Incentive scheme					
	Non-potable water					
	Innovative tariffs				1.5	

Table 11-30: Guildford preferred plan – Overall plan (DYCP) for resource management

	Delivery date and ongoing supply demand benefit (Ml/d)								
	AMP7	AMP8	AMP9	AMP10	AMP11	AMP17	AMP19	AMP21	AMP22
Guildford	**2020-2024**	**2025-2029**	**2030-2034**	**2035-2039**	**2040-2044**	**2070-2074**	**2080-2084**	**2090-2094**	**2095-2099**
Groundwater scheme									
Groundwater Dapdune								2.2	2.2
Removal of network constraint									
Ladymead	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Dapdune							1	1	1
Conveyance									
Shalford to Netley Mill									
Baseline deficit	0.3	-2.1	-6.5	-7.5	-8.1	-10.2	-11.3	-12.2	-12.6

Table 11-31: Guildford preferred plan – Water resource schemes (delivery year in chronological order)

Resource schemes	DYCP yield (Ml/d)	Delivery year
Ladymead removal of network constraint	4.6	2024
Dapdune removal of network constraint	1	2081
Groundwater Dapdune	2.2	2091

Table 11-32: Guildford preferred plan – Annual average leakage forecast

Guildford – DYAA	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Average leakage forecast (Ml/d)	13	11	10	9	9	9

Table 11-33: Guildford preferred plan – Meter penetration

Guildford	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11	End AMP22
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45	2099/2100
Household meter penetration (%) (incl. void)	55	73	88	90	91	91	93

Table 11-34: Guildford preferred plan – PCC (DYAA)

Guildford	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11	End AMP22
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45	2099/2100
PCC (l/h/d)	146	138	132	129	123	121	108

Table 11-35: Guildford preferred plan – Programme appraisal metric scores

Metrics / Programme	Cost (£m NPV)	Resilience	Deliver-ability	Environ. benefit	Environ. Adverse
Preferred	52.6	0.44	0.98	12	5

Building the preferred plan

11.150 Our preferred plan is built from the outcomes of our programme appraisal process and we have followed the same governance process outlined above for the London, SWOX and SWA WRZs in developing our preferred plan.

11.151 We consider that a plan based initially on integrated demand management from 2020 is appropriate having regard to relevant guidance. In addition, removal of a network constraint and a transfer main are also required to maintain security of supply until the 2080s.

11.152 The preferred plan for Guildford ensures that security of supply is maintained throughout the planning period and the resource zone is resilient to a 1 in 200 year drought event.

11.153 The problem characterisation of the WRZ is low.

Guildford - preferred plan summary

11.154 The above sections summarise the preferred plan for Guildford. We consider the preferred plan has the right overall balance, aligns to customer research and provides sufficient long-term resilience.

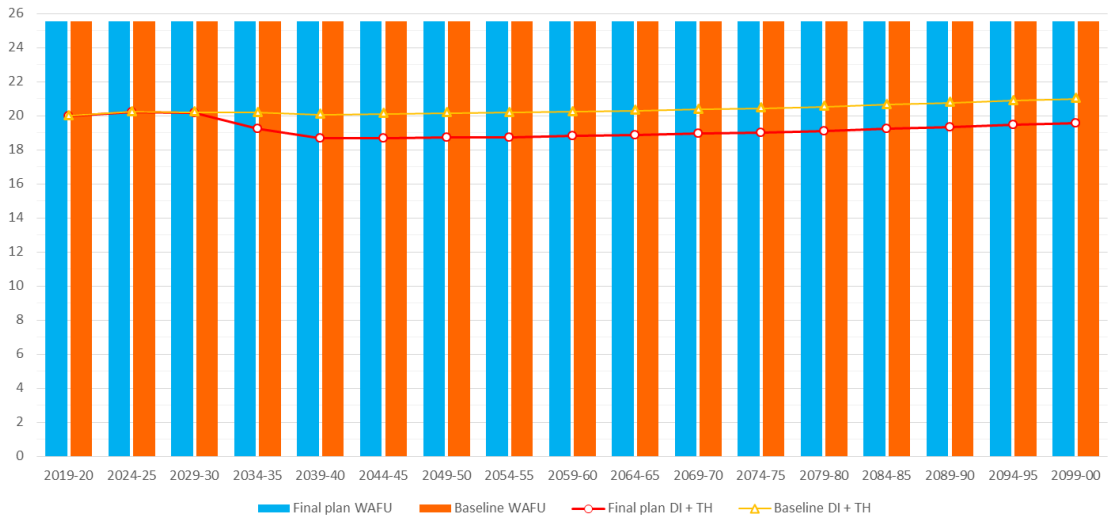
G. Henley

The preferred plan for Henley

11.155 As illustrated in Figure 11-7, Henley has no forecast supply-demand deficit over the planning period for either DYAA or DYCP. The resource zone is classified as low risk.

11.156 To ensure an equitable policy for our customers across our WRZs, our PMP will be the core demand management strategy in the Henley WRZ. This is consistent with the policy set out in our WRMP14.

Figure 11-7: Henley supply-demand balance (DYCP) over 80-year planning horizon



Plan description

11.157 Although we forecast that Henley will be in surplus throughout the planning period, integrated demand management is implemented from 2030-2035. This will ensure water usage reduction will continue by promoting water efficiency and our PMP.

11.158 The preferred plan reduces leakage by 0.35 Ml/d and total demand by 1.47Ml/d.

11.159 Total household smart meter penetration of 95% is achieved by 2035/35.

11.160 Table 11-36 to Table 11-40 outline the details of the preferred plan.

Performance of the plan

11.161 The preferred plan for Henley ensures that security of supply is maintained throughout the planning period and that the zone is resilient to a 1 in 200 year severe drought event.

Table 11-36: Henley preferred plan – Overall plan (DYCP)

Henley		Delivery date and ongoing supply demand benefit (Ml/d)			
		AMP9	AMP10	AMP11	AMP12-AMP22
		2030-2034	2035-2039	2040-2044	2045-2100
Total benefit from DMP		**0.93**	**0.56**	**Benefits maintained**	
Leakage reduction	**Total leakage reduction**	**0.33**	**Benefits maintained**		
	Household metering CSL	0.3			
	Bulk metering CSL AMP9: 346 meters AMP10: 0 meters AMP11: 0 meters	0.03			
	Replacement metering CSL				
	Mains replacement				
	Pressure management				
	Innovation				
	DMA enhancement				
Usage reduction	**Total usage reduction**	**0.6**	**0.56**	**Benefits maintained**	
	Household metering AMP9: 3,852 meters AMP10: 0 meters AMP11: 0 meters	0.3	0.06		
	Water efficiency	0.3			
	Innovation				
	Incentive scheme				
	Non-potable water				
	Innovative tariffs		0.5		

Table 11-37: Henley preferred plan – Annual average leakage forecast

Henley – DYAA	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Average leakage forecast (Ml/d)	4	4	4	3	3	3

Table 11-38: Henley preferred plan – Meter penetration

Henley	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11	End AMP22
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45	2099/2100
Household meter penetration (%) (incl. void)	68	72	76	95	96	96	96

Table 11-39: Henley preferred plan – PCC (DYAA)

Henley	End AMP6	End AMP7	End AMP8	End AMP9	End AMP10	End AMP11	End AMP22
	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45	2099/2100
PCC (l/h/d)	141	138	138	129	122	120	111

Table 11-40: Henley preferred plan – Programme appraisal metric scores

Metrics / Programme	Cost (£m NPV)	Resilience	Deliver-ability	Environ. Benefit	Environ. Adverse
Preferred	4.089	0.44	1	3	1

11.162 Our preferred plan is built from the outcomes of our programme appraisal process.

11.163 We consider that a plan based on demand management mid-way through the planning period is appropriate.

11.164 The problem characterisation of the WRZ is low.

Henley - preferred plan summary

11.165 The above sections summarise the preferred plan for Henley. We consider the preferred plan has the right overall balance, aligns to customer research and provides sufficient long-term resilience.

H. Summary supply-demand balance

11.166 The total supply-demand balance for all WRZs for our preferred plan is summarised in Table 11-41.

Table 11-41: Total supply-demand balance for all WRZs (Preferred Plan)

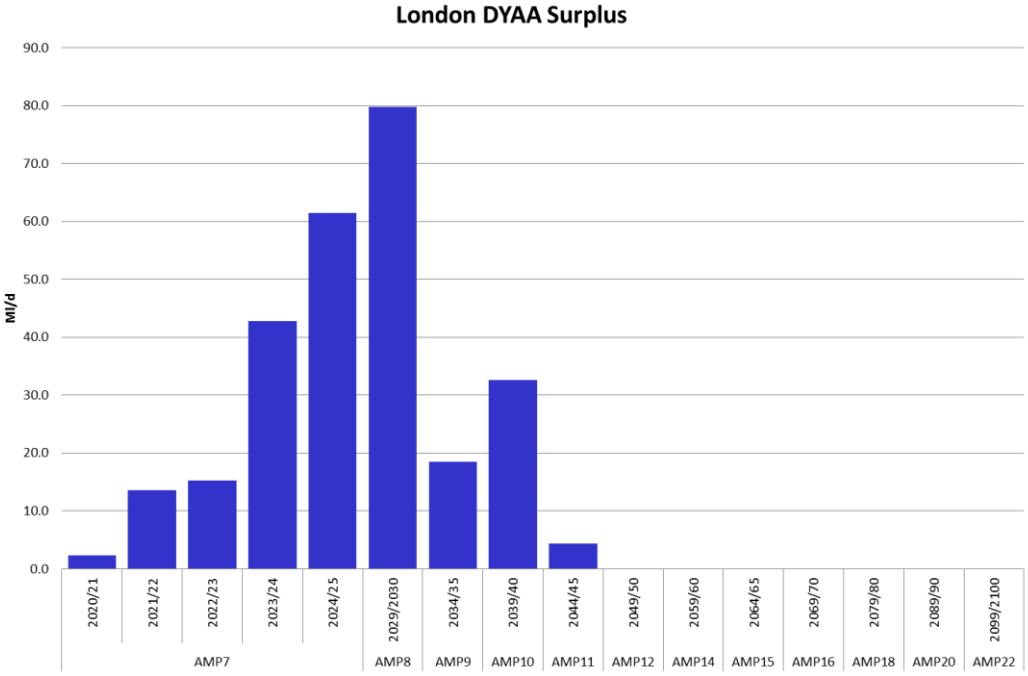
WRZ	Item	Volume (Ml/d)															
		AMP7					AMP8	AMP9	AMP10	AMP11	AMP12	AMP14	AMP15	AMP16	AMP18	AMP20	AMP22
		2020/21	2021/22	2022/23	2023/24	2024/25	2029/30	2034/35	2039/40	2044/45	2049/50	2059/60	2064/65	2069/70	2079/80	2089/90	2099/2100
London (DYAA)	DI+TH	2149	2131	2123	2088	2069	2008	1988	1945	1965	1983	2019	2035	2049	2070	2089	2110
	WAFU	2152	2145	2138	2131	2130	2087	2007	1978	1969	1983	2019	2035	2049	2070	2089	2110
	SDB	**2.4**	**13.6**	**15.3**	**42.8**	**61.4**	**79.8**	**18.5**	**32.6**	**4.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
SWOX (DYCP)	DI+TH	344	344	341	338	335	321	321	313	312	311	309.9	311	313	316	320	325
	WAFU	355	354	354	354	353	352	344	537	537	514	459.8	415	391	348	341	345
	SDB	**10.4**	**10.7**	**12.7**	**16.0**	**18.7**	**30.3**	**23.2**	**224.5**	**225.1**	**203.0**	**149.8**	**103.3**	**77.8**	**31.9**	**28.7**	**19.9**
SWA (DYCP)	DI+TH	177	179	180	180	179	170	168	164	166	168	169	169	170	173	177	181
	WAFU	190	190	190	190	183	182	179	174	174	174	174	174	175	178	181	185
	SDB	**13.0**	**10.9**	**10.0**	**9.7**	**3.6**	**12.7**	**10.8**	**10.7**	**8.0**	**6.5**	**5.4**	**5.2**	**4.8**	**4.6**	**4.4**	**4.2**
Kennet Valley (DYCP)	DI+TH	129	130	131	131	131	133	126	122	122	122	121	122	122	124	126	129
	WAFU	151	151	150	150	150	149	145	144	144	143	142	142	142	141	140	139
	SDB	**21.8**	**20.4**	**19.4**	**19.0**	**17.9**	**15.7**	**18.7**	**22.5**	**22.2**	**21.6**	**21.1**	**20.5**	**19.4**	**16.9**	**13.8**	**10.5**
Guildford (DYCP)	DI+TH	65	65	65	65	65	65	65	65	65	66	66	66	67	68	69	70
	WAFU	68	68	68	68	73	72	70	70	70	70	70	70	69	70	71	73
	SDB	**2.8**	**3.1**	**3.1**	**3.2**	**7.8**	**7.9**	**4.3**	**4.8**	**4.2**	**3.8**	**3.2**	**3.0**	**2.5**	**1.6**	**1.6**	**2.9**
Henley (DYCP)	DI+TH	20	20	20	20	20	20	19	19	19	19	19	19	19	19	19	20
	WAFU	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
	SDB	**5.4**	**5.3**	**5.3**	**5.3**	**5.3**	**5.3**	**6.2**	**6.9**	**6.8**	**6.8**	**6.7**	**6.7**	**6.6**	**6.4**	**6.2**	**6.0**

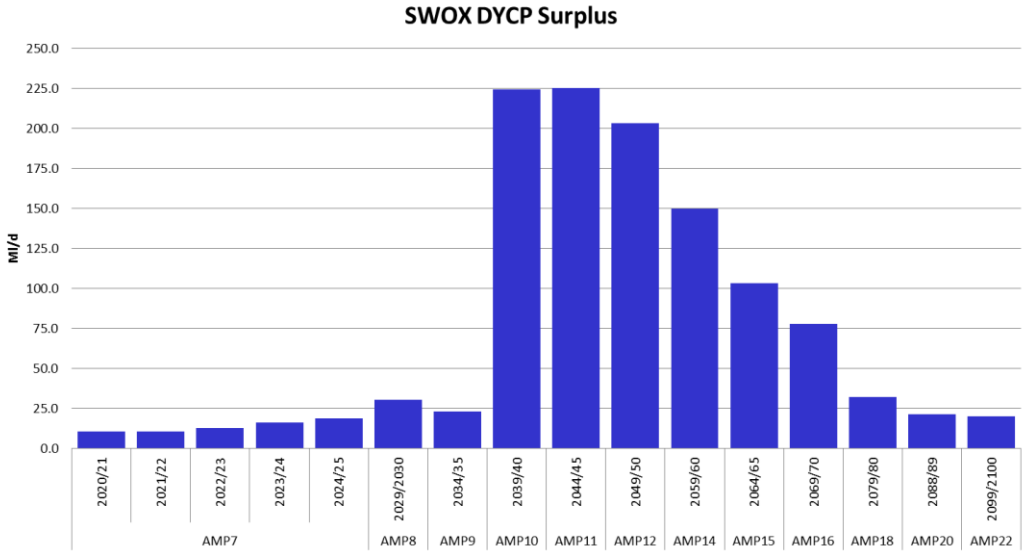
11.167 Figure 11-8 illustrates the surplus for London, SWOX and SWA in the preferred final plan. These three zones have been combined due to the complexity of water resource management between zones that are donors and receivers of raw water. The SESRO increases available water resources in the late-2030s. This large-scale water resource scheme is expected to provide sufficient resilience to cover the demand of London, SWOX and SWA caused by population growth, climate change and regional water demand from south east England. Supply resilience is improved to a 1 in 200 year severe drought event from 2030 onwards with the delivery of the combined groundwater, wastewater re-use and raw water transfer schemes which enhance resource availability in London.

11.168 From the 2080s, security of supply resilience is maintained through the supported Severn Thames Transfer scheme. This scheme addresses long-term requirements of climate change and population growth.

11.169 For the rest of the three Thames Valley WRZs (Figure 11-9), Henley and Kennet Valley WRZs have a steady surplus across the 80-year span while stress in the supply-demand balance can be observed in Guildford WRZ from the mid-2020s.

Figure 11-8: Surplus for London (DYAA), SWOX and SWA (DYCP)





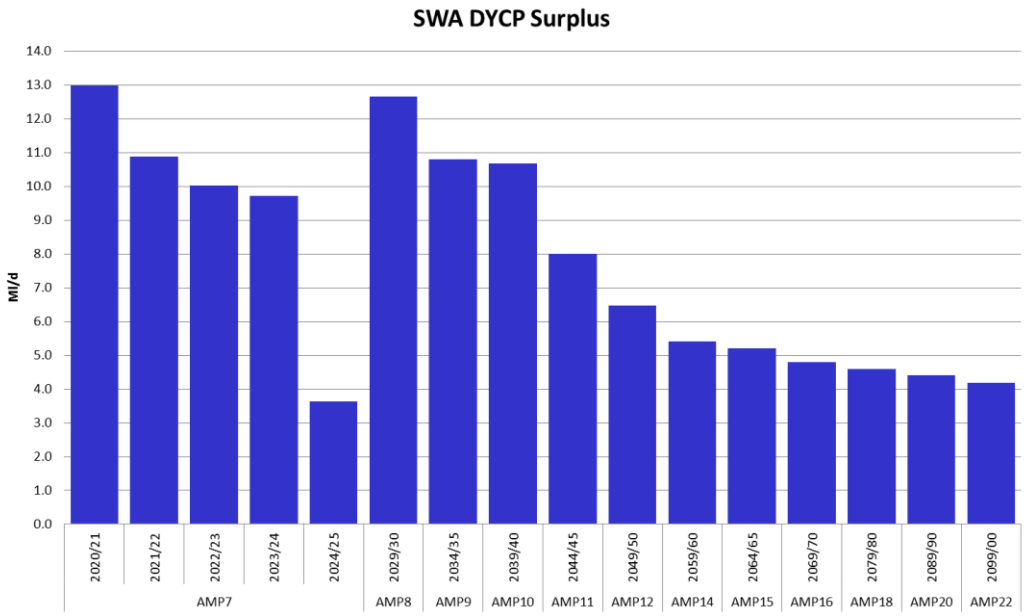
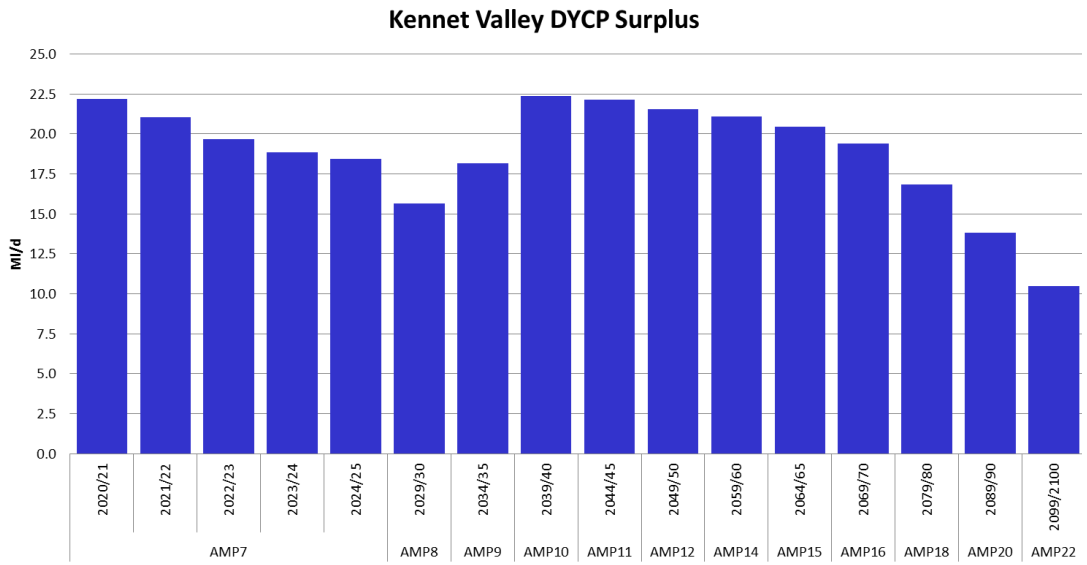
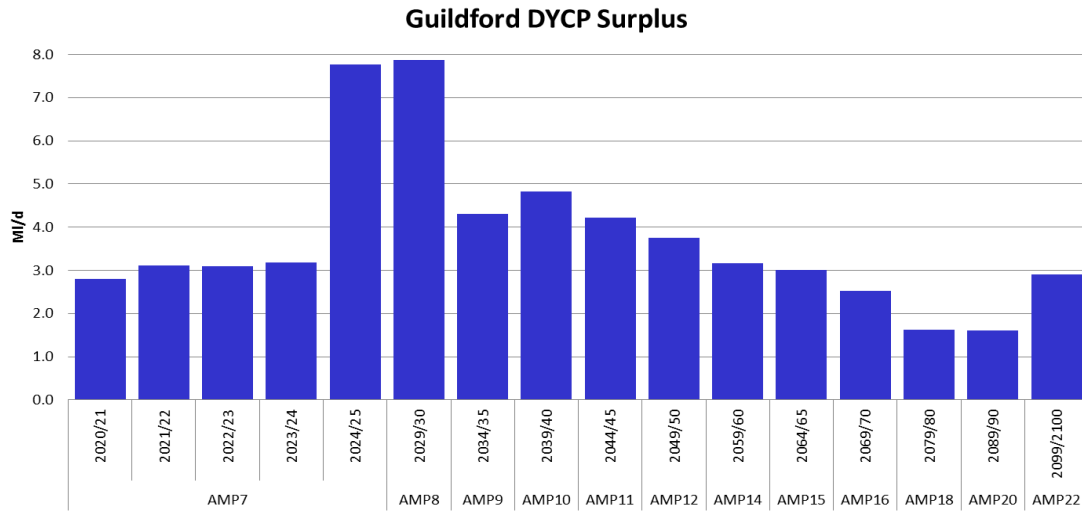
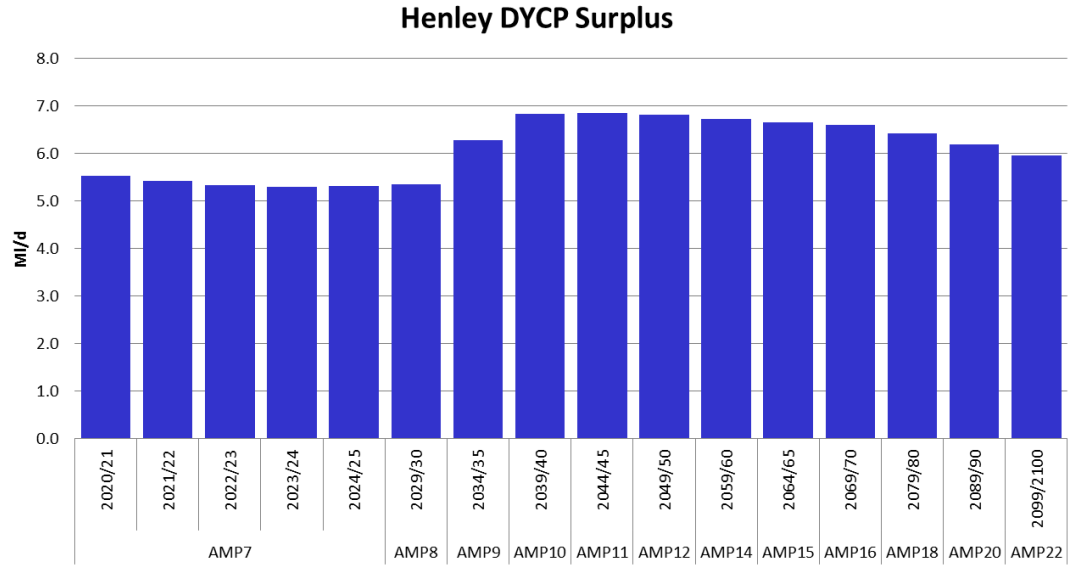


Figure 11-9: Surplus for Kennet Valley, Guildford and Henley (DYCP)







I. Preferred plan – overview of demand management outputs

Per capita consumption forecasts

11.170 Our preferred plan follows the Government's objective which sets a clear target for water companies, who are either designated as being in a water stressed area or where their PCC is above the national average, to significantly reduce demand[21].

11.171 Continuing the integrated demand management approach that we set out in our WRMP14 allows us to achieve this important objective. The combined effect of our PMP, together with a reward based incentive scheme in the London WRZ and widespread financial incentive based tariffs throughout our supply area, proactive industry leading water efficiency activities and

[21] H M Government 2018 A Green Future: Our 25 Year Plan to Improve the Environment

innovative non potable supplies to new developments facilitates a significant reduction in PCC throughout our supply area. The preferred plan PCC profiles are shown in Figure 11-10 for London and Figure 11-11 for Thames Valley.

11.172 These graphs clearly show the reduction in PCC of water across our entire water supply area and demonstrate the potential effectiveness of our integrated demand management approach in reducing usage. In Section 8: Appraisal of demand options we have set out the savings assumptions that we have included in our demand management options; namely a 17% reduction in household usage in response to change in customer behaviour resulting from being billed on a metered tariff following the roll out of our household metering programme. A further usage saving of 60 Ml/d is expected to be achieved by the end of AMP8 from the implementation of our water efficiency programme.

Figure 11-10: PCC for London (DYAA)

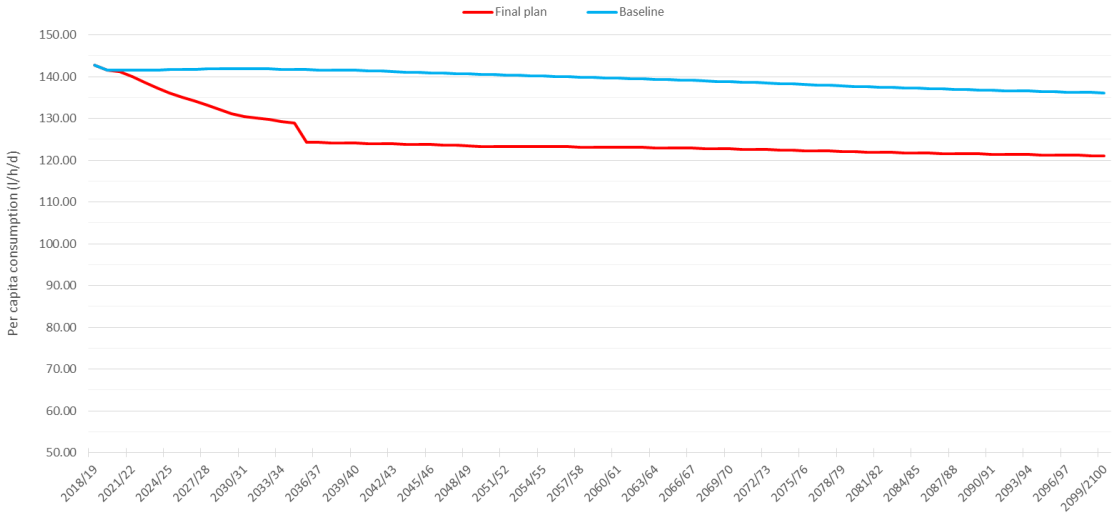
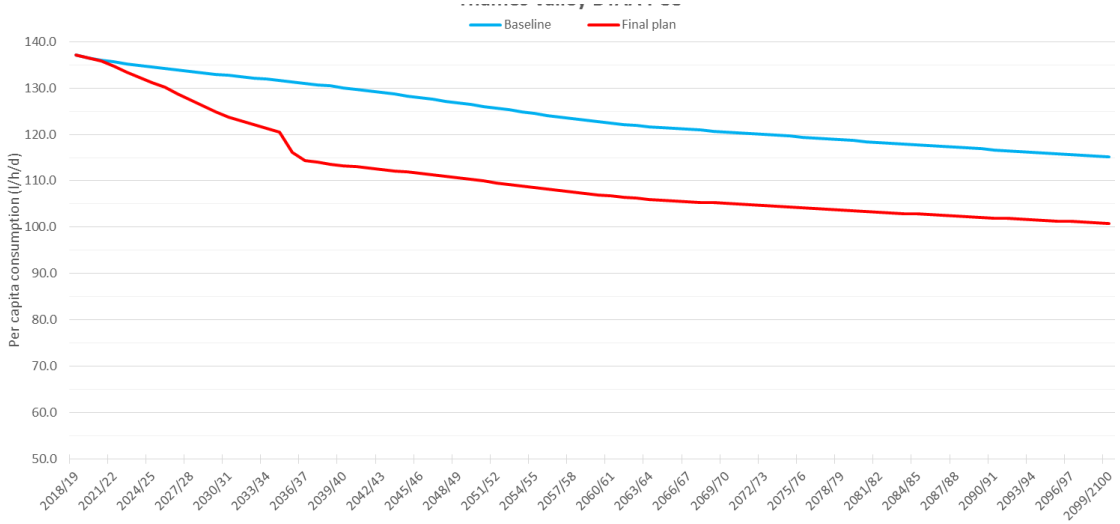
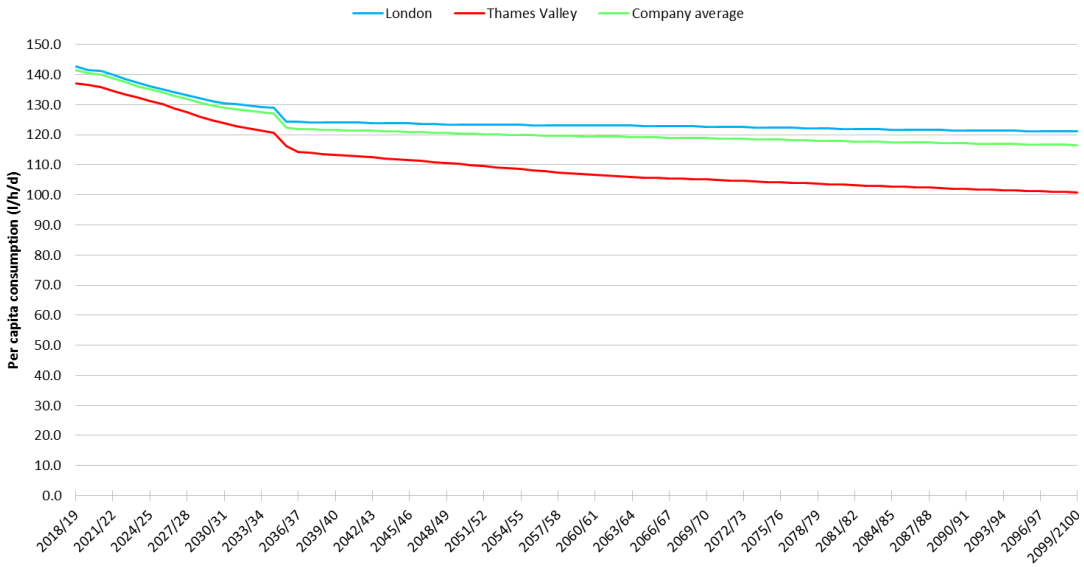


Figure 11-11: PCC for Thames Valley (DYAA)



11.173 The demand management programme in our plan brings about a reduction in DYAA per capita water use in London to 124 l/h/d at 2044/45, with further ongoing reductions thereafter to the end of the planning period, such that average household consumption is approximately 121 l/h/d. In Thames Valley, where consumption is more typical of that found elsewhere in England the equivalent figures are 112 l/h/d and 101 l/h/d, respectively. Average household consumption across our supply area is shown in Figure 11-12 with forecast regional consumption of 121 l/h/d in 2045 and 117 l/h/d at 2099. The figures shown are dry year consumption figures and consumption would be lower during a normal year.

Figure 11-12: DYAA household PCC – WRMP19 preferred plan



11.174 In Section 3: Current and future demand for water, we have explained that household PCC in London is higher than in the rest of our supply area due to the following four factors:

- The high proportion of rented properties with relatively fast turn over in tenancy means that households do not have the same incentive to invest in water efficient fixtures and fittings and associated reductions in water use
- The higher proportion of properties with complex supply arrangements means that inevitably there is a lower proportion of individual households paying for their water usage on a measured tariff
- The higher proportion of flats means that the opportunities for discretionary water use savings are lower in London than in the Thames Valley area, and in other parts of England and Wales
- There is a higher population in London whose cultural and religious beliefs result in higher water usage than in other sectors of the population

11.175 A higher PCC in London in comparison with the Thames Valley and other areas in the UK is therefore not unexpected. The extent of the London WRZ population as a proportion of the total Thames Water supply population is very significant. London's population comprises 77% of the total Thames Water population. This is much more significant than in any other water company.

11.176 Although the forecast reduction in water usage goes beyond the economic levels of demand reductions (SELDM), further potential reductions in PCC have been brought about through the implementation of punitive financial tariffs from 2035. This is in response to concerns raised by Ofwat that PCC in our draft WRMP19 was above the national average. However, our research to date has shown that customers do not consider that rising block tariffs are equitable, potentially unfairly penalising large households for what might be considered essential water use, and impacting adversely on water affordability for the poorest.

11.177 In WRMP14 we included an assumption in our plan that sophisticated financial tariffs targeted at high discretionary water use could reduce consumption by 5%. This option has been included in our WRMP19 to address the concern voiced by Ofwat. A study by Reynaud (2015) has shown the estimated price elasticity of household water demand in 28 EU countries is negative[22]. The price elasticities typically vary between -0.5 and -0.1 across countries. Facing a price increase of 10%, Reynaud suggests it is expected that the household water consumption will be reduced by 1 to 5%. The elasticity in demand for water is shown to be narrow, such that very large changes in price would be required to secure a significant reduction in demand. Further subsequent research by Reynaud (2018) considers that there is no elasticity in demand[23]. The price that companies can charge for water is controlled by Ofwat and as such it is not a measure that is directly within our control to further reduce consumption. To impose such a tariff is therefore dependent on agreement with Ofwat. We welcome customers and stakeholders' views on the inclusion of such tariff types in our WRMP19.

11.178 Changes in the regulations applying to new appliances and buildings could also help to further reduce household consumption but again this is not something that is directly within a water company's control and requires legislative changes in Building Regulations.

[22] Joint Research Centre Technical Reports Modelling Household Water Demand in Europe. Insights from a cross-country econometric analysis of EU-28 countries. Arnaud Reynaud 2015 EUR 27310 EN
[23] Reynaud, A. and Romano, G. (2018) Advances in the economic analysis of residential water use: An introduction, Water, 10, 1162-1172

11.179 If there is a concerted desire to see household consumption significantly reduced beyond the ambitious levels set out in our draft plan this will require proactive joint activity with regulators and Government to deliver such aspirations.

11.180 We consider that it would be high risk to plan on these reductions being achieved without appropriate changes in legislation, in light of the significant uncertainty associated with timing of the impacts of climate change and the potential for earlier onset.

Leakage forecasts

11.181 In our preferred plan, we expect that leakage reductions are delivered across all our WRZs.

11.182 In London leakage reduction is achieved through a combination of customer supply pipe savings associated with the roll out of our household and bulk metering programmes, DMA enhancement, pressure management, mains replacement and AMP6 Leakage Reduction carry over. In AMP7, this also includes 23.3 Ml/d of AMP6 ALC Deferral activity. In addition, we have introduced a range of new tools in AMP6 to improve analysis of the supply-demand balance and thereby improve the efficiency and effectiveness of our leakage detection and repair activity. This includes tools for targeting mains replacement which we will continue to develop and enhance.

11.183 In Thames Valley leakage reduction is achieved through a combination of customer supply pipe leakage reduction associated with the roll out of our household and bulk metering programmes, DMA enhancement, mains replacement and AMP6 Leakage Reduction carry over.

11.184 The difference between the baseline and final plan leakage forecast is shown in Figure 11-13 for London and Figure 11-14 for Thames Valley WRZs.

Figure 11-13: DYAA leakage forecast for London

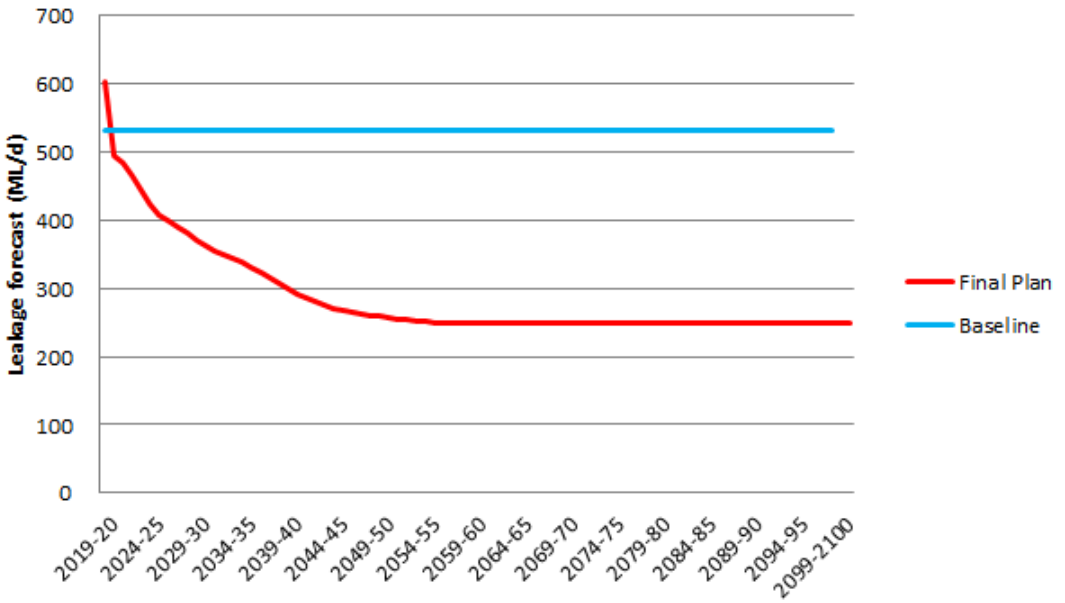
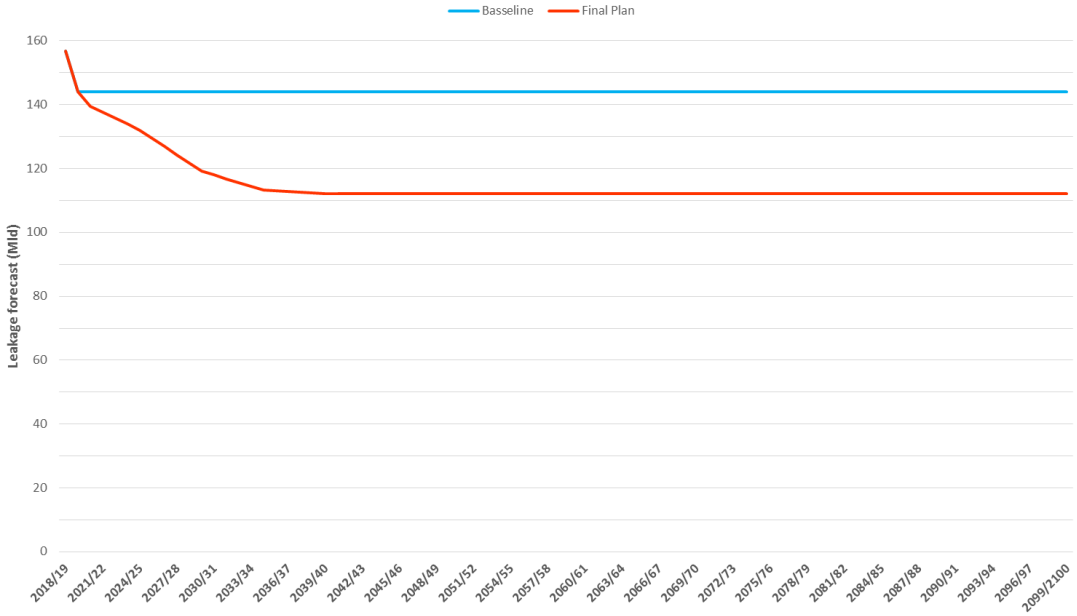


Figure 11-14: DYAA leakage forecast for Thames Valley WRZs



11.185 WRMP14 set out our ambition to reduce reported leakage by 108 Ml/d in the period to 2035, including 59 Ml/d of reduction by 2020. Our WRMP19 goes beyond this, with a total leakage reduction of 229.3 Ml/d between 2020 and 2035. This reduction in leakage goes significantly beyond the sustainable economic level of leakage (SELL)[24].

11.186 The forecast leakage reduction in London at 2050 is 274.2 Ml/d, and 306 Ml/d for the Thames Water region as a whole. Removing the impact of the AMP6 ALC Deferral leakage reduction that has been included in AMP7, the forecast leakage reduction in London at 2050 is 250.9 Ml/d and 282.7 Ml/d for Thames Water region as a whole. These values comply with the recommendation of the NIC in its April 2018 report to halve leakage from our 2016/17 position by 2050. It also aligns with the view expressed by customers that long term leakage should be approximately 15% of water put into supply.

11.187 In the short term, opportunities for additional large scale pressure management (i.e. in excess of activity for asset management) have been exhausted in London by the end of AMP7 and Thames Valley by the end of AMP6. In the medium term, opportunities for DMA Enhancement are assumed to become limited at the end of AMP8 and new customer side leak repairs associated with the rollout of our household and bulk metering programme limited by the end of AMP9. Consequently, in the longer term, leakage reduction will be primarily achieved through mains replacement and innovation. Mains replacement is a reliable method to secure leakage reduction. This has been demonstrated in the AMP4 period 2005-2010 when the company replaced approximately 2000km of distribution mains in London and secured a sustainable leakage reduction of 200 Ml/d. Mains replacement is, however, a very expensive option and inevitably causes disruption and inconvenience to customers while the work is undertaken. There is therefore a compromise to be drawn between continuing to reduce leakage in line with

[24] Definition can be found on Ofwat's website at https://www.ofwat.gov.uk/households/supply-and-standards/leakage/

customer preference and the impact on customer bills and affordability and day-to-day inconvenience that the activity will create.

11.188 Ofwat and Government[25] have set out requirements for companies to deliver reductions in leakage of 15% by 2025. This is a very ambitious target and has a high degree of risk associated with its delivery. We have set out our commitment to such a reduction.

11.189 In 2012 Thames Water and Ofwat jointly commissioned an independent review of the cost effectiveness of the mains replacement activity that the company had undertaken . The findings of this review noted that there were benefits in linking mains replacement activity with the availability of household metering infrastructure to facilitate effective targeting of the activity. This is why we have developed a programme that includes DMA Enhancement and customer side leakage reduction associated with our household and bulk metering programme roll out over the medium term.

11.190 We have no doubt that there will be further innovations in leakage detection activity and mains rehabilitation techniques which will facilitate further cost effective reductions in leakage beyond the levels set out in our WRMP19, but at this stage we have used the best information available to us to set out what we consider is a deliverable and best value programme. Furthermore, as we roll out our PMP we expect to find water currently reported as leakage is actually usage or wastage within customer properties.

11.191 We consider that, currently, this approach is the optimum approach given the high cost of mains replacement and the uncertainties in reported leakage levels.

Metering forecasts

11.192 The household smart meter penetration for London and Thames Valley is shown in Figure 11-15 and Figure 11-16, respectively. In both graphs the effects of our PMP are evident.

11.193 In London the household programme is expected to be completed by 2030 and 73% of individual households will have had a meter installed and be charged for their water use on a measured tariff. All property connections will be metered but given the large proportion of blocks of flats with complex plumbing arrangements it will not be economic or practical to meter all households on an individual basis. Metering these properties at the boundary will however enable detection and targeting of supply pipe leakage. Furthermore, measured consumption details at the total property level together with knowledge of the number of individual households will facilitate understanding of whether very high water usage is occurring and thereby facilitate targeting of water efficiency activity, including smart household water audits.

11.194 For London over 78% of household meter penetration (including voids) is subsequently achieved in the early 2050s and for the Thames Valley over 90% of individual household meter penetration (including voids) is achieved by 2040, together with the metering of all property connections. The ongoing increase in the percentage of meter penetration thereafter is due to all new properties being metered.

11.195 We expect the steady increase of household meter penetration will contribute to behavioural change and associated reductions in leakage and water usage. It will also facilitate the

[25] H M Government 2018 A Green Future: Our 25 Year Plan to Improve the Environment

introduction of reward based incentive schemes and potentially high discretionary water usage tariffs, if required.

Figure 11-15: Household meter penetration for London WRZ

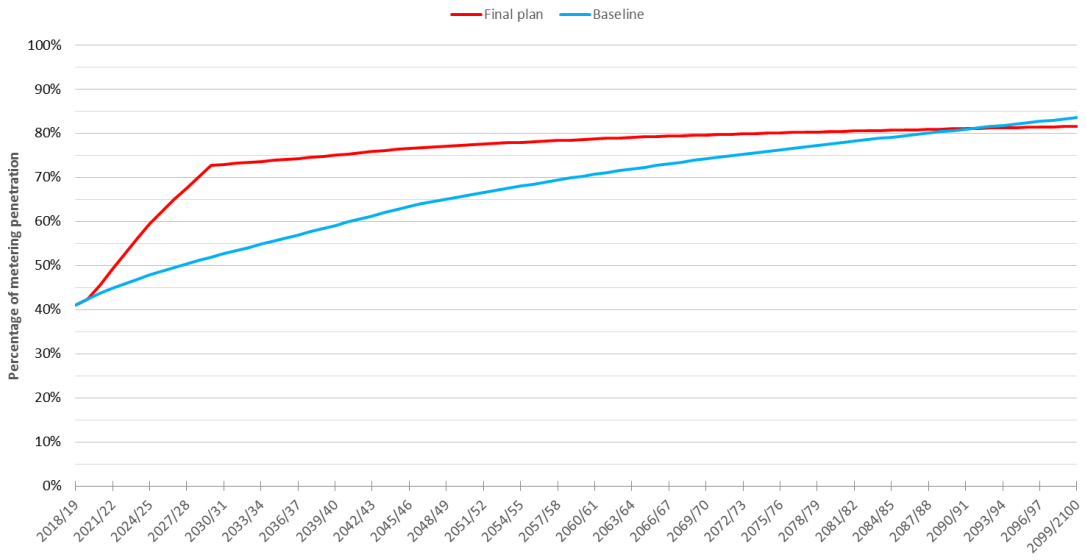
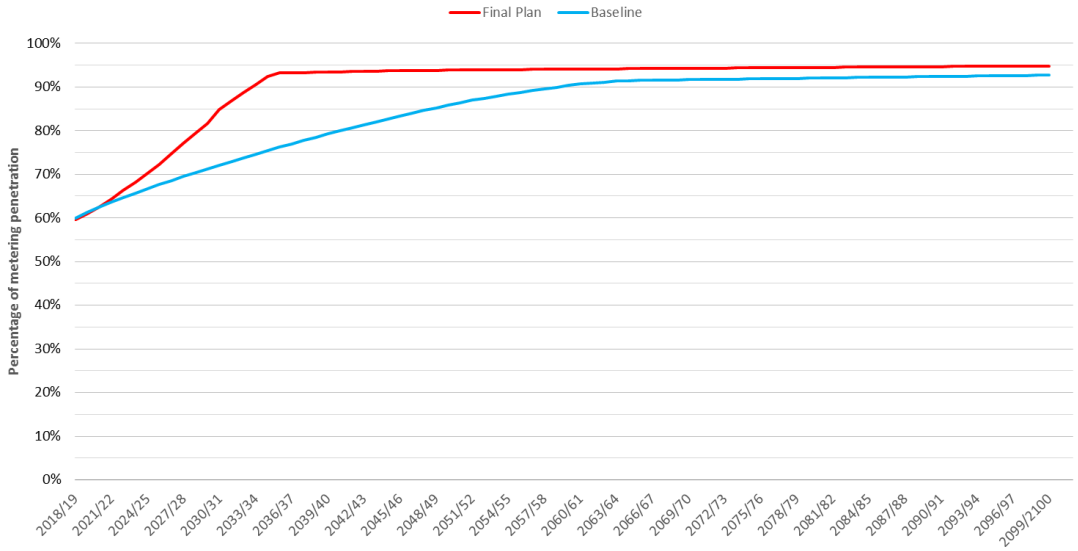


Figure 11-16: Household meter penetration for Thames Valley WRZs



Water efficiency forecasts

11.196 Water efficiency is a core component of the sustainable management of water resources. There are five categories of activity that make up our enhanced Water Efficiency Programme; Smarter Home Visits, Smarter Business Visits, Wastage Fix ('leaky loos'), Housing Association Fix and Innovation.

11.197 The total water efficiency savings per AMP have been optimised based on our current water efficiency demand management options. However, we also recognised there was opportunity to be more ambitious with our customer usage reductions. Consequently, to enhance customer usage reductions, specifically in AMP7, we included further water efficiency activity in the form of innovation. This innovation is based on our work with other water companies through the Water Efficiency Network, our role within the UK Water Efficiency Strategy Steering and Leadership Groups, and our efforts during the 2018 'heatwave'. Potential areas of demand reduction innovation to be considered could include; alternative water supply options for large irrigation users, innovative engagement through partner digital platforms, and working closely with Defra on water labelling.

11.198 Table 11-42 details the breakdown of our Water Efficiency programme activities and the associated usage savings expected each AMP. This shows that by the end of AMP12 a 99.5 Ml/d usage reduction will have been achieved. Beyond AMP12, we will continue to undertake water efficiency activity to maintain these benefits to 80 years.

Table 11-42: Water efficiency activity savings Ml/d (end of AMP)

Total water efficiency saving per year	AMP7	AMP8	AMP9	AMP10	AMP11	AMP12	AMP13 - AMP22
	2024/ 25	2029/ 30	2034/ 35	2039/ 40	2044/ 45	2045/49	2049 - 2099
London							**Benefit maintained**
Smarter Home Visits (Ml/d)	6.3	6.0	0.1	0.0	0.0	0.0	
Smarter Business Visit (Ml/d)	10.0	2.0	0.8	0.0	0.0	0.0	
Wastage Fix ('leaky loos') (Ml/d)	8.0	1.4	3.3	0.0	0.0	0.0	
Housing Association (Ml/d)	0.1	0.6	0.0	0.0	0.0	0.0	
Innovation (Ml/d)	0.5	8.1	12.7	5.0	5.0	5.0	
Total London Benefits (Ml/d)	**24.8**	**18.1**	**16.9**	**5.0**	**5.0**	**5.0**	
Thames Valley							**Benefit maintained**
Smarter Home Visits (Ml/d)	1.3	1.7	1.1	0.2	0.0	0.0	
Smarter Business Visit (Ml/d)	2.2	1.4	0.0	0.0	0.0	0.0	
Wastage Fix ('leaky loos') (Ml/d)	1.4	2.0	3.4	1.9	0.0	0.0	
Housing Association (Ml/d)	0.0	0.0	0.0	0.0	0.0	0.0	
Innovation (Ml/d)	4.4	2.5	1.2	0.0	0.0	0.0	
Total Thames Valley Benefits (Ml/d)	**9.3**	**7.6**	**5.7**	**2.1**	**0.0**	**0.0**	
Total Company Benefits (Ml/d)	**34.1**	**25.7**	**22.6**	**7.1**	**5.0**	**5.0**	**Benefit maintained**

J. Environmental assessment of the preferred plan

11.199 We have carried out extensive and comprehensive environmental assessment of all of the Constrained List option elements and of the alternative options and programmes considered in the subsequent programme appraisal process. We have developed scheme design, mitigation measures and investigated environmental effects at an unprecedented level of detail for a strategic plan, recognising the scale of the investment necessary to address a very substantial supply deficit over the next 80 years. For the larger schemes, we have carried out detailed strategic level investigations of environmental effects which we have used to develop mitigation packages to minimise adverse effects on the environment.

11.200 As we have increased our level of investigation and consulted widely with regulators and stakeholders, we have, inevitably, identified issues that were not foreseen at the initial option screening stage. In the majority of cases, we have addressed identified substantive concerns through further iteration of the scheme design and/or mitigation measures such that the residual adverse effects are reduced to acceptable levels. Through this detailed approach to addressing environmental effects, our SEA, HRA and WFD assessments indicate that, despite the scale of new resource schemes required, our WRMP19 has overall minor to moderate adverse effects and minor to moderate beneficial effects on the environment and society. Details of these assessments can be found in Appendix B: SEA environmental report, Appendix C: HRA – stage 1 screening and Appendix BB: WFD.

11.201 Our preferred plan is compliant with the Habitats Directive and associated Habitats Regulations with the application of appropriate mitigation measures. We will continue to work with Natural England to ensure we protect, and where possible enhance, relevant European sites near to proposed water resource infrastructure as we implement our plan.

11.202 We have also considered the cumulative effects of the preferred plan, including effects with our revised draft Drought Plan 2018, plans of other water companies, River Basin Management Plans, as well as land use, development and other infrastructure plans. Both beneficial and adverse effects have been found arising from temporary construction and operational activity. These have been described in Appendix B: SEA Environmental Report.

11.203 Consideration of potential environmental impacts at an early stage and, where necessary, development of suitable mitigation packages has resulted in the schemes in our preferred plan being considered compliant with the objectives of the WFD subject to further investigations being carried out to confirm these conclusions in relation to several options. Mitigation measures may be necessary to be implemented in the form of additional flow augmentation support and/or abstraction licence controls to avoid WFD deterioration risks in respect of the Epsom groundwater option once more detailed investigations of the effects of increasing abstraction within existing licence limits are completed in dialogue with the Environment Agency. Further investigations will also be carried out to confirm the WFD assessment conclusions for the Deephams reuse and Oxford Canal options, and if necessary, develop additional mitigation measures to ensure WFD compliance.

11.204 We have examined reasonable alternative programmes to the preferred plan as described in Section 10: Programme appraisal and scenario analysis. The parallel environmental investigations of alternative options in London to those in the preferred plan will continue to be

progressed in the period to 2022/23. This will ensure that the WRMP19 is a robust plan with alternative water resource schemes available should any of the options in the preferred plan subsequently prove infeasible.

11.205 The water management schemes within the preferred plans for Kennet Valley, Guildford and Henley WRZs have been subject to the same environmental and social assessment process as set out for the preferred programme for London, SWA and SWOX.

11.206 The environmental and social adverse effects are broadly negligible to minor in nature for the additional demand management options for each of the three WRZs. Beneficial effects are mainly of a minor significance.

11.207 The groundwater schemes at Dapdune and Ladymeads water treatment works (removal of constraints), have mostly negligible to minor beneficial effects. Adverse effects of these groundwater options are mainly of a negligible or minor significance.

11.208 There are cumulative major beneficial effects for the Demand Management Programmes in relation to these measures acting in combination achieving a major scale of demand savings across the Thames Water supply area and, thereby, contributing to sustainable water management. The cumulative benefits will help reduce growth in demand for water and growth in energy use for water pumping and treatment.

11.209 In conclusion, the schemes forming the preferred plan for Kennet Valley, Guildford and Henley WRZs are compliant with Habitats Regulations and with WFD objectives. Overall, the environmental and social effects of this plan for Kennet Valley, Guildford and Henley WRZs are predominately of a minor to moderate significance (both adverse and beneficial effects).

11.210 Overall, through detailed environmental investigations we have developed a comprehensive plan that delivers reliable, resilient water supplies to our customers over the long term. The environmental and social effects of the preferred plan are predominately of minor to moderate significance (both adverse and beneficial effects). Whilst some major adverse effects have been identified, which is to be expected given the scale of the schemes necessary to address a very large supply deficit, many of these major effects are temporary in nature and largely unavoidable while construction works take place. Where some of the major effects are related to extended construction periods over a number of years we would consider whether further additional mitigation measures can be applied to reduce the identified effects in dialogue with regulators, planners, stakeholders and any local communities affected. Opportunities have also been identified for beneficial effects and we will look to see where we can further enhance these benefits as we implement our plan over the coming years.

K. Greenhouse gas emissions and carbon accounting

11.211 As a part of the Annual Return process, we produce an estimate for the emission of greenhouse gases from our water supply activity. The operational carbon calculation for the year 2016/17 uses the revised UKWIR (2016/17) Carbon Accounting Workbook version 11 and the associated guidance document. This is the methodology supported by Ofwat for reporting operational greenhouse gases. The 2016/17 reported emissions per Ml/d of water supplied are 0.230 tonnes of CO2e/Ml/d.

11.212 By applying the resultant 0.230 tonnes of CO2e/Ml/d to the baseline and final planning forecasts, a long-term trend can be produced, Figure 11-17.

11.213 For the DYAA scenario in the base year, 2016/17, our estimate is 226,001 tCO2e. Under the baseline scenario demand continues to increase across the forecast period, primarily due to population growth, resulting in an emissions estimate of 249,568 tCO2e in the final year of the plan, 2099/00, 23,567 tCO2e higher than in the base year.

11.214 The reductions in demand, forecast as a result of the integrated demand management programme, contained within the final plan gives a final emissions figure of 207,604 tCO2e which is a reduction of 41,964 tCO2e compared to the forecast baseline in 2099/100.

11.215 The greenhouse gas impact of supply options has been incorporated into option appraisal (see Section 10: Programme appraisal) and has formed part of the consideration of delivering a balanced plan. The cost associated with the carbon equivalent greenhouse gas impact (tCO2e), across the planning period has been presented in Table 11-43. The carbon costs associated with other feasible options and preferred options can also be found in Table 5 of each WRZ, see Appendix A: WRMP19 planning tables.

11.216 It is important to note that Table 11-43 does not present a like for like comparison of carbon between options as the operational carbon for each option only relates to the number of years that it is in operation for in the preferred programme. For example, Table 11-43 indicates much higher carbon emissions for the Abingdon reservoir (for which emissions over 73 years are included) than for the Severn Thames Transfer (for which emissions over 25 years are included). However, on a like for like basis at full utilisation over 80 years (as presented in Table 5 of the WRMP19 planning tables in Appendix A) the Abingdon reservoir has lower whole life carbon emissions than the Severn-Thames Transfer, even not accounting for the fact that (monetised) carbon is discounted in Table 5 and also not accounting for differences in WAFU benefit between the STT and Abingdon Reservoir which have not been normalised for.

11.217 The carbon included in Table 11-43 includes carbon for development of resources for supply to Thames Water, and the wider South East region in the case of strategic schemes such as SESRO. It does not include for the development of replacement resources where these are needed to allow existing resources to be redeployed to Thames Water. United Utilities and Severn Trent have estimated an additional total of 3,972 tCO2e for replacement resources associated with the “RWP_STT UU/ST Opt B” option to support flows in the River Severn, by providing an alternative supply to Oswestry and Shrewsbury.

11.218 The Raw Water Purchase options from Didcot and Essex & Suffolk Water do not require new capital works and no direct carbon emissions associated with these options have been identified.

Figure 11-17: Greenhouse gas emissions tCO2e – 2016 to 2100

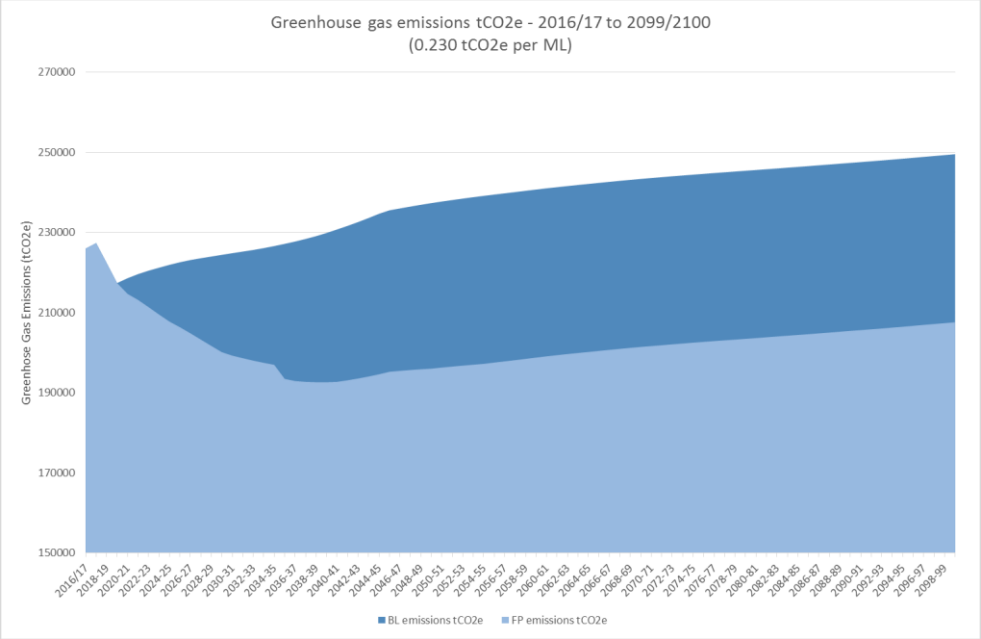


Table 11-43: GHG Impact of Supply and Demand Options tCO2e across planning period

Options	Carbon Impact Across Planning Period (tCO2e)
AR_Kidbrooke (SLARS1)	57,688
AR_Merton (SLARS3)	48,337
ASR_Horton Kirby	38,677
ASR_South East London (Addington)	20,650
CON_Deephams to KGV Intake 60 MLD	14,921
DMP_GUI_Sprint4a	96,345
DMP_HEN_Sprint4a	2,770
DMP_KEN_Sprint4a	90,501
DMP_LON_S4a	2,016,434
DMP_SWA_S4a	82,098
DMP_SWX_S4a	113,241
GW_Addington	7,928
GW_Dapdune	0
GW_Datchet	20,933
GW_Merton	20,221
GW_Southfleet/Greenhithe	61,391
IPR_Deephams 45	138,556
NTC_Dapdune	2,056
NTC_Epsom	11,841
NTC_Ladymead	1,671
NTC_New River Head	7,575
RES_Abingdon 150Mm^3	884,143[26]
RWP_Chingford (E&S)	0
RWP_Didcot	0
RWP_Oxford Canal to Cropredy	50,928
RWP_STT Mythe	0
RWP_STT Netheridge	20,532
RWP_STT UU/ST Opt B	0[27]
RWP_STT Vyrnwy 60	0[28]
CON_Deerhurst to Culham 300	278,970
IZT_R Thames to Medmenham	26,570

[26] The carbon for Abingdon reservoir 150Mm^3 includes 224,165 tCO2e for replacement of assets in year 60 as applied using standard asset lives in our Asset Planning System. A review of the replacement items has identified that the replacements include items such as the railway sidings (which may not be required after construction) and inner face protection to the reservoir (which is likely to only require partial repair). A review of the year 60 asset replacement for the reservoir indicates that this has been overestimated and that a more appropriate estimate is 79,220 tCO2e. Taking this into account the adjusted total carbon over the planning period for the Abingdon 150Mm^3 reservoir would be 739,198 tCO2e, a reduction of 144,945 tCO2e

[27] Replacement resources need to be developed by United Utilities and Severn Trent for the RWP_STT Vyrnwy 60 and RWP_STT UU/ST Opt B resource options and the estimated carbon impact across the planning period for these replacement resources is 19,378 tCO2e and 23,803 tCO2e respectively

11.219 The values in Table 11-43 have been taken from EBSD+ modelling outputs and adjustments to incorporate carbon for STT Netheridge support and Oxford Canal. These values provide total carbon impacts of each of the supply and demand options, including operational carbon at expected utilisation across the 80 year planning period.

L. Water Resources South East Regional Planning

11.220 In parallel with the WRMP19 timeline, the WRSE group has carried out a single-objective least cost optimisation for several scenarios for the six water companies in the South East.

Comparison of WRSE and TWUL scenarios

11.221 The WRSE core scenarios utilise the same supply, demand and target headroom forecasts as for our revised draft WRMP19, although the planning horizon analysed is 60 years rather than 80 years. The same options are available with the same interconnectivities, although the cost of each option is annuitised. Data and model similarities and differences are listed in Table 11-44 below

Table 11-44: Differences between Thames Water and WRSE data

Data in WRP Tables	TWUL EBSD	WRSE EBSD	[WRSE - TWUL] Supply Demand Gap
Planning horizon	2099/2100	2079/80	[-20 years]
BL Distribution Input			[2079-99] -64Mld
BL WAFU (own sources)			[2079-99] -39Mld
Exports: London to Affinity	Fixed profile	Modelled	-16Mld to -116Mld
Target headroom	BL & FP	BL	-24Mld
1:200 drought resilience	2030	2030 for TW	
1:500 drought resilience	What-if	2035 for all	+142Mld
Drought permits	No	5 WRSE scenarios.	{-265Mld}
Uncertain SRs	No	All	+16 or +32Mld
Chalk Streams	Preferred	No	-24Mld
Options	Cost profile	Annuitised costs	n/a

11.222 The fundamental difference between WRSE and Thames Water scenarios is the shorter planning horizon; the WRSE assessment ends in 2079/80, 20 years before TWUL's end date, and excludes the final 103Ml/d of TWUL deficit arising from continued growth and WAFU reduction linked to the impacts of climate change. In the TWUL revised draft WRMP this is when the STT is commissioned.

11.223 Besides the planning horizon, the WRSE 1:200 ('severe') drought scenarios differ from the TWUL BL+DRO+WRSE scenario only in that the existing exports to Affinity Water are all

modelled, rather than fixed in the baseline supply demand balance, and there is an additional reduction to DO (16 or 32Ml/d) due to uncertain sustainability reductions in 2035 or 2040.

11.224 The WRSE scenarios which allow selection of drought permits and orders (DP&Os) enable comparison of the cost of using permits to cope with a drought against the cost of building resources to provide the required additional DO. Initial analysis[28] indicates that the cost of replacing the use of drought permits and orders to provide the additional 537Ml/d across the WRSE region from 2035 could be around £150 million NPV.

11.225 However, WRSE scenarios which allow DP&Os are not compatible with WRMP19 planning for resilience. There are four WRSE scenarios which plan for 1:200 drought resilience without the use of DP&Os, and these are compared with Thames Water and Affinity Water planning (Table 11-45). One further scenario has been assessed for impact of 1:500 extreme drought resilience planning, Scenario 8.

Table 11-45: Comparable Thames Water (TW) and WRSE scenarios for the TW supply area

WRSE Scenario	TW Scenario	Difference from TW scenarios
Scenario 4	BL+DRO / BL+DRO+WRSE/	Affinity exports not in baseline (-16Mld / -116Mld); +16Mld uncertain SRs from 2040
Scenario 5	BL+DRO / BL+DRO+WRSE/	Affinity exports not in baseline (-16Mld / -116Mld); +16Mld uncertain SRs from 2040; no TUBs[29]
Scenario 9	BL+DRO / BL+DRO+WRSE/	Affinity exports not in baseline (-16Mld / -116Mld); +32Mld uncertain SRs from 2040
Scenario 11	BL+DRO / BL+DRO+ WRSE	Affinity exports not in baseline (-16Mld / -116Mld); +16Mld uncertain SRs from 2035; no TUBs
Scenario 8[30]	1:500 drought What-if	Affinity exports not in baseline (-16Mld / -116Mld); -142Mld drought DO required from 2035 not 2040

11.226 Thames Water's BL+DRO scenario, not including intra-regional transfers, aligns with the WRSE scenarios 5 and 11 until 2040 and 2035, respectively, after which 50% uncertain sustainability reductions (16Ml/d) are included in the WRSE scenarios and scenario 4 aligns more closely.

11.227 Thames Water's preferred scenario has a different additional 48Ml/d of deficit due to final target headroom and the reduction of abstraction from vulnerable chalk streams and water courses.

11.228 In summary, WRSE scenario 5 aligns most closely with Thames Water's supply-demand deficit until 2040. After this date WRSE scenario 4 is the closest, although by 2079-80 the deficit is 47Ml/d greater in the TWUL preferred scenario than scenario 4, when not including the exports to Affinity Water. The TWUL planning horizon extension increases this additional deficit to be solved in the TWUL problem to 150Ml/d by 2099/2100.

[28] WRSE Paper 9: Improving Resilience to Drought Events, Senior Leadership Steering Group, 14 March 2019
[29] Temporary Use Bans are within the baseline for Thames Water but a scenario for the remainder of WRSE, where removal would increase the deficit by 91Mld
[30] Scenarios 4, 5, 9 and 11 are all for 1 in 200 year drought events. Scenario 8 is for a 1 in 500 year drought event

WRSE Results

11.229 Key strategic options selected for WRSE's 1:200 scenarios are in Table 11-46 below.

Table 11-46: Comparable WRSE scenario outputs: strategic options

Recipient	Strategic Option	(Mld)	Scen4	Scen5	Scen9	Scen11	TWUL WRMP19
Thames Water	Deephams reuse	45	2030	2030	2030	2030	2030
Affinity Water	Grand Union Canal (GUC)	50	2045	2030		2030	
Affinity Water	Minworth/GUC Transfer	100			2045		
Affinity Water	Transfers from SESRO	50-100	2060	2050 2065	2075	2050 2065	2038
Thames Water	$SESRO_{Mld}$	69-294	2050_{210}	2050_{69} 2055_{199}	2075_{69}	2050_{294}	2037_{294}
Thames Water	Beckton Reuse	95-190	2075		2050 2065		

11.230 The WRSE 1:200 scenario results indicate that new strategic resources for both Thames Water (London) and Affinity Water are required by 2050, with Affinity Water's requirement earlier than London. Where TUBs are permitted for Affinity Water, a strategic resource (Minworth/GUC transfer) is selected in 2045; where not, in 2030. As TUBs are in the baseline for TWUL the first London strategic resource is built in 2050 for all four scenarios.

11.231 In its draft plan (DYCP), by 2034-35 Affinity Water's central zones (WRZ1 to WRZ6) have 6Ml/d of additional water from King's Walden and Runley Wood groundwater sources and 84Ml/d of demand reduction through demand management, before importing 21.6Ml/d from London WRZ to meet requirements. In WRSE scenarios 5 and 11 Affinity Water's central zones have 5.1Ml/d of additional water from the same two groundwater sources and 78.5Ml/d of demand reduction, both capacities being less due to some errors in application of restrictions in the WRSE model. The WRSE model therefore also selects the GUC transfer into Affinity Water WRZ1 by 2034-5, importing 27Ml/d and not utilising the existing transfers from London WRZ. This implies that the minor shortfall of ~5.5Ml/d due to capacity and utilisation restrictions for the groundwater and demand options in the WRSE model pushes the model to select a strategic investment, and with the SESRO earliest start year being 2035-6 this has to be the transfer from Severn-Trent. This then delays the commissioning for the SESRO until it is required by both companies.

11.232 For the majority of the comparative scenarios shown here, rather than a London-only strategic resource in 2050, the SESRO is built (in Scenarios 4, 5 and 11) to enable water provision to both London and Affinity Water. In scenario 9, the WAFU reduction of full uncertain sustainability reductions in 2040 means that Affinity Water requires more water by 2045 and the large (100Ml/d) Minworth/GUC transfer is selected. This delays Affinity Water's requirement for further resource until 2075, and so a reuse plant is built to supply London in 2050, with a small shared strategic reservoir following in 2075.

11.233 The 1:500 year extreme drought scenario results in commissioning of the SESRO in 2035 after Deephams reuse in 2030, with the SESRO supplying Affinity Water immediately from 2035, the Minworth 100Ml/d transfer to Affinity WRZ1 in 2050, and Beckton reuse (150Ml/d) in 2060 for

London. If the South East region were to move to 1:500 year drought resilience, the SESRO would be the primary resource for both Thames Water and Affinity Water, with further strategic resources required from the 2050s .

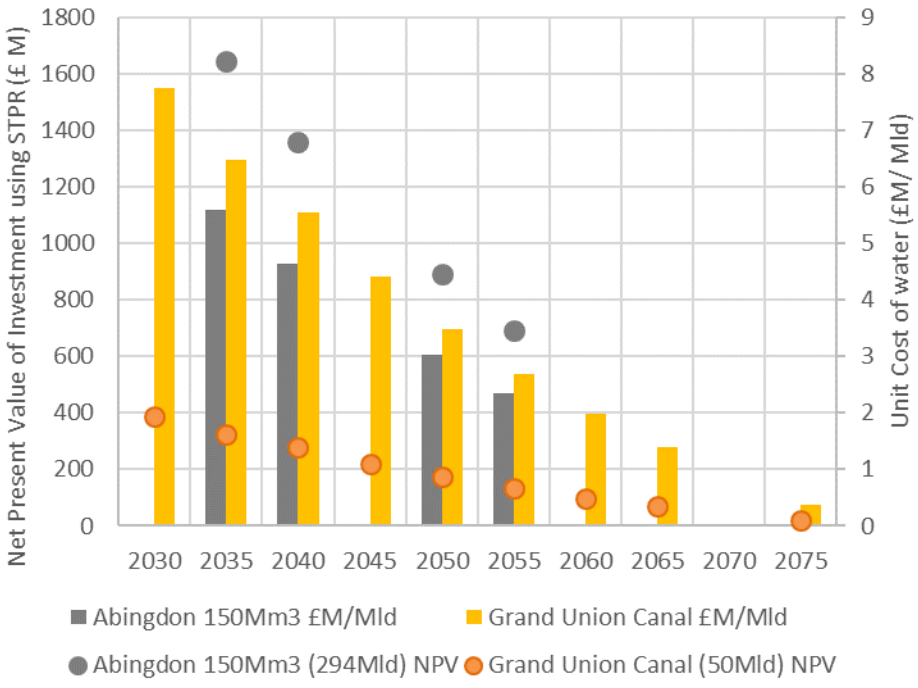
11.234 The SESRO is in fact selected in all the scenarios tested by the WRSE model: in 2035 when 1:500 year drought resilience is required, or later in the horizon (2050-2075) as Thames Water and Affinity Water's growing needs coincide.

WRSE Programme Appraisal

11.235 In the WRSE scenario closest to the TWUL BL+DRO+WRSE scenario final need (Scenario 4), the Minworth/GUC transfer is selected in 2045 followed by the 100Mm^3 reservoir in 2050. Rather than build two strategic resources in consecutive AMPs, it would be efficient and less disruptive to build a larger strategic resource in 2045 to supply the ongoing needs of both companies.

11.236 While discounting favours delaying high-capital expenditure schemes by implementing lower capital options first, since the perceived cost reduces dramatically over time (Figure 11-18 below), analysis of the (discounted) cost per megalitre of water provided by the GUC transfer in comparison with the SESRO shows that it is only because the GUC transfer is smaller (and therefore less expensive to build) that it is selected first: building the larger reservoir first would be cheaper in terms of unit cost of water. Without discounting, or at a lower discount rate, the reservoir would therefore be selected first and as explained for the IGEQ metric in Appendix W, a discount rate of 1% (catastrophe risk only) may be more relevant for water, which does not reduce in utility, and where usage is encouraged to decline or stabilise rather than increase.

Figure 11-18: Effect of discounting on comparative costs[31] of SESRO and GUC transfer



[31] Discounted costs taken directly from WRSE scenario outputs. Missing years indicate that that option was never commissioned in that year.

11.237 The increase in cost (NPV) of replacing the GUC transfer with the larger SESRO in 2045 (Scenario 4) would be circa £150 million[32].

11.238 The least cost optimisation runs for WRSE have a final gap (tolerance) of 2%. Once the least cost solution is within less than 2% of the cost of the nearest alternative solutions, the optimisation terminates. With the total cost of the solution for Scenario 4 at £15.6 billion, the gap at termination is ~£300 million, and a solution which includes the 294Ml/d SESRO in 2045 (~£150M more than least cost) would therefore be included as a potential programme to be adjusted and analysed further if least-cost optimisation continued beyond the 2% gap to pinpoint the least cost solution more closely, and could actually be the basis for a least cost programme optimised to 0%.

11.239 Independent programme appraisal by both Thames Water and Affinity Water has led to preferred plans where the SESRO is currently preferred before multiple smaller strategic options for the separate companies; it is delivered in 2037/38 for availability in summer 2038. For the WRSE model, this requires the SESRO to be commissioned in 2035 (to solve the 2039/40 supply-demand problem), at an additional cost of ~£600 million. This equates to the cost of not discounting the SESRO expenditure by an additional ten years (Figure 11-18) and can be offset against the benefit of earlier resilience to 1:500 drought, the ability to further reduce abstraction from vulnerable water sources, and to mitigate any risk associated with the high levels of demand management planned within the WRSE region for which, in order to maintain security of supply, customers would need to reduce water use as forecast.

11.240 As discussed below, further investigation of Minworth/GUC transfer, the STT and the SESRO will be carried out before the decision point in 2022/23 to determine the best value long term strategic regional supply options for the South East, and WRSE modelling will support this decision.

M. Adaptive alternative options approach

11.241 Our preferred plan set out in subsections 11-B to 11-G gives details of the programme of demand management and water resource option development that we consider is the best value investment programme to maintain security of supply throughout the 80 year planning period. It is based on results of studies that have been undertaken to date examining the feasibility of a wide range of water resource options.

Programme of studies 2019-2022

11.242 In the period to 2022/23 we have set out a continuing programme of ongoing studies to be undertaken with regulators, other water companies and third party organisations to continue to examine the feasibility of a number of these options, namely further investigations of

- Deephams reuse scheme
- Beckton reuse scheme

[32] Approximately +£115M to increase the reservoir size from 100 to 150 Mm3; +£35M to bring forward the transfers to Affinity zones 1 and 4 to 2045 and 2060; -£220M cost of the GUC (removed); +£220M due to reduction in discounting moving the 150Mm3 reservoir from 2050 to 2045.

- Oxford Canal
- Severn Thames Transfer, and
- SESRO

11.243 These studies are in addition to those associated with the delivery of groundwater schemes which are planned in the period 2020-2030, and the ongoing investigations into a number of other potential resource options which are currently considered infeasible e.g. Teddington Direct River Abstraction. Further details of the studies are set out in Appendix XX.

11.244 For the Deephams reuse scheme, we will carry out further investigations of the potential effects of operation of this scheme, including:

- Agreeing with the Environment Agency the most appropriate hydrological datasets to update the assessment of the hydrological effects on the freshwater River Lee from the Pymmes Brook confluence at Tottenham Locks to the tidal limit at Three Mills Lock (and particularly the reach at Hackney Marshes). These agreed datasets will be used to support additional assessments set out below.
- Assessing the impact on fish habitat and other ecology in more detail (including effects on the WFD ecological potential), building on the recent ecological survey and modelling evidence gathered by Thames Water.
- Assessing the cumulative impact of pollution incidents arising from storm events.
- Assessing effects on the salinity and sediment conditions in Bow Creek (Lee estuary) to support the assessment of effects on the Bow Creek water environment.
- Review with the Port of London Authority whether the scheme will lead to any adverse effects on navigation in Bow Creek.
- Assessing the effects of the scheme on the water environment of the Thames Tideway.
- Exploring any additional mitigation measures that may be required to protect the river or estuarine environment during operation of the scheme, as well as any opportunities for delivering net environmental gain.

11.245 For the Beckton reuse scheme we will carry out further investigations of the potential effects of operation of this scheme, including:

- Reviewing the effects of this scheme on the dilution and dispersion of chemicals in the Thames Tideway. This may require monitoring and/or modelling of the Tideway water quality to support the assessment.
- Updating the assessment of the effects of the scheme on the salinity regime of the Middle Thames Tideway and possible adverse effects on aquatic species that are sensitive to small changes in salinity. In particular, we will update the assessment in relation to the species designated within the Lower Thames Estuary recommended Marine Conservation Zone.
- Reviewing the environmental effects relating to the construction of the conveyance infrastructure from Beckton to the Lee Valley Reservoirs, including consideration of alternative conveyance routes.
- Agreeing any requirements for additional baseline water quality monitoring.
- Reviewing with the Port of London Authority whether there would be any navigation effects in the Middle Thames Tideway arising from operation of the scheme.

- Exploring any environmental or navigation mitigation measures that may be required during operation of the scheme, as well as any opportunities for delivering net environmental gain.

11.246 For the Oxford Canal scheme we will carry out further investigations of the potential effects of operation of this scheme, including:

- Working with CRT to assess the environmental effects of the CRT groundwater abstraction in the Birmingham area that will support the raw water transfer. Where necessary, this might include pumping tests to monitor the effects of the pumping on the water environment (groundwater and surface water).
- Carrying out an agreed baseline water quality monitoring programme for the canal and the relevant reaches of the River Cherwell to support the assessment of possible changes to water quality in the canal or River Cherwell (including on algal growth).
- Assessing the effects of the existing CRT abstraction from the River Cherwell at Cropredy to inform the environmental baseline conditions.
- Carrying out an agreed monitoring programme of the baseline flow, habitat condition and ecology of agreed reaches of the River Cherwell.
- Confirming the operational details of the scheme and assessing any effects on the environment of the Oxford Canal and the River Cherwell (downstream to Cropredy), in particular on canal and river water quality, ecology, aquatic habitats and the potential risks of the transfer of any invasive non-native species (INNS).
- Exploring any environmental mitigation measures that may be required during operation of the scheme, as well as any opportunities for delivering net environmental gain.

11.247 For the Severn Thames Transfer scheme we will carry out further investigations of the potential effects of the various support options that are required to secure the reliable supply of the scheme. These investigations include:

Vyrnwy Reservoir Flow Support Option

- Continuing the continuous water quality monitoring in Vyrnwy Reservoir and the upper reaches of the River Vyrnwy that we commenced in 2017.
- Reviewing the new water quality data and update the assessment of the risks to river water quality risk due to operation of the flow support option.
- Carrying out river channel and flow surveys as well as ecological monitoring (particularly fish species) of the River Vyrnwy to inform the assessment of potential environmental effects on the river.
- In partnership with the Natural Resources Wales, Environment Agency, United Utilities and Severn Trent Water, carry out a series of flow support trials to monitor the effects of the additional flows on the hydrology, river hydraulics, geomorphology, water quality and ecology of the River Vyrnwy. These trials will help inform the environmental assessment.
- Exploring the environmental mitigation measures that may be required during operation of the scheme in consultation with Natural Resources Wales, Environment Agency, United Utilities and Severn Trent Water. This could include operational controls and river habitat improvement activities.
- Considering the opportunities for delivering net environmental gain.

11.248 There is a risk that the releases from Vyrnwy Reservoir direct to the River Vyrnwy will not be acceptable environmentally and that instead an alternative option to release water via the United Utilities Vyrnwy Aqueduct will be required, involving a new raw water pipeline and discharge to the River Severn downstream of the River Vyrnwy confluence. If this option is required to be investigated the following investigations would be carried out:

- Agree scope of environmental surveys of the pipeline route with Environment Agency, Natural England, Historic England, and relevant local planning authorities.
- Review any effects of the pipeline on hydrology (surface water and groundwater) and the aquatic environment via a targeted walkover survey of the pipeline corridor (including river crossings and the possible effects on wetland habitats).
- Carry out heritage assets walkover survey and assessments in dialogue with Historic England.
- Carry out HRA and WFD assessments of the pipeline construction and operation.
- Undertake a river environmental walkover survey and aquatic ecology survey of the proposed new discharge point to establish any sensitive habitats and species that could be affected by the construction of the new discharge facility.
- Carry out river environmental surveys and/or modelling to assess the effects of the discharge on the downstream river environment.
- Explore any environmental mitigation measures that may be required during operation of the scheme, as well as any opportunities for delivering net environmental gain.

11.249 We will continue to liaise closely with Affinity Water as it undertakes studies to examine the feasibility of effluent transfer from Severn Trent's Minworth wastewater treatment works to its supply area via the GUC. Effluent transfer from Minworth to support the Severn Thames Transfer is an option examined in our programme appraisal process but not selected in the preferred programme due to its significant environment impact. The option is included in the programme of studies within Affinity Water's WRMP19 and we will look to learn from the outcome of this work to inform the future potential of the option to support the Severn Thames Transfer if it is not subsequently selected by Affinity Water.

11.250 For the SESRO scheme, we will carry out some specific further investigations relating to water quality and invasive non-native species (INNS):

- Review previous work carried out on reservoir water quality and the proposed mitigation measures to maintain good water quality conditions in the reservoir (including algae). Review whether the mitigation measures remain appropriate or if changes are required.
- Review the information on reservoir mixing in relation to water quality under a range of drought conditions and consider whether further water quality monitoring and/or reservoir water quality modelling needs to be undertaken.
- Updating previous modelling and assessment work to examine the effects of the discharge of water from the reservoir on the River Thames, particularly on river water temperature, water quality and ecology, under a range of different drought conditions and climate change scenarios. Consider the need for any additional mitigation measures.

- Assessing the potential risk of transfer of INNS from the reservoir into the River Thames under a range of drought and climate change scenarios. This will include assessing the risks of INNS entering the reservoir from a range of possible entry pathways. Consider the need for any additional mitigation measures.
- Review the assessment of the volume of water that is "lost" between the discharge of water to the River Thames and the downstream abstraction intakes in the Lower River Thames.
- In consultation with the Environment Agency, further assess the potential effects of the scheme operation on water levels and navigation in the River Thames, and consider whether any additional mitigation measures may be required.
- Review the potential effects on the River Thames arising from the construction of the abstraction and discharge facilities at Culham, including any mitigation measures that may be required during construction.
- Exploring any further opportunities for delivering net environmental gain beyond those associated with the diversion of various small watercourses and the reduction in abstraction from various chalk streams enabled by the reservoir scheme.

Monitoring and reporting

11.251 In the period to 2022/23 we will put in place a system of monitoring and reporting to give regulators and stakeholders visibility of our progress delivering the programme of studies for WRMP24. This will facilitate stakeholder input and engagement to the overall work programme. We will continue to report progress through our quarterly Water Resources Forum, which we will run jointly with both WRSE and Affinity Water where appropriate, and the associated technical stakeholder meetings. We will provide 6-monthly updates on progress to government and regulators in addition to the submission of quarterly progress reports to the Regulators' Alliance for Progressing Infrastructure Development (RAPID) relating to the work programme associated with investigations of the strategic regional options (SROs). These reports will use the template prescribed by RAPID. Our proactive work with WRSE, as well as RAPID, will ensure our work programme is aligned with neighbouring water companies as well as those further afield who are working with us to investigate the SROs. An annual update of progress will be reported through the Environment Agency's June Annual Review of the water resources programme. Full details of the outputs and monitoring plan which will be reported are given in Table 11-47. This includes:

- Progress against target with the demand management programme (water efficiency savings, reduction in PCC, progressive metering programme installations, leakage reduction);
- Population growth against forecast;
- Reporting progress on industry workstreams, coordinated through Water UK and Waterwise, to facilitate mandatory water labelling on water using products, changes to fitting standards and building regulations;
- Delivery of water supply schemes, including several groundwater schemes against the investment programme (scheme milestones, associated yield and quality against expectations), and;
- Ongoing results of options studies against the programme of investigations.

Table 11-47: The adaptive plan monitoring programme

Assessment Area	Monitoring Activity	Metric	Purpose and relationship with decision point
Water balance Summary	SDB	Ml/d	Actual vs predicted – Confirm if movement is within Headroom expectations
	DI		
	WAFU		
Growth	Population	000s	Actual vs predicted and updates to projections
	Properties		
	PCC	l/hd/d	
AMP7 Delivery - Demand options	Leakage	Ml/d	Actual vs predicted – assumptions and impact assessment
	Metering	Activity	Meters installed – assumptions and impact assessment
	Water Efficiency		Activity delivered – assumptions and impact assessment
AMP7 Delivery – Supply options	New River Head	Delivery progress update	Delivery vs WRMP19
	Horton Kirby		
	Southfleet & Greenhithe		
	Didcot		
	Ladymead		
Strategic option studies	IPR Deephams	Progress update (see App XX for details)	Readiness for 2022/23 decision point (2030 scheme delivery)
	IPR Beckton		
	West London		
	Oxford Canal		
	STT		Readiness for 2022/23 decision point (2037 scheme delivery)
	SESRO		
Regional need	Affinity Water	Update	Updated need position
	Southern Water		
	Sutton and East Surrey		
	South East Water		
	WRSE		Regional modelling update
Environmental need	Water Industry National Environment Programme (WINEP)	Update	• Progress with current investigations / delivery • Likelihood and magnitude of further sustainability reductions in the future • West Berkshire Groundwater Scheme
Resilience required	Regulators	Design drought	Update return period and DO

11.252 Our WRMP19 stakeholder engagement programme, which has been commended by our Customer Challenge Group (CCG), will continue as an effective means of securing stakeholder input to the ongoing programme of work.

Alternative options plan 2022/23 decision point and regulatory governance

11.253 As set out in subsection 11-B, our WRMP19 is adaptive and allows for results of the ongoing programme of studies to continue to inform the selection of strategic options that will be promoted as part of the best value investment programme. In order to enable the schemes to be delivered within their respective lead times without risk to the overall robustness of the plan,

a decision will need to be made in 2022/23 which finalises the strategic water supply schemes for promotion and delivery. This decision point relates to both the resource options being promoted to secure resilience to a severe 1 in 200 drought event by 2030 as well as the strategic regional resource options to maintain ongoing security of supply resilience in the medium and long-term (Figure 11-18) across the South East.

11.254 The timing of this decision point in 2022/23 aligns with one chosen by Affinity Water to confirm the strategic options that it will promote as part of its own WRMP. This allows for the completion of investigations that Affinity Water is undertaking on a number of strategic water supply options for its plan, as well as the success of its demand management programme.

11.255 There is no requirement for construction work on the large regional strategic resource options to begin in the AMP7 period (2020-2024); only further detailed site investigations are required in order to facilitate the completion of detailed scheme design which would subsequently enable the schemes to be progressed to planning application stage.

11.256 The 2022/23 date also aligns extremely well with the regulatory timetable for the next WRMP, i.e. WRMP24, and as such it will facilitate stakeholder and customer engagement and input to the decision making process through the statutory consultation process associated with the next set of WRMPs. A sophisticated programme appraisal process will be used to inform the selection of the options that will comprise the best value investment programme.

11.257 The timeline allows for programme appraisal at WRSE regional level, as well as at the individual water company plan level for both Affinity Water and Thames Water. WRSE acknowledges that its current single objective modelling approach is too simplistic to reliably determine the timing and order of strategic resource developments and it is currently developing much more sophisticated and appropriate regional system simulation models and investment decision support tools to facilitate development of a robust regional water resources strategy in time for WRMP24.

11.258 The timetable aligns with the process set out in Ofwat's July 2019 Draft Determinations[33] which has confirmed development to planning application stage of regional strategic water resource schemes for the South East and East. Ofwat's investment requirements have been reviewed with the other seven water companies[34] who have included the promotion of the strategic water resource options within their WRMP19 plans. The proposed timing for the gateways that Ofwat has indicated should be used to monitor progress and control investment is shown in the WRMP24 timetable listed below.

11.259 The expected WRMP24 statutory timescale is as follows:

- National Framework Guidance to regions — December 2019
- Publication of statement of need (SON) for the SE — February 2020
- Water Resources Planning Guideline — Autumn 2020
- Updated SON for the SE — February 2021
- SRO Gate 1 investigation activities — June 2021
- Initial WRSE Regional plan — August 2021

[33] Ofwat PR19 Draft Determinations 18 July 2019
[34] Affinity Water, Anglian Water, Severn Trent Water, South West Water, Southern Water, United Utilities and Wessex Water

• Draft Regional Plan for consultation	January 2022
• WRSE regional plan to inform company WRMP24	April 2022
• Draft WRMP24 and revised WRSE regional plan	August 2022
• Draft WRMP24 publication for consultation	September 2022
• SRO Gate 2 investigation activities	September 2022
• Statement of Response and revised draft WRMP24	March 2023
• WRMP24 submission to Secretary of State	Spring 2023
• Commencement of pre-application work re DCO for SESRO	July 2023
• Final Draft WRSE Regional Plan	September 2023
• SRO Gate 3 activities	September 2023
• Hearing/Inquiry WRMP24	Autumn 2024
• Secretary of State approval of WRMP24 (SRO needs case)	March 2025
• Pre-application work for SESRO DCO	Mar 2025-Feb 2026
• Statutory consultation on SESRO DCO	March 2025
• Application for SESRO DCO	April 2026

11.260 The WRMP19 recognises that following further studies a decision will be made in 2023 as to whether it is necessary to proceed with the SESRO to ensure the security of water supply in the South East generally and for Affinity Water and Thames Water specifically.

11.261 If the decision taken in 2023 is that the SESRO is necessary, it is imperative that the future timetable for the next round of WRMPs and for the required development consent order ("DCO") leaves enough time for the SESRO to be developed by the time it is needed i.e. by summer 2038.

11.262 This means that any application for a DCO for the SESRO will need to be made by April 2026 if the SESRO is to be available for use by summer 2038.

11.263 Therefore, if the decision taken in 2023 is to proceed with the SESRO then it is vital the promotion of the subsequent WRMP24 proceeds in parallel with the promotion of a DCO for the SESRO. Specifically, the timetable must allow for the need for the SESRO to be established through the WRMP process as is anticipated by the proposed Water Resources National Policy Statement (NPS) with pre-application investigations, activities and assessments related to the DCO process for the SESRO (and which are unrelated to the need for the SESRO) being carried out in parallel to the WRMP process. The pre-application work for the SESRO DCO will need to commence in July 2023 to facilitate the application in April 2026.

11.264 To enable the above, it has been agreed that if a decision is made in 2023 to proceed with the currently preferred option of the SESRO the timetable set out above will be adhered to by Thames Water and Affinity Water and will be required to be facilitated by the Secretary of State and the Environment Agency.

11.265 Figure 11-18 shows the 2022/23 decision point in relation to both delivery of Thames Water's own resilience to a severe 1 in 200 year drought event as well as supporting medium and long-term maintenance of security of supply resilience in the wider regional WRSE context. The central *Expected: future 2* represents the WRMP19 preferred plan and requires delivery of the

first strategic regional resource (SESR) in 2037/38. The more *Challenging: future 1* with higher growth, earlier climate change impacts and greater resilience requirements[35] would bring forward development of the second strategic regional resource option (Severn Thames Transfer) to the 2040s. The *Optimistic: future 3* and *Aspirational: future 4* would see the strategic regional resource delayed until the mid-2040s or later. The drivers for the different futures are shown in Table 11-48 and are taken from the Adaptability analysis previously set out in Section 10.

Table 11-48: Single[1] and in-combination drivers for different futures

Driver	Aspirational	Optimistic	Expected	Challenging
Deficit change	*~150Mld less*	*~100Mld less*	-	*~150Mld more*
Timing of change	*2055*	*2045*	-	*2050*
Population	ONS16 Low[1]	ONS16 Low[1]	*Most likely*	CaMKOx
PCC	105lhd by 2065[1]	110lhd by 2065[1]	*121lhd by 2045*	No reduction[1]
Leakage	*Half leakage*	*Half leakage*	*Half leakage*	Reduce by ⅓[1]
Climate Change	*Impact 2080s*	*Impact 2080s*	*Impact 2080s*	Impact 2050s
Resilience	*1:200*	*1:200*	*1:200*	1:500[1]
Regional need	Delayed 2055[1]	Delayed 2045[1]	*100Mld 2037/8*	Increased 2050[1]

1 Single driver which on its own would be sufficient to trigger a different future to that in the Preferred Plan

11.266 At this early stage in the planning process it is not possible to definitively determine what the precise thresholds are which would define that there has been movement away from the Expected future to one of the alternatives since this would be the subject of a detailed planning and modelling exercise itself. This is why delivery of the Plan in the period to 2022/23 will be carefully monitored, which, together with the development of more sophisticated regional planning decision support tools, will enable an informed decision to be made as part of the next Water Resources Planning exercise i.e. WRMP24.

11.267 In 2022/23, the findings of the supply option studies detailed earlier together with the findings of the wider monitoring activities in Table 11-47 will be evaluated as part of the development of WRSE's regional plan. This information will provide confirmation of the path to be taken at the decision point for Thames Water's resilience to drought and the region's security of supply as shown in Figure 11-18.

11.268 The timing of this decision point aligns with Gate 1 in the evolving collaborative process outlined within Ofwat's Draft Determinations for the regional strategic schemes. The recommendation that Thames Water sets out for development will be aligned as appropriate with other water companies' plans.

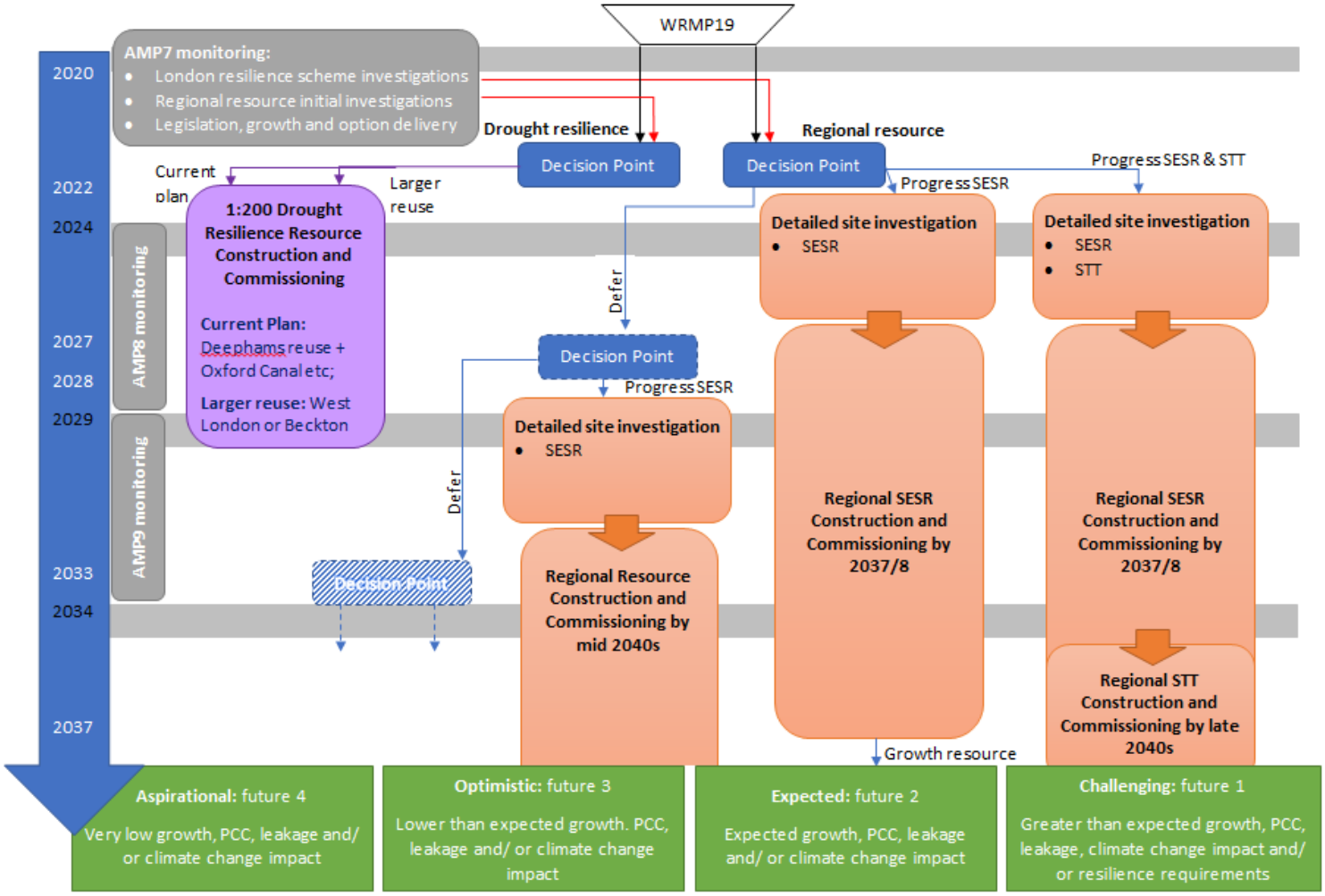
11.269 It is expected that this recommendation will be provided to RAPID. This group includes representatives of the EA, Ofwat, and DWI to ensure regulatory alignment and robust decision making to assist Defra and the SoS, (and the Welsh Assembly Government).

11.270 This decision point in 2022/23 allows the required options to continue into planning phases without compromising the need for the resource to be available by summer 2038. Further gates are expected to apply, along with WRMP24 and PR24, which allow further tests to confirm the

[35] Main drivers for different futures taken from the Adaptability drivers in Figures W-34 to W-38, Appendix W

continuation of the chosen options. For the regional strategic options in our plan, actual construction will not start until AMP8 (2025-2030).

11.271 Figure 11-18: Alternative Options Plan decision points



N. Summary

11.272 This section has presented our preferred plan for the period of 2020 to 2100.

11.273 We have conducted a sophisticated programme appraisal process in Section 10: Programme appraisal, which has led to the identification of the preferred plan following a step-by-step iterative approach taking account of and applying relevant water supply/demand metrics whilst maintaining a holistic view of the efficient and economical system of water supply in our area that we are required to provide.

Our preferred plan for London, SWOX and SWA

11.274 During programme appraisal we have derived our preferred plan for London, SWOX and SWA as a combined zone due to the complexity of the supply demand challenge in these three zones.

11.275 Our strategy, as provided for in the preferred plan, is to combine demand management with resource scheme development to secure long-term resilience to drought based on best-value delivery of water services to our customers. The plan elements are listed below:

- Start implementing a reward based incentive scheme in London WRZ, accompanied by our PMP and enhanced water efficiency activity to reduce customer usage. With widespread household meter penetration, implement an incentive based financial tariff in 2035 throughout the combined zone to further reduce household consumption.
- Undertake significant mains replacement and other leakage control activity to reduce leakage.
- Implement a combination of groundwater development, wastewater reuse and raw water transfer schemes in 2030 to facilitate increased resilience to severe drought events, followed by the SESRO in 2037/38 and the supported Severn Thames Transfer from 2083 to provide sufficient resilience against increasing demand and forecast reductions in water available for use. There are also third party water trading schemes in London WRZ and the development of small scale groundwater schemes in the London and SWA WRZs.

11.276 A growing deficit is observed in the SWA WRZ from the mid-2030s but there are insufficient local resource schemes to resolve the issue within the zone itself. Additional raw water is required to be transported into the WRZ from a strategic water supply scheme located in the west of the River Thames catchment.

11.277 Likewise, London is facing significant challenges from population growth, decreasing water availability due to the impacts of climate change, increasing South East regional demand and potential environmental requirements linked to the achievement of WFD objectives. There is no single large-scale resource scheme that can provide sufficient resilience for London and the South East in the long-term and our preferred programme is a combination of demand management measures and new water resource schemes.

11.278 The preferred plan delivers the WRSE water resource requirements of Affinity Water.

Our preferred plan for Guildford, Kennet Valley and Henley

11.279 Our plan is to continue to focus on demand management through roll out of our PMP to deliver benefit of increased resilience against population growth and reductions in water availability due to climate change.

11.280 Our PMP will be extended to Guildford WRZ from 2020 together with enhanced water efficiency activity to reduce customer usage. Incentive based tariffs will be introduced from 2035.

11.281 Removal of the network constraint at Ladymeads will allow an extra 4.6 Ml/d supply to Guildford WRZ as early as 2024 to resolve the increasing short-term deficit due to population growth.

11.282 In the Kennet Valley WRZ, we will implement our progressive metering programme from 2030 to maintain security of supply resilience in the long-term.

11.283 Investment in Henley WRZ will be minimal due to the existing and continuing supply surplus. However, the roll out of our PMP will be extended to this zone from 2030 to ensure that there is a consistent and equitable policy across Thames Water's supply area that customers pay for their water usage on a measured tariff. Furthermore, the demand management programme will promote water usage reduction which helps to improve resilience against extreme weather events such as drought.

11.284 In conclusion, we have selected our preferred plan by examining a wide-range of factors, including financial, environmental and social impacts, resilience to drought, customer preference and deliverability. A series of scenario tests and performance stress testing have been undertaken to demonstrate that the plan is robust and adaptable and that the proposed investment represents no regrets, best value investment that is consistently selected under a wide variety of different and uncertain futures. By these means we consider that our WRMP19 preferred plan is consistent with an adaptive pathways approach to long term best value water resource management decision making.