GARD response to

Water Resources South East's Consultation on Future Water Resource Requirements

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Response to WRSE's consultation on Water Requirements

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1. Are there any further key challenges and opportunities we face in the region with regard to water resource availability that you believe we should consider?

We have numerous concerns about WRSE's assessment of water availability which we have set out in Section 2 of our response. Our concerns can be summarised as:

1.1. Despite recognising the need for an adaptive regional plan, able to accommodate uncertain future deficits, WRSE's report gives no consideration to possible ranges of future deficits and the large uncertainties around future estimates of population growth, climate change, need for sustainability reductions and forecast effectiveness of demand management measures. 9

1.2. WRSE's report quotes future resource deficits in its Table 1 and throughout the report, which do not take account of the post-2025 demand management measures already in the WRMPs of the six water companies in the South East. These planned measures reduce the regional deficit by about 700 Ml/d. 11

1.3. We think it is inappropriate and misleading for WRSE to quote the Table 1 deficits as "headline" values, without pointing out that the deficits will be much lower when all the planned demand management measures are implemented. 12

1.4. We also think WRSE's report should have made clear that, according to the WRMPs, no regional deficit will arise until near the end of the century – 2079 from GARD's analysis of the WRMPs. The earlier need for more resources only arises from WRSE's assumptions about loss of supply for 1:500 year resilience and much larger environmental reductions. 12

1.5. We think that the population growth in WRMPs has been substantially over-estimated due to: 15

- assumptions that every new house projected in a local development plan will be built, with no allowance for historic failure to meet housing targets
- failure to adequately allow for long term falls in fertility, longevity and immigration.

1.6. The WRSE population work should explain clearly where it lies in relation to the ONS Low, Principal and High population projections for the South East. This would enable Ofwat and other stakeholders to judge more easily its credibility and indicate how much headroom is already built into the calculation. 19

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1.7. Our analysis of the forecasts of future PCC reductions in the WRMPs shows that there are large differences between the six water companies' expected reduction in PCC and achievement of the Government's 110 l/head/day target. WRSE should not accept the WRMP forecasts of future meter penetration and PCC reduction, but should aim for a similarly ambitious approach across and consistency in future PCC reductions across the region.	20
1.8. Similarly, WRSE should not accept the forecast leakage reductions in the WRMPs, which show wide variations in the water company forecasts and even for supply zones within the same company.	28
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1.10. WRSE's deficit forecasts include 274 Ml/d of sustainability reductions in addition to those allowed in the WRMPs, but should also make allowance for the enhanced chalk stream flows making more water available for supplies taken from the lower reaches of rivers. This could reduce the impact of the sustainability reductions on the deficit by about 80%, equivalent to about 200 Ml/d less deficit.	30
1.11. Thames Water is making much larger allowances for climate change in London than for their Thames valley zones or other companies outside London. We think that the London climate change forecasts should recognise the evidence suggesting that climate change of the past 100 years has not materially affected supplies in the South East to date, and might have <u>increased</u> the availability of water supplies for London. We think the Thames Water's climate change forecasts for London have failed to recognise that severe reservoir depletion in summer droughts only occurs if chalk groundwater levels are exceptionally low in the previous spring, and that the groundwater levels in spring are dependent on winter rainfall, which appears to be increasing with climate change.	32-39
1.12. We think that WRSE should independently review all the water companies' climate change forecasts, particularly: • The probability of the three worst droughts of the past 100 years for London occurring in the first 25 years of the period "by chance", as Thames Water have said. • The need for any climate change reduction in present day supply output, noting	39

the evidence of lack of any adverse climate change impact to date.

- The regional dependence of supplies, both groundwater and surface water, on chalk groundwater levels that are strongly influenced by winter rainfall which may be increasing due to climate change.
- The reliability of the stochastically generated weather data and modelling used in climate change impact assessments.

1.13. In our opinion, the allowances for uncertainty and "safety factors" in WRSE's deficit forecasts are excessive. The WRMPs already make substantial allowances for uncertainty in target headroom, climate change headroom, outage allowances and emergency reservoir storage. Thames Water's emergency storage in the London reservoirs is said to allow 30 days' supply, but in reality could maintain supplies for about 5 months in the most severe droughts like 1921 and 1934, which extend deep into the autumn and winter. WRSE have added further safety factors by allowing for 1:500 years resilience and large loss of supply for sustainability reductions, without allowing for return chalk stream flows. 40

2. We have set out our first thoughts on environmental ambition. Do you think this is focused on the key opportunities in our region? Are there any other areas of opportunity you think we could benefit from?

We agree that WRSE should plan for much larger sustainability reductions than currently shown in the WRMPs. In particular, we strongly support the 'Chalk Stream First' proposal for the Chilterns chalk streams. However, we think the WRSE should take into account: 30

2.1. In considering the feasibility of sustainability reductions, allowance should be made for the enhanced chalk stream flows becoming available for the supplies taken from the lower reaches of river such as the Thames, Lea, Itchen and Test. 31

2.2. The investigation of the availability of enhanced chalk stream flows for downstream supplies should involve regional groundwater modelling in conjunction with simulation of modelling of the downstream surface water supplies, for example using Thames Water's WARMS2 model. 32

2.3. If the leakage levels in Thames Water's Thames valley zone are brought down to the levels of other companies, there will be less need for sustainability reductions and more water available to facilitate them. 31

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3. What are your views on how the region could or should use temporary approaches, such as drought permits, to managing continuous water availability in drought events?	
The resilience design standard for supplies has been raised from 'worst historic' drought (probably 1:100 years) in the 2014 WRMPs, to 1:200 years in the 2019 WRMPs, and now to allowing for a 1:500 year drought in WRSE's regional forecast. In our opinion, when coping with an event as rare as a 1:500 year drought it would be appropriate to allow some temporary approaches.	-
This applies particularly to easing of environmental restrictions which have been retained at high levels for protecting designated sites. An example would be the Severn estuary which currently has a high hands-off flow to protect the estuary and migratory fish. We think it would be appropriate to allow some reduction in this HoF in severe droughts, recognising the infrequency of occurrence and the natural ability of environments to recover from rare adverse events.	-
There should be more incorporation of drought measures into licence conditions, so that they can be an assured part of deployable output and less delay in getting permissions. The gradual reduction of the Teddington hands-off flow in the Lower Thames Operating Agreement and the West Berkshire Ground Water Scheme are examples of licensed drought measures. There is potential for more such measures to be incorporated in licences.	-
4. Do you think we have we missed any key water users within the region? If so, can you please provide details of these water users and the sectors they may be in?	
We have no suggestions.	
5. We have set out the initial options for managing water resources in the region. What are your suggestions on further options we could consider?	
We agree the list of generic options put forward by WRSE. We have commented in detail on many of these option types in our responses to Thames Water and Affinity Water's WRMPs. We hope that WRSE will take note of the comments we have made when considering these options for the South East regional plan. The main text of this report gives references to the relevant parts of our consultation responses, which can be seen on GARD's website at http://www.gard-oxon.org.uk/downloads.html.	43
With the switch to 1:500 year resilience, we propose investigation of the option of reducing the allowance for emergency storage in the London reservoirs, recognising that the current allowance for emergency storage would in reality allow London's	43

supplies to be maintained without Level 4 restrictions for much longer than Thames Water's nominal 30-day standard.

If there is to be large scale reduction in supplies from continuous chalk groundwater abstraction, there will be opportunities to use the groundwater instead as drought sources, similar to the West Berkshire Ground Water Scheme. Examples would include the chalk streams of the Chilterns, the River Test and the River Itchen. There could be a similar opportunity in the Hampshire Avon catchment, allowing a transfer from the South West Region into the South East. 44

6. This plan requires engagement across a wide range of stakeholders. What are your views on how best to achieve this and are there any key stakeholders you suggest the plan engages with?

We think that to date there has been minimal transparency of WRSE's work on the South East regional plan. The report on Future Water Resource Requirements is an example. This provides outline detail of forecast regional deficits, in Table 1, but provides no information on how the figures were derived or breakdown into individual companies. The report section on options is merely a generic list, with no indication of which option variants are being considered or justification for their choice. -

We are also aware that various consultancy teams have been working on aspects of the regional plan for nearly a year and have produced interim reports. None of this information has been made available to stakeholders. -

We think that interim reports should be made available as the work progresses, giving stakeholders the opportunity to comment as the investigation evolves, rather than presenting results as a fait accompli at the end. -

There should be more stakeholder meetings at which technical work is discussed, with full technical papers being made available in advance of the meeting, rather than only being presented in PowerPoints on the day. -

There should be opportunities for interested stakeholders to attend small technical meetings, allowing detailed technical discussion which is not feasible at large stakeholder meetings. -

7. Do you have any further comments?

We have no further comments.

1. Introduction

About GARD

Group Against Reservoir Development (GARD) is a community based organisation representing the interests of local residents and businesses, mainly in the South Oxfordshire villages of Steventon, Drayton, East and West Hanney and Marcham, who would be affected by Thames Water's plans to build a major new reservoir near Abingdon.

We strongly welcome Ofwat's initiative in promoting, funding and over-seeing a regional approach to developing strategic water resources. In our opinion, in the past 25 years there has been insufficient regulatory attention to planning of water resources on a regional and national scale. Too much has been left to the water companies who have focused on their own needs, rather than making best use of scarce regional and national water resources.

Recognising that the proposed Abingdon reservoir is said to be a potential solution to regional and national water resource shortages, we have taken a keen interest in the water resource plans not just of Thames Water, but also of other water companies in the South East region and companies who could be suppliers of water transfers into the South East. For this reason, we have responded to the consultations on the WRMPs of Affinity Water, South East Water, Anglian Water, Severn Trent Water, United Utilities and Welsh Water, as well as to both Thames Water's WRMP consultations. GARD's responses to the consultations on Thames Water and Affinity Water's plans can be seen here http://www.gard-oxon.org.uk/downloads.html.

Scope of this response

WRSE's report on future water resource requirements understandably focuses on the forecast deficits of the water companies who are the main abstractors of water in the region. Virtually all the data in the report relate to water supply deficits. Therefore, we are surprised that none of the 7 main consultation questions asked by WRSE's report, as listed on page 27, relate to the deficit forecasts.

The bulk of this consultation response covers WRSE's current deficit forecast and the plans to refine them. We have provided only a few comments on resource options, because WRSE's report only provides a generic list of option types, with no detail of individual options. In the first section of this response, we have provided short answers to WRSE's seven set questions, referring to our comments on the forecast deficits where relevant.

Lack of transparency

WRSE's report contains no supporting evidence to justify the large forecast deficits. The forecasts are said to have been based on individual company WRMP forecasts, but no detail is provided. In particular, there is no detail of:

- Breakdowns into the individual water companies
- Population growth
- Changes in PCC
- Changes in meter penetration
- Locations of environmental reductions in supply and how they were chosen
- Climate change reductions in supply or how they were derived

Therefore, in commenting on the forecasts, we have gone back to individual company forecasts and assembled forecasts for the whole SE region. We have also summarised our previous comments in the WRMP consultations to Thames Water and Affinity WRMPs, providing links to our full consultation responses. Where necessary, we have also addressed the water company responses to our comments in their published Statements of Response.

2. Deficit forecasts

2.1 The need to consider ranges and uncertainty in deficit forecasts

WRSE's report says that *"Each regional group is required to produce a single, adaptive plan that builds resilience to a range of uncertainties and future scenarios*[1]*."* Despite the need to plan for uncertain deficits, the report does not discuss the extent of uncertainty in the forecasts, or state their basis – eg 'central estimate' or 'worst case'.

All components of the deficit are stated as single values in the report, rather than a range of values to cover the large uncertainties in each component. We note that the Environment Agency's report on future needs, usually termed the "National Framework" report, regularly refers to uncertainty and provides wide ranges of forecasts, for example in Figure 1 showing EA's forecast household consumption in 2050 (from Figure 14 in the EA report)[2]:

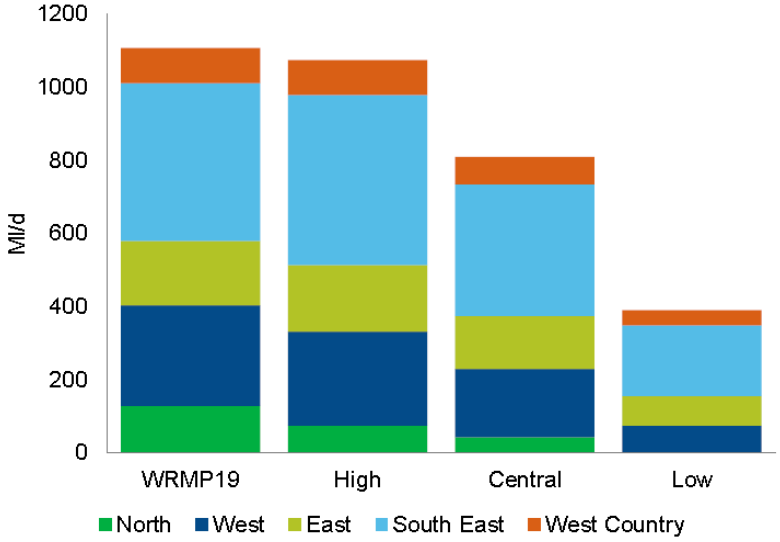


Figure 1 - EA National Framework range of forecast household use 2050

[1] WRSE Report, page 6
[2] EA report, Meeting our future needs: a national framework for water resources, March 2020, page 38

The EA's National Framework report is transparent about considering ranges of values to reflect uncertainty. As an example of good practice, we have copied in full below the extract from the EA's National Framework report which explains and justifies the scenarios used for population growth[3]:

> As well as the aggregated water company population forecasts, we also have a dataset generated by Cambridge Econometrics for the Climate Change Risk Assessment 3 project (CCRA3). This uses population projections published by the Office for National Statistics (ONS), which are based on historical data to 2016, with local authority projections provided to 2041 and national projections to 2100.
>
> The Cambridge Econometrics dataset includes high, medium and low scenarios and each of these are plausible futures. The projections provided in the dataset are based on assumptions which are subject to inherent uncertainty. For example, population projections are based on assumptions of future levels of fertility, mortality and migration but these assumptions are influenced by many factors and future outcomes are likely to be different from the assumptions made.
>
> We have compared the water company data to the Cambridge Econometrics data and found that the high scenario matches closely with the aggregate data produced by the water industry. This is what we would expect to see given government guidance to water companies is to plan for growth detailed in local authority plans so that they are not a barrier to that growth.
>
> The Cambridge Econometrics data has the benefit of being based on consistent national assumptions and including comparable medium and low scenarios. For these reasons we have used it for the majority of our analysis, typically looking at the high scenario due to its alignment with the water company plans.
>
> Using a high population scenario introduces the possibility of over estimating population growth and therefore demand. However, the risks from over estimating population growth are preferable to those from underestimating it. To manage these risks, regional groups should revisit their assumptions around population regularly as part of the planning process to correct for any changes.

Extract from EA's National Framework Report explaining ranges of population forecasts

Consideration of ranges of deficit forecasts will be essential if the WRSE is to provide a genuinely adaptive plan, which is able to accommodate a range of future scenarios. As the report stands, there is no recognition of uncertainty.

The language of WRSE's report, suggests an unwarranted and misleading degree of certainty in the forecasts, for example on page 10:

> Together, the total additional water needed by all water users in the South East region is projected to be just over **1 billion litres per day at 2050** and almost **1.7 billion litres per day at 2100.**

We note that similar language, implying unjustified certainty, is used in WRSE's latest monthly newsletter, which summarises the findings of WRSE's report, for example[4]:

[3] Ibid, page 37
[4] WRSE monthly newsletter for March 2020, page 1

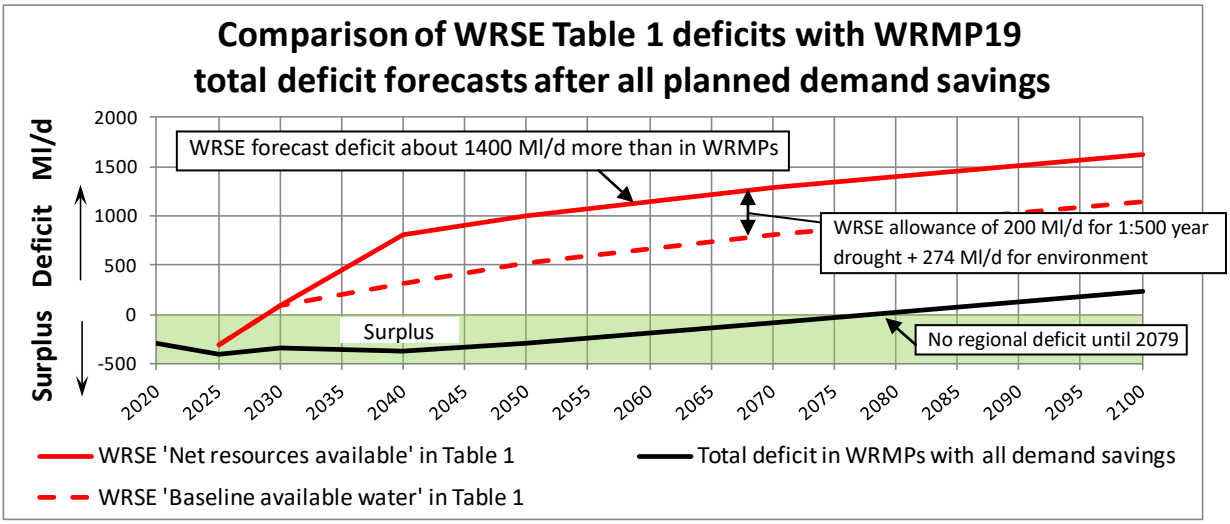
*"WRSE's Future Water Resource Requirements document provides the initial resource position for the region and, for the first time, for **all** water users.*

*It shows the stark reality of the water resource challenge being faced – by 2050 there will be a deficit in **public water supplies alone** of around 1 billion litres per day and by 2100 this will have risen to over 1.7 billion litres per day."*

In our opinion, the use of such language, without reference to uncertainty, is inappropriate.

2.2 Breakdown of WRSE's deficit forecasts

WRSE's report does not make clear whether their headline deficit figures, eg 1 billion litres per day deficit in 2050, allow for future demand and leakage reductions. From our analysis of the water companies' WRMP19 tables and additional information received from WRSE[5], it appears that WRSE's deficits only include planned demand savings up to 2025. They do not include the demand and leakage reduction planned in the WRMPs from 2025 onwards, totalling about 700 Ml/d. When these demand reductions are included, the deficits forecast in the WRMPs are far less than those shown in WRSE's Table 1, as shown below:



Note: All deficits are on the annual dry year basis. WRMP deficits include all planned demand savings up to 2100 and planned new sources up to 2025. Apart from Thames Water, all company forecasts are extrapolated to 2100.

Figure 2 - Comparison of WRSE deficits with WRMP deficits after planned demand savings

The c.1400 Ml/d difference between WRSE forecasts and the WRMPs is made up roughly:

- 700 Ml/d for planned demand reductions after 2025 (ie leakage, metering, etc)
- 200 Ml/d for 1:500 year resilience
- 274 Ml/d additional environmental protection
- 220 Ml/d unexplained discrepancy between WRSE and WRMP figures

In the absence of any detailed breakdowns in WRSE's report, we have not been able to find the source of the unexplained figures. This needs further investigation.

[5] Email and attachment from Meyrick Gough to John Lawson, 15.4.2020

Although we accept that there is some uncertainty in future demand and leakage reduction in the WRMPs, we think it is misleading to quote headline future deficits without taking account of the large demand management reductions already planned in the WRMPs, or the even larger reductions which can be achieved if Government targets for PCC and leakage are met (see later comments in Sections 2.5 and 2.6 of this response).

It is also misleading to show only the deficits for the region as a whole, without any breakdown into water companies or sub-regions. Table 1 shows how the WRMP deficits in Figure 2 break down into the water companies, with Thames Water's deficit further divided between London and their Thames valley zones:

WRMP supply demand balance with all demand savings up to 2100 and planned new sources up to 2025							
Water company (all deficits in	**2020**	**2025**	**2030**	**2040**	**2050**	**2070**	**2100**
Thames Water London	4	69	110	133	81	-20	-132
Thames Water Thames valley zones	103	103	123	149	147	144	124
All Thames Water	107	172	232	283	227	124	-8
Affinity Water	33	26	43	32	10	-79	-213
South East Water	67	92	80	48	52	61	59
Southern Water	62	72	-35	-19	-13	-28	-65
Portsmouth Water	3	13	-7	-6	-5	-3	0
Sutton & E Surrey Water	18	24	25	28	26	13	0
SDB total for South-East	**291**	**398**	**339**	**365**	**298**	**90**	**-227**

Data from WRMP supply demand balance (SDB) tables

Table 1 - Breakdown of WRMP regional deficits by water company

There are a number of important conclusions that can be drawn from the analysis of the deficit forecasts in Figure 2 and Table 1 which we think should have been made clear in WRSE's report:

1. The statutory WRMPs, which have been through extensive public consultations and regulatory reviews, show no regional deficit until 2079, according to GARD's analysis.

2. The huge deficits shown by WRSE have arisen almost entirely from the exclusion of the post-2025 demand savings in the WRMPs and WRSE's assumptions about loss of supply due to 1:500 year resilience and the additional environmental reductions.

3. A large part of the deficit after 2070 arises from extrapolation of earlier data, without any supporting evidence (particularly Affinity Water's deficit).

4. On the WRMP figures, Thames Water as a company is scarcely in deficit at all and South East Water and Sutton & East Surrey are in surplus throughout – there could be opportunities for resolving the London deficit and Affinity Water's by better sharing of the overall resources of the Thames valley.

5. The need for a decision on major sources by 2023 only arises if the change to 1:500 year resilience and additional environmental protection are considered urgent and "must haves". Otherwise the decision can be delayed, perhaps by decades.

Beyond 2025, the WRSE's growth in distribution input almost exactly matches the totals of baseline distribution inputs from the WRMPs as shown in Figure 3:

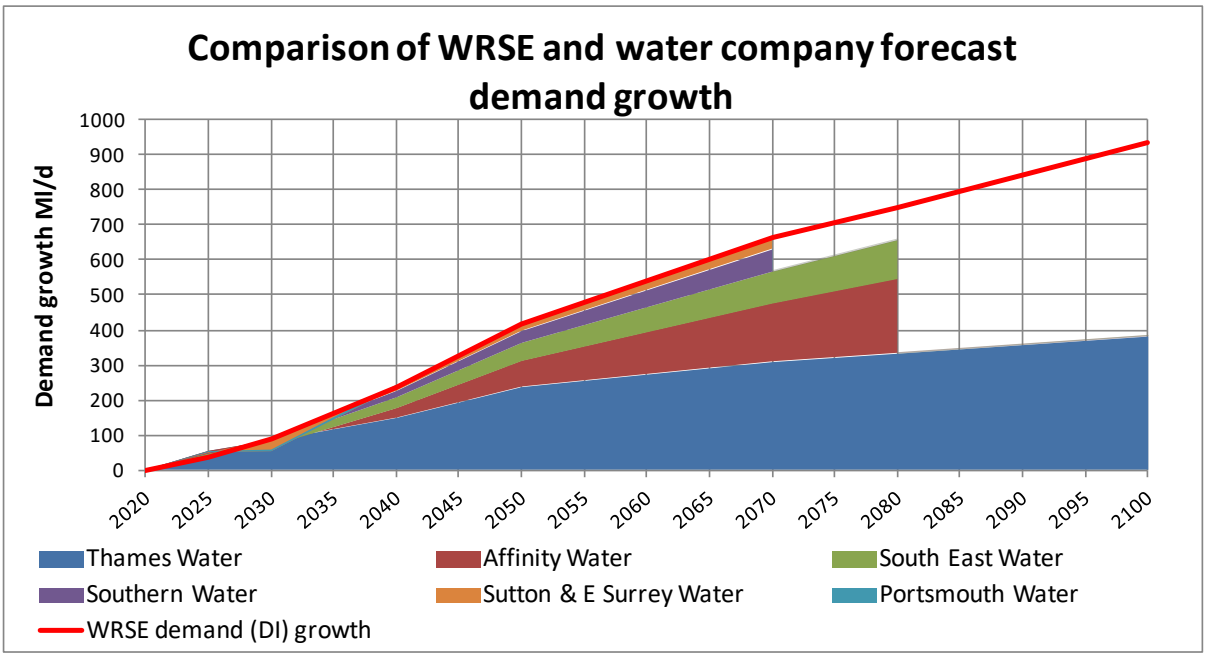


Figure 3 - Comparison of WRSE and water company forecasts of demand growth

Therefore, it appears that WRSE's report has simply used the forecast baseline demand growth in the WRMPs, recognising these forecasts will be reviewed and up-dated by the demand forecasting work currently in progress.

Figure 3 shows that the majority of the forecast demand growth comes from the plans of Thames Water and Affinity Water. GARD commented extensively on the demand forecasts in consultation responses to Thames Water and Affinity Water's WRMPs. We have summarised our comments in the following sections of this response covering:

- Population growth
- Per capita consumption – baseline and future projections
- Leakage – baseline and future projections

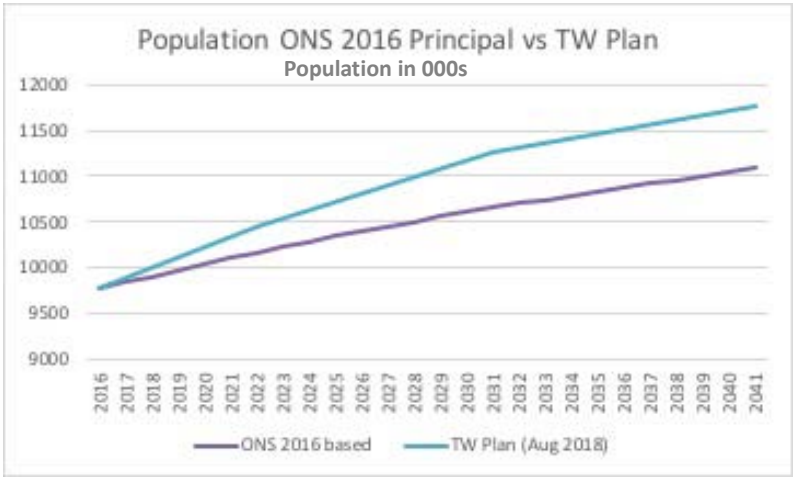
We have also commented on the water company rebuttals of our comments in their Statements of Response to the WRMP consultations. We hope that our findings will be reviewed and properly taken into account in WRSE's current work on regional demand forecasting.

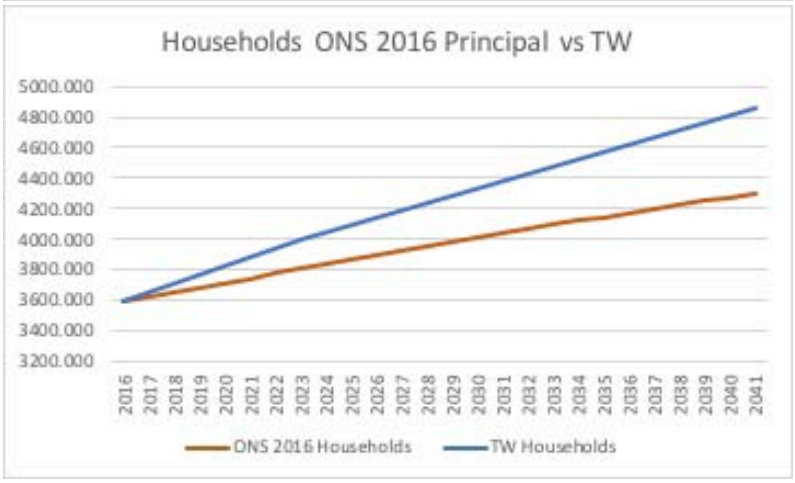
2.3 Population forecasts

Thames Water's WRMP population forecasts

GARD commented in detail on Thames Water's population forecasts in our response to the

consultation on the revised WRMP[6]. We showed the large differences between Thames Water's forecasts of population and households in 2041, compared with growth forecast using Office of National Statistics growth rates for the South East, as shown below:





	2016/17	2041/42	Increase
Population			
ONS 2016 Principal based	9,779,115	11,085,000	1,305,885
TW Plan based	9,779,115	11,755,000	1,975,885
Population difference			**670,000**
Households			
ONS 2016 Principal based	3,602,900	4,298,576	695,676
TW plan based	3,602,900	4,860,000	1,257,100
Household difference			**561,424**

Figure 4 - Differences between TW and ONS population and household growth to 2041

There are similarly large differences in Thames Water and ONS-based population forecasts to 2100 as shown in Figure 5:

[6] GARD response to TW's consultation on the revised WRMP, pages 21-29 http://www.gard-oxon.org.uk/downloads/GARD%20%20response%20to%202nd%20Consultation%20on%20TW%20draft%20WRMP%20Rev%2029.11.18.pdf

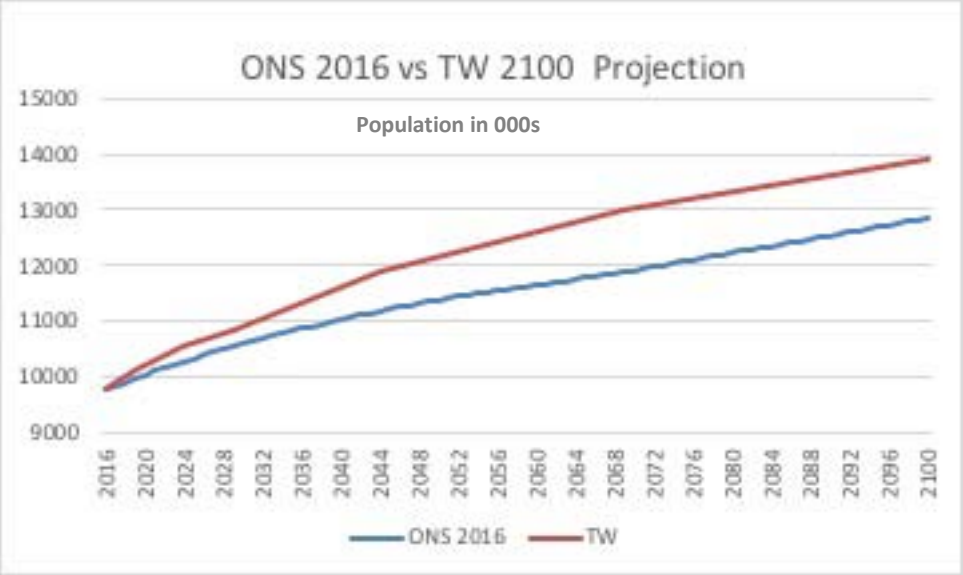


Figure 5 - Comparison of TW and ONS-based population forecasts to 2100

The differences between Thames Water's forecasts and those based on the ONS growth rates for the South East are so large that TW's forecasts cannot be considered to have been credible, even in 2018, prior to Brexit and new Government focus on growth in the north of England. We consider the flaws in Thames Water's forecasts to have been:

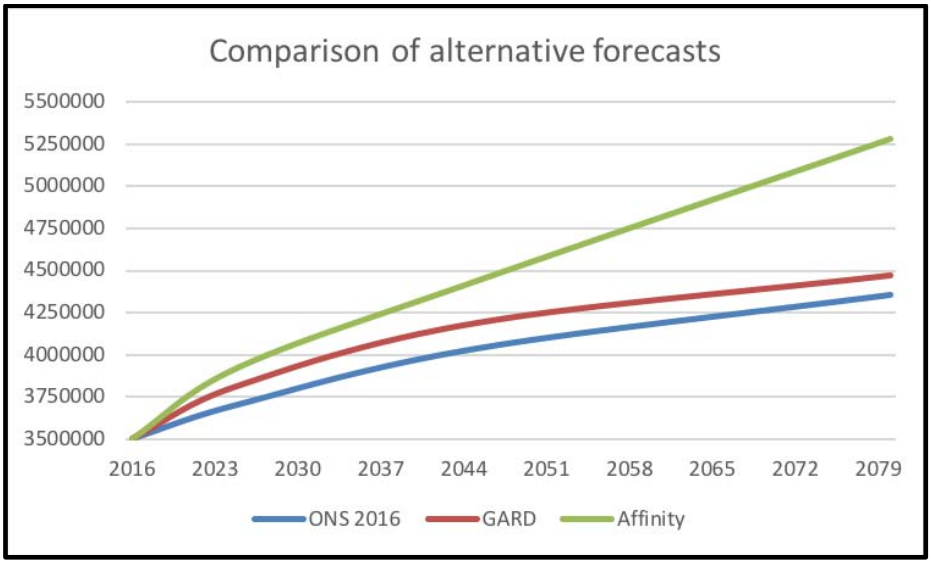
- Assumptions that every new house projected in a local development plan will actually get built, with no allowance for historic failure to meet housing targets.
- Assumptions of upper limits of forecasts for fertility, longevity and immigration, ignoring signs that growth in all three may have stalled.

In our consultation response we concluded that Thames Water's population forecasts were over-inflated by 670,000 in 2045 and 1,060,000 in 2100. Assuming per capita consumption of 125 l/head/day, this corresponds to inflation of demands by 84 Ml/d in 2045 and 132 Ml/d in 2100, from over-forecasting population growth.

Affinity Water's WRMP population forecasts

GARD also commented in detail on Affinity Water's population forecasts in our response to the consultation on their revised WRMP[7]. Using the Office of National Statistics forecast growth rates for the South East, we concluded that Affinity's population forecasts were substantially over-inflated as shown below:

[7] GARD response to TW's consultation on the revised WRMP, pages 17-26 http://www.gard-oxon.org.uk/downloads/GARD%20response%20to%20Affinity%20final%20-v3-23-04-19.pdf



COMPARISON OF ESTIMATES	Source of estimate	Base year population	Total population forecast by 2024/25	% increase by 2024/25	Total population forecast by 2044/45	% increase by 2044/45	Total population forecast by 2079/80	% increase by 2079/80
Total of WRZ 1-8	ONS 2016	3,506,516	3,709,893	5.8%	4,039,506	15.2%	4,358,599	24.3%
	GARD	3,506,516	3,821,501	9%	4,191,350	19%	4,474,430	28%
	rdWRMP	3,506,516	3,930,182	12%	4,440,157	27%	5,284,792	51%
Difference between Affinity and GARD calculation			108,681		248,807		810,362	

Figure 6 - Comparison of ONS 2016, GARD and Affinity population forecasts

As with Thames Water's population forecasts, Affinity's forecasts appear excessive due to lack of realism in local authority development plans and failure to recognise changing immigration and fertility rates and slow-down in mortality improvements. At a PCC assumption of 120 l/head/day, the over-inflation of population forecasts corresponds to excess demand forecasts of 31 Ml/d in 2045 and 97 Ml/d in 2080.

Thames Water and Affinity Water's responses to GARD's criticism of population forecasts

In their final WRMP, Thames Water rejected GARD's criticisms and made no significant changes to their population forecasts. Similarly, Affinity Water rejected all of GARD's points.

GARD rebuttal of TW and Affinity SoR and proposals for population growth forecasts in WRSE's current demand review

Since neither Thames Water nor Affinity Water accepted GARD's arguments on population in our response to their WRMP, it is worth restating some of the basic concepts underlying our calculations. GARD has not developed complex population models. Instead, as noted, we simply apply ONS principal population projection growth rates (regional or sub-regional as appropriate) to a water company's starting population or household figures and calculate

expected population numbers at intervals over time. This is then compared with the water company projection as a 'sanity check'. Where the projections differ, we try to understand why, considering the evidence produced by each company. Where company arguments for increase above ONS are reasonable, we incorporate them into our figures. This can be seen in Figure 6, where the resultant GARD calculation lies between the ONS and Affinity projections. We also examine the range of ONS variants to consider how high, or low, these projections might be, using different assumptions for immigration, fertility and death rates. It is notable that, over the last few years of ONS future projections, numbers have fallen with each new update as the fertility rate continues to fall and the mortality rate rises. This contrasts with water company projections that seem to increase with each update.

Our calculations also take account of the key points raised by the ONS statistician with each update. In its latest population estimates for the UK and England,[8] the ONS notes that:

1. The UK population grew by only 0.6% between mid-2017 and mid-2018, the same rate of growth as in the previous year.
2. In the year to mid-2018, there were fewer births (negative 2%) and more deaths (positive 3%) than in the last year; natural change was at its lowest since 2004.
3. In the last two years, population growth in the UK has been at its lowest rate since 2004. For the fifth year in a row, net international migration was a bigger driver of population change than births and deaths.
4. Net international migration in the year to mid-2018 was 275,000, which was 6,000 higher than the average for the past five years
5. In the 12 months to mid-2018, the four local authorities with the fastest-growing populations were all in central London (City of London, Westminster, Camden and Tower Hamlets); the relatively high level of population growth in these areas is partly a reflection of the increase in net international migration between mid-2017 and mid-2018.
6. However, overall population change to the year mid-2018 has remained fairly stable as an increase in net international migration has been roughly matched by the fewest births in over a decade and the highest number of deaths since the turn of the century.

Selectively choosing the 1st, 2nd and 3rd points, it is easy to argue that population growth, and hence demand increase, will be low. Selectively choosing points 4 and 5 bolsters the argument that population growth, and hence demand increase, will be high. The final comment, however, sets both arguments in perspective.

It can be seen from figures 4, 5 and 6 that both the Thames Water and Affinity Water models

[8] Population estimates for the UK, England and Wales, Scotland and Northern Ireland: mid 2018 dated 26 June 2019

assume a much higher growth rate over the next 5 years than the ONS. This runs directly counter to the points made by the ONS statistician, particularly point 3, which notes that for the last 2 years growth has been at its lowest rate since 2004. The next point, that the 4 fastest growing local authorities are all in London, has frequently been used to argue the South East as a special case and that it outgrows the rest of England. Of the 4 local authorities quoted, it is worth noting that whatever the City of London growth rate, with a population of only 8,500 in 2018, it is insignificant to the overall numbers. The last 3 authorities are clearly larger at around 250,000 each, but while high growth rates in these areas might cause local supply issues for their water company, the effect when considering the South East as a single water system is minor.

The case for making the South East an exception is further undermined by examination of the growth figures for England and the South East over the last 10 years as shown below:

	England Annual %age	**South East Annual %age**
2009	0.74	0.77
2010	0.85	1.02
2011	0.88	0.87
2012	0.73	0.83
2013	0.70	0.78
2014	0.83	0.92
2015	0.86	0.85
2016	0.87	0.90
2017	0.64	0.56
2018	0.64	0.58

Table 2 - Comparative annual growth rates England and the South East

It can be seen that the South East rate of growth in 3 out of the last 5 years has been below that of England and generally falling. The average growth rate for England over the last 5 years is 0.77% and for the South East 0.76%. Whether this alignment is temporary as a result of Brexit, or other factors, remains to be seen with future updates.

By basing forecasts solely on local authority plans, water companies ignore the reality that in Oxfordshire, as just one example, the historical build rate is around only 40% of planned (CPRE calculated figures). It is inevitable that any figures calculated by this methodology will overestimate actual growth rates. We understand that in Wales, ONS projections are used to plan for future population growth and that this works well. We acknowledge that Ofwat specifies using local area plans as the starting point for population projections, and this is often quoted at us by water companies. However, our own discussions with Ofwat makes it clear that water companies should conduct their own sanity check on their figures (using historical data, ONS projections etc) and that revision, accompanied by supporting evidence, would be acceptable. We don't understand why water companies consistently refuse to follow this approach since, from an economic point of view, over provision and the

associated waste of resources and capital is as bad as under-provision.

Another key factor to consider is that, by consistently using projections at the high end of probability, water companies are undermining the headroom calculation. The headroom calculation is based on the assumption that for each factor considered, the most likely outcome is chosen. It would be entirely reasonable in this case, to calculate a safety margin that covers a worse out turn. On the contrary, if the highest projection is chosen, any headroom calculation applied will be larger than necessary as it is applied to both the expected case and the excess.

We would like any WRSE population section to include justification, with supporting evidence, as to why any projection that is higher than the ONS principal projection is credible. This should include a full determination of the economic and environmental costs of adopting projections that are likely to result in unnecessary excess capacity. The discussion should indicate where the WRSE projection is believed to lie in the range between ONS low and high projections, so that Ofwat and stakeholders can more easily determine the probability of such an outcome. This should lead to a more sensible discussion on whether headroom is already included in the calculation or further addition is justified.

Whatever figures are chosen by WRSE for the assumed South East population projection, it is likely that they will need to be revised down quickly. Political factors mitigating against previously expected growth in the area include Brexit, the shift to rebalancing with the North, expectations of reduced overall immigration and the economic effects of the corona virus pandemic. The latter is likely to have considerably reduced the rate of immigration for 2020, possibly beyond, and will have economic effects that may last for several years.

2.4 PCC forecasts

Introduction

WRSE's deficit forecast appears to have used the per capita consumption (PCC) forecasts in the water companies' WRMPs[9]:

> *"We have forecast per capita and leakage using the water companies' projections, which take account of the long-term reductions from schemes delivered by 2025. The National Framework has fixed these at 2024/25 levels and considered three scenarios for per capita consumption and leakage up to 2050."*

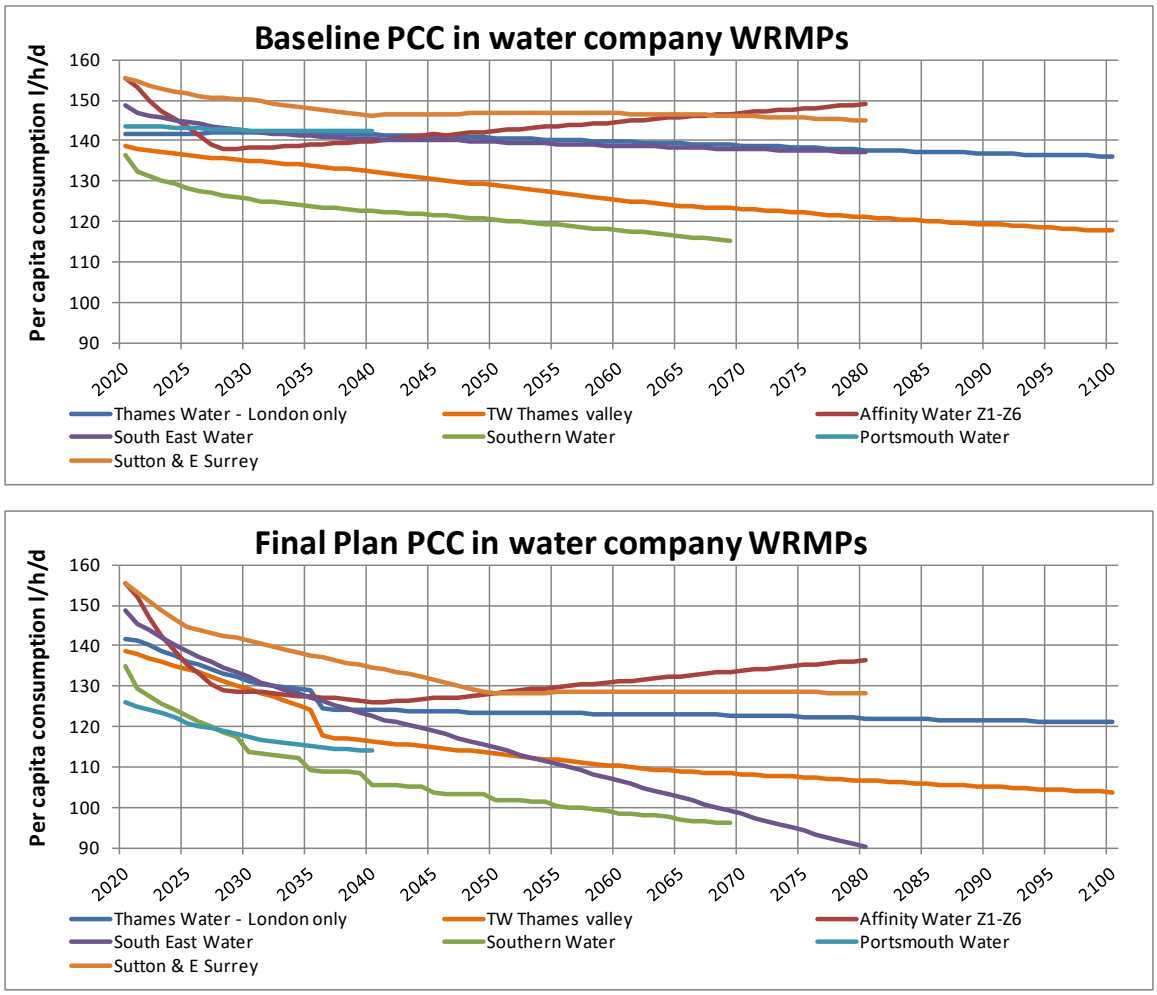
Although WRSE have acknowledged that the EA used a scenario approach for the National Framework report, there is no explanation of why they have not also considered scenarios of demand saving. Neither does WRSE's report suggest their follow-up studies will consider scenarios of demand saving, for example the extent and effectiveness of smart metering.

[9] WRSE Report, page 16

The EA's National Framework report says that *"Regional groups should contribute to a national ambition on average PCC of 110 l/p/d by 2050 - this should be reviewed every 5 years".* The WRMPs of Thames Water and Affinity did not match this ambition, so we assume that WRSE's PCC forecasts have also failed to match the EA's ambition, with no explanation or justification offered in the report.

Comparison of PCC and meter penetration forecasts in WRMPs

GARD's analysis of the published final WRMP tables of the six water companies shows there are big variations in the forecast per capita consumption, both in the Baseline forecasts and the Final Plan forecasts which allow for additional demand management measures, as shown below:



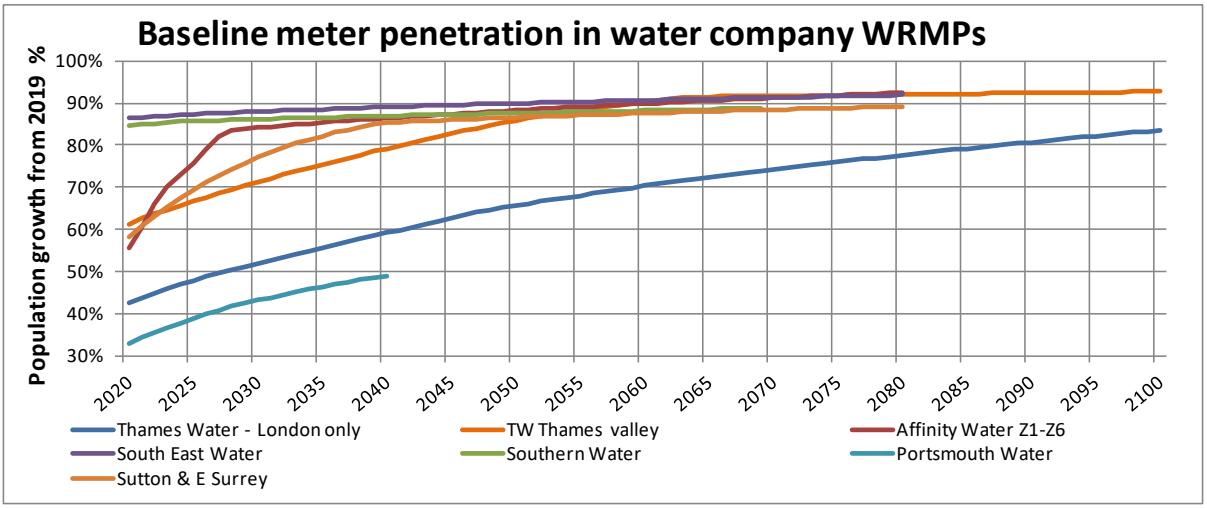
Notes: 1. TW Thames valley zones comprise SWOX, SWA, Kennet Valley, Henley and Guildford
2. Affinity zones Z7 and Z8 are excluded because they are outside the Thames valley
3. Water company figure are numeric average of zones without taking account of household numbers

Figure 7 - Comparison of water company PCC forecasts

The inconsistencies in the water companies PCC projections raise a lot of questions, which we believe should be addressed by WRSE, for example:

- Would Thames Water's PCC in London be a lot less than 124 l/h/d by 2040, if meter penetration was more than 75%, with smart meters and tariff structured tariffs?
- Why are the PCCs for Thames Water's Thames valley zones, much higher than Southern Water's forecast PCCs?
- Why does Affinity's plan, for both the baseline and final plan forecasts, show rapid reduction in PCC in the early years, although never less than 130 l/h/d, and substantial increases thereafter?
- Noting that most of the water companies' supply zones outside London are broadly comparable in terms of demography, geography and economy, why are there such big differences in forecast PCC?
- Is the 'straight line' reduction in South East Water's PCC realistic?

These questions cannot simply be answered by differences in the metering ambitions of the water companies, as shown below:



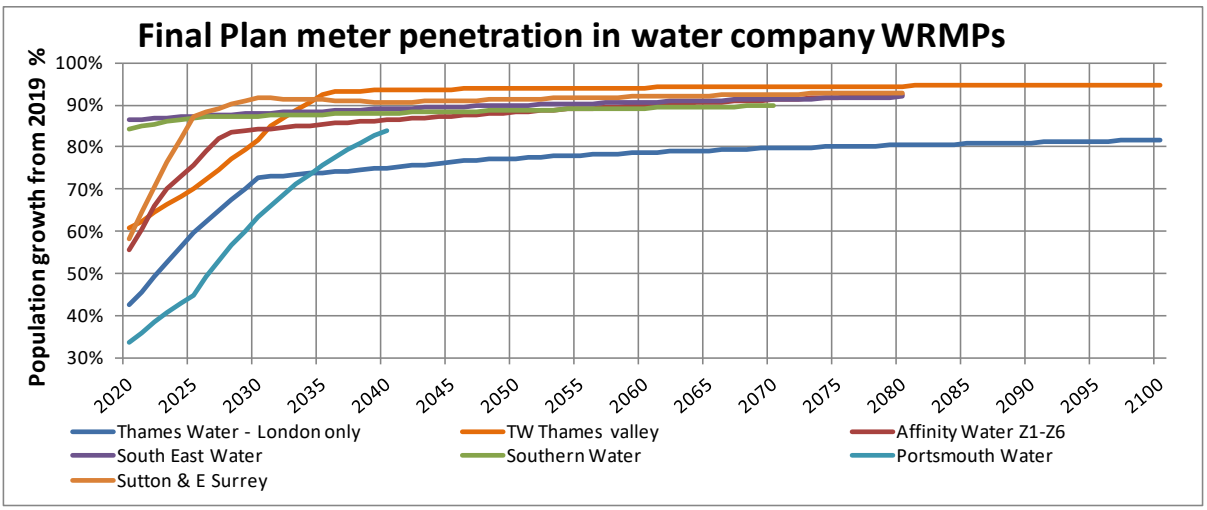


Figure 8 - Comparison of water company metering projections in WRMPs

The meter penetration plots raise more questions;

- As all companies are projecting meter penetration outside London of around 90% by 2035, why are there such big variations in Final Plan PCC?
- Noting that Southern Water already have meter penetration approaching 90%, how are they able to forecast PCC continuing to fall to below 100 l/h/d?
- Why are other water companies outside London not able to achieve similarly low PCCs, when they increase meter penetration to around 90%?
- Is this due to widely variation assumptions about the use and effectiveness of smart metering?

In our opinion, WRSE's report should have answered these questions, or explained how they will be addressed in the current investigations.

GARD's comments on PPC in consultation responses to TW and Affinity's WRMPs

GARD raised numerous similar questions about Thames Water and Affinity's PCC forecasts in our consultation responses to their WRMPs[10] [11]. For example, we pointed out Thames Water's repeated under-estimation of the effectiveness of metering in successive versions of their WRMPs since WRMP09, as shown below:

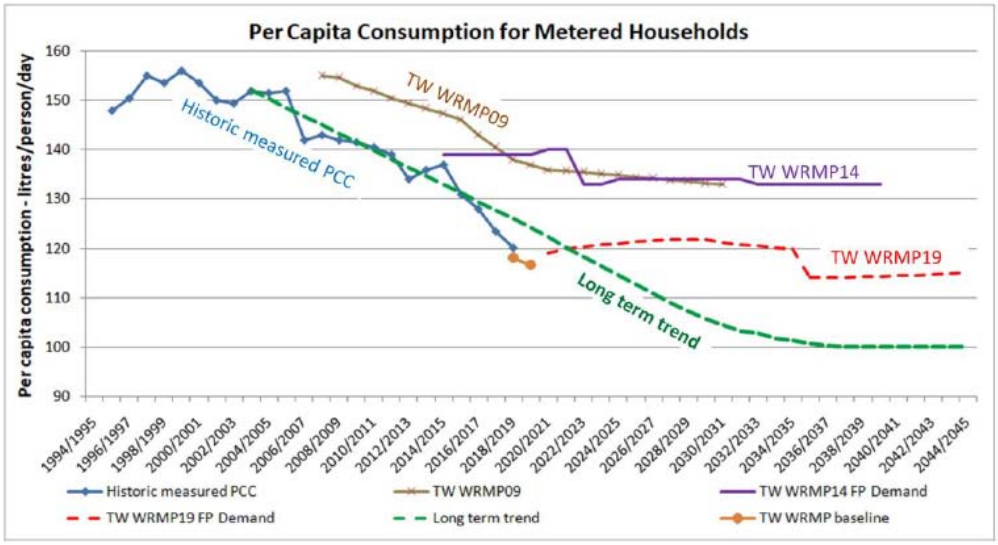


Figure 9 - Thames Water's underestimation of metered PCC in successive WRMPs

TW actual measured PCC has been taken from several sources.[12] [13] [14] As can be seen in Figure 9 the WRMP forecasts have been consistently about 10 l/h/d above the actual measured PCC, widening in recent years to nearly 20 l/h/d greater. The actual measured PCC

[10] GARD response to TW's 2nd dWRMP consultation, pages 29-35
[11] GARD response to Affinity's 2nd WRMP consultation, pages 26-34
[12] TW Water Resources Forum 5th October 2012 image 13.
[13] FT online Consumption in the Thames Water region
[14] Thames Water WRMP tables

in 2016/17 was about 120 l/h/d[15]. Thus effectively after only four years of WRMP14, both baseline model and final plan had over-forecasted the measured PCC, even the lower final plan by about 19 l/h/d. This shows that Thames has over-forecast PCC by large amounts, even in the short-term let alone the medium to long term.

Thames Water are forecasting a fall of about 5 l/h/d in 2035 when incentive tariffs are to be introduced. However, this does not appear to take into account that the future meters will not be dumb meters but smart meters giving lower PCC. With smart meters and incentive tariffs, we believe that the general downward trend in TW's measured PCC shown in Figure 9 will continue, albeit at a slower rate. This would put Thames Water's PCC in the region of 100-110 l/h/d, which would be in line with the EA's National Framework target of 110 l/h/d[16], and the forecast PCCs of other companies like Southern Water and United Utilities.

We made similar comments on Affinity's PCC assumptions, also pointing out large differences in assumptions for different zones in their Central Region, as shown below:

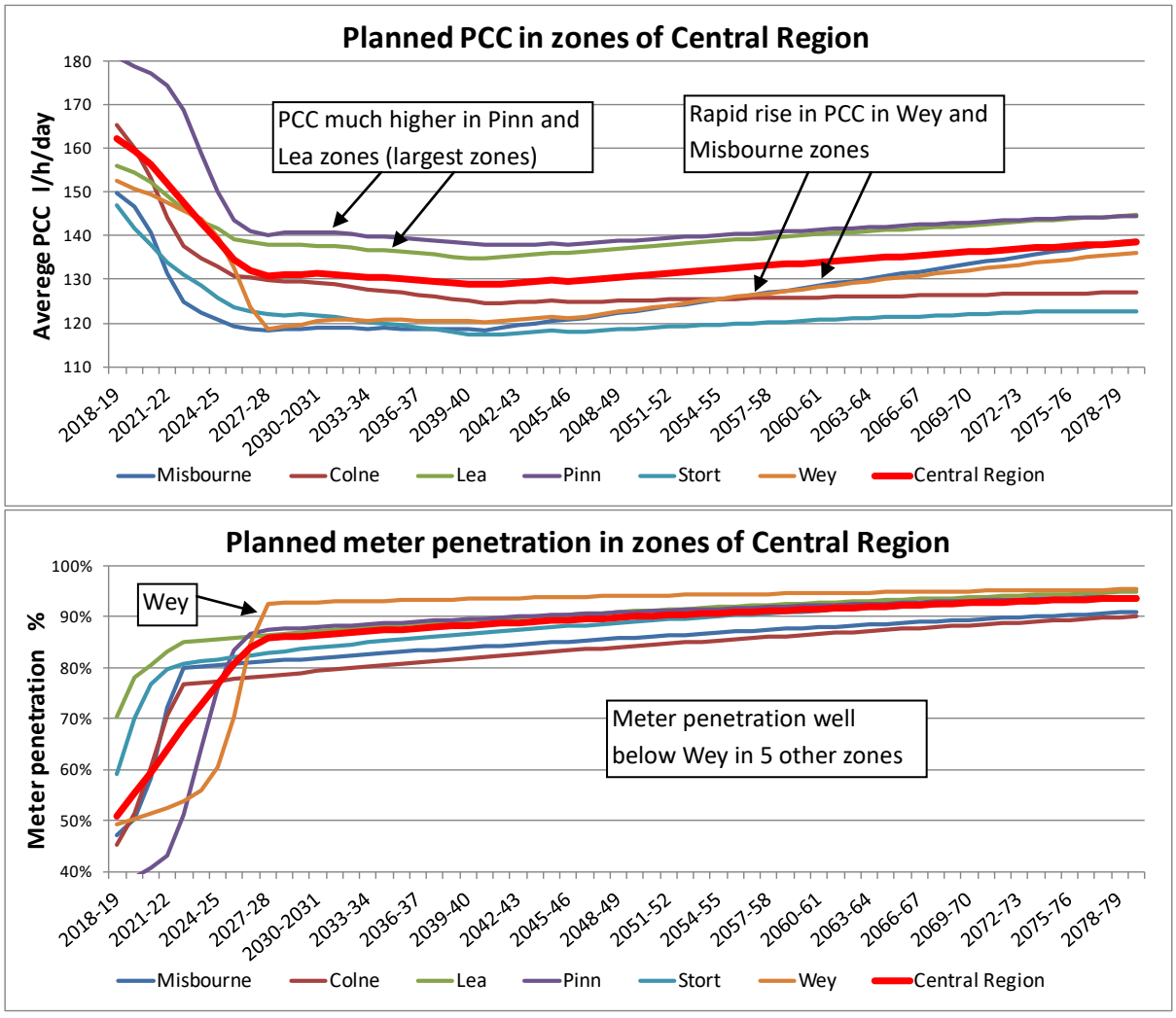


Figure 10 - Affinity's Final Plan PCC and metering assumptions by zone

[15] Thames Water WRMP Tables
[16] EA National Framework report, page 10 and Table 3 on page 65

This shows significant differences between the zones and raises a number of questions:

- Why is meter penetration much higher in Wey zone than all the others?
- If over 90% meter penetration is achievable in Wey zone, why not in the others?
- Why is PCC much higher in the Pinn and Lea zones, the two largest zones?
- Why are any zones showing growth in PCC?
- Why is the PCC growth in Wey and Misbourne zones, much higher than the others?

In GARD's opinion, there should be consistency of assumptions between zones, with the poorer performing zones brought in line with the others, and with all striving for industry best practice.

We consider that a level of approaching 100 l/h/d for measured PCC post 2035 would be a reasonable assumption, at least as one of several planning scenarios. This would be consistent with Southern Water's 'Target 100' in their WRMP, which aims to achieve PCC of 100 l/h/d by 2040. We also note that United Utilities in its largely urbanised Strategic Zone are forecasting a 2045 measured demand of 103 l/h/d.

Thames Water and Affinity responses to GARD's criticisms of PCC forecasts

Both water companies brushed aside GARD's criticisms in the Statements of Response to the consultations. For example, in addressing GARD's point about the over-estimation of measured PCC in successive WRMPs, Thames Water responded[17]:

> *"As answered earlier this is a different model to that used for both WRMP09 and WRMP14. While GARD are happy to highlight the overestimation of measured PCC it is more informative to look at the prediction of household demand. As is clearly shown when comparing outturn consumption with forecast values it can be seen that these models underestimate total household consumption.*
>
> *A key failing of micro-component was that they were never validated statistically but yet their use was mandated. The new models developed using multiple linear regression have been validated and we expect their predictive ability to be significantly better than previous micro-component models."*

To answer GARD's assertion that Thames Water should aim to achieve PCCs in the region of 100-110 l/h/d, in line with the EA's National Framework target, Thames Water responded[18]:

> *"GARD have provided no evidence to support their prediction for PCC. We have laid out the reasoning behind our trend adjustments to PCC within Section 3 of our revised draft WRMP, paragraphs 3.177 - 3.181 and consider this ongoing trend to represent a pragmatic approach to forecasting future PCC."*

[17] Thames Water Statement of Response to 2nd WRMP consultation, Appendix H, page 190
[18] Ibid, page 191

In their Statement of Response, Affinity have been similarly dismissive of GARD's criticism of their PCC forecasts, for example[19]:

> *"Therefore, although we are planning on delivering 80% meter penetration by 2025, which represents a lower target than at the dWRMP19, we still plan to achieve 90% penetration by 2045. At the time of the first strategic resource development (2038) we are only planning to deliver 3Ml/d less than the ultimate 2045 meter programme saving. We do not therefore consider that this contributes to a 'gross over-estimate' of demand."*

We note that the figures quoted above are incorrect for their Central Region, where the forecast meter penetration is 76% in 2025 and 87% in 2045. Affinity's Statement of Response then says:

> *"As a result we are planning to reduce our PCC to 129 litres per head per day (l/h/d) by 2025, from 152l/h/d in the base year. This is the largest PCC reduction in the industry for this period. Significant additional explanation and quantification has been added to Chapter 6 of the fWRMP19 to demonstrate how we will meet the 129 l/h/d AMP7 target and the strategy beyond that. "*

Again, we note the figures quoted are not correct for the Central Region for which forecast Final Plan PCC is 135 l/h/d in 2025, reaches a minimum of 126 l/h/d in 2041 and then rises steadily to 136 l/h/d by 2080. Affinity have not explained why they are not able to reach the PCC levels achieved by other water companies, or the large differences in projected PCCs for their own zones in the Central region. There is no justification of the rises of PCC in their Wey and Misbourne zones to about 140 l/h/d by 2080.

GARD suggestions for WRSE's further work on forecasting PCC

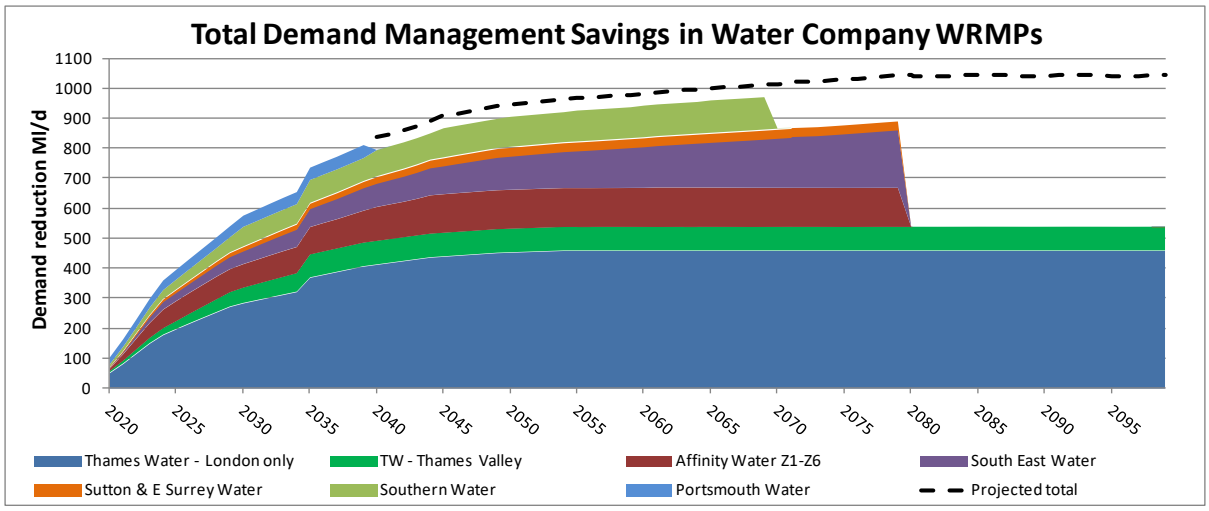
Our analysis above shows that there are large differences in demand management aspirations amongst the water companies of the South East Region. It is apparent from Thames Water and Affinity Statements of Response to GARD's comments on their WRMPs, that they have no intention of changing their present PCC forecasts, achieving the EA's National Framework target of 110 l/h/d or aligning their forecasts with approaches by other companies projecting lower PCCs.

Therefore we think it is important that, in preparing demand forecasts for the South East Region, WRSE should independently review all the water company PCC forecasts, not merely accepting what is in the WRMPs. There should consistency of approach between all the water companies and deviations from the 110 l/h/d target should be analysed and justified.

2.5 Demand management measures

The six water companies are forecasting that demand management measures will reduce total regional demand by about 900 Ml/d by 2045 and 1040 Ml/d by 2100, as shown below:

[19] Affinity Statement of Response to 2nd WRMP consultation, Appendix 22, page 2



Note: the savings are the differences between baseline and final plan distribution inputs in the WRMP tables

Figure 11 - Demand savings from measures planned in WRMPs

If these demand reductions are viewed as % of water into supply, they reveal large differences in the amount of demand reduction and rate of improvement planned by each company:

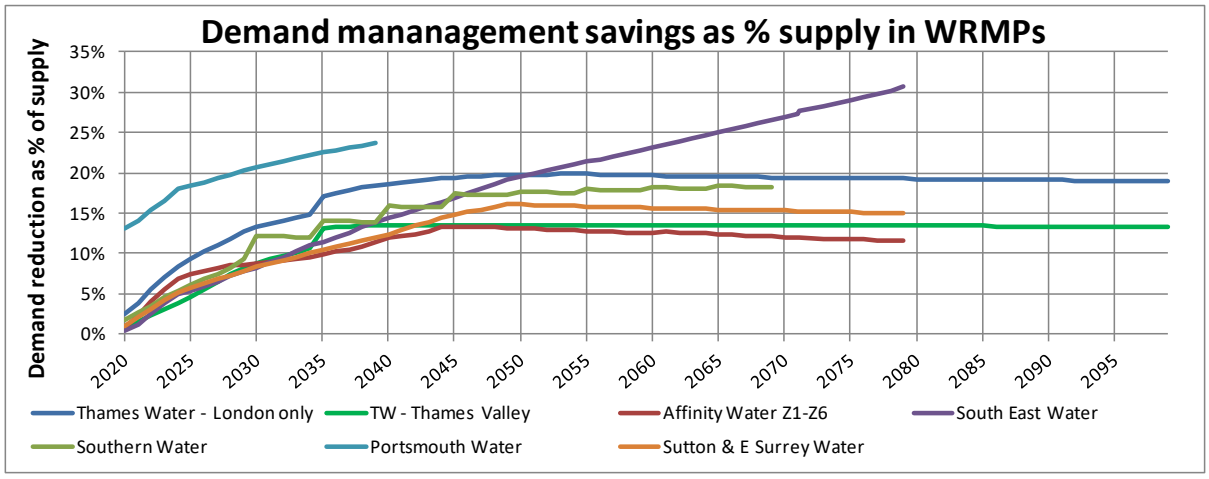


Figure 12 - Variations in planned WRMP demand saving as % of supplies

Some observations on the comparative performance of the companies shown in Figure 12:

1. Although Thames Water's forecast % reduction of demands in London has a similar profile to Southern Water's forecast, Thames Water are starting from much higher levels of PCC and lower meter penetration. If Southern Water can continue to achieve demand savings, despite their already high meter penetration, why can Thames Water not achieve more in London and continue to get improvements beyond 2040?

2. Why are Affinity showing a reduction in % savings beyond 2045? They are forecasting large increases in population and housing growth, so the new housing stock would be better able to benefit from smart meters and tariff structuring.

3. Why is South East Water able to forecast continuously rising demand savings through to 2080, whereas Thames Water and Affinity's zones in the Thames valley show almost no savings beyond 2045, or even reductions in savings?

In our opinion, WRSE should not accept the demand reduction forecasts in the WRMPs without question, as appears to be the case from the report[20]:

> *"We have forecast per capita and leakage using the water companies' projections, which take account of the long-term reductions from schemes delivered by 2025."*

We think that WRSE should critically review the demand management proposals in the WRMPs to understand where differences lie, whether there are good reasons to justify differences and where there is scope for improvement. In Section 2.3, we have shown some examples of large differences in company plans for meter penetration and estimates of PCC reductions. We believe there are similar discrepancies in company plans for leakage reduction.

Figure 13 shows the total planned regional demand savings from Figure 11, split into leakage savings and customer demand reductions:

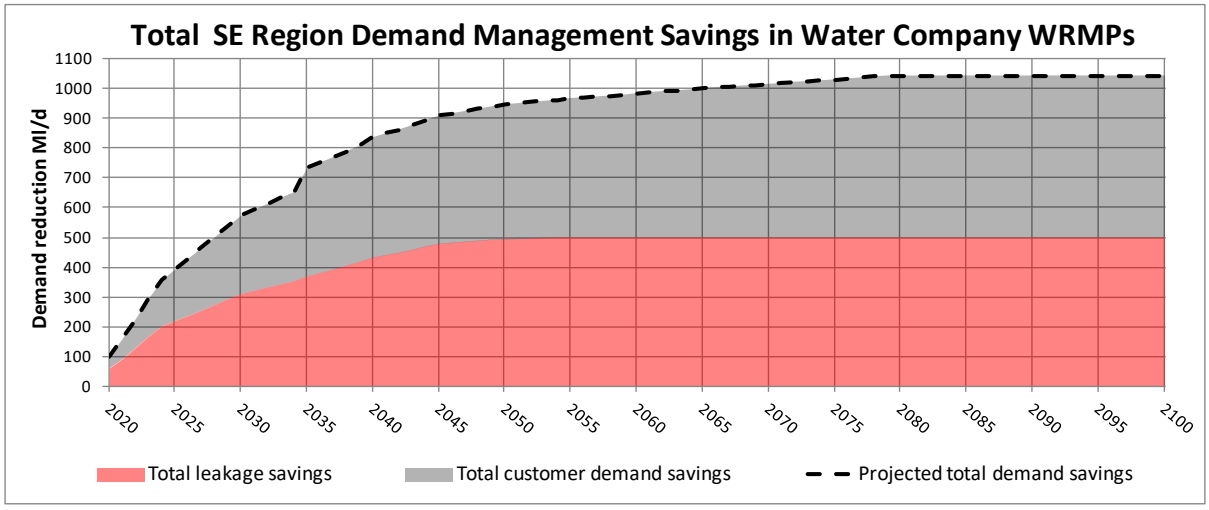


Figure 13 - Share of planned demand savings between leakage and customer demands

The forecast demand savings are shared more or less equally between leakage savings and customer demand reductions. In Section 2.3, we have shown that there a big differences between the six water companies' forecasts of reductions in customer demands.

There are also large differences in the water companies' plans for leakage savings. This is apparent from Figure 14, which shows leakage savings as litres/property/day[21]:

[20] WRSE Report, page 16
[21] All leakage figures taken from Tables '2 BL Supplies' in the WRMPs

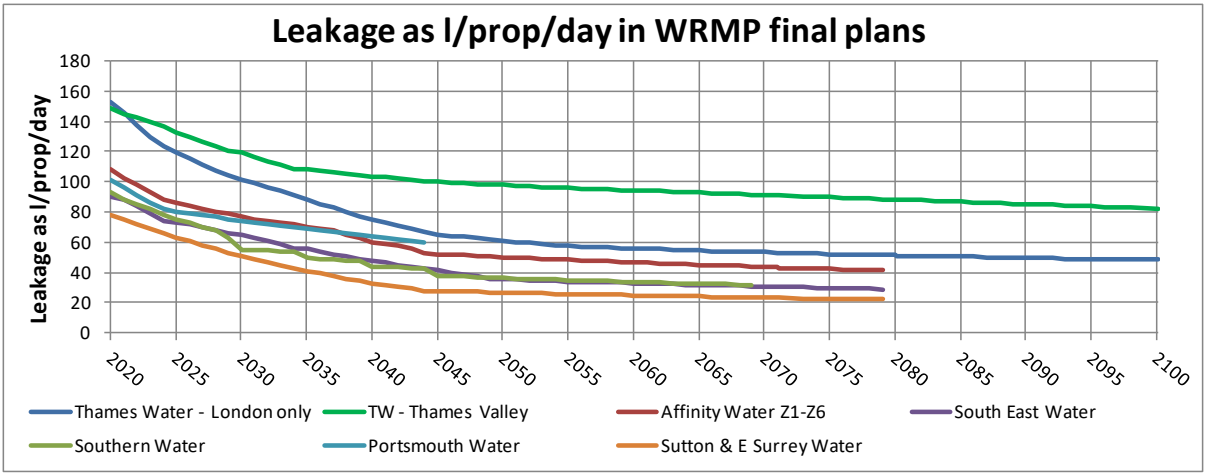


Figure 14 - Differences in water company demand reduction forecasts

There are also large differences in compliance with the Government's target of 50% reduction in leakage by 2050, as shown in Figure 15:

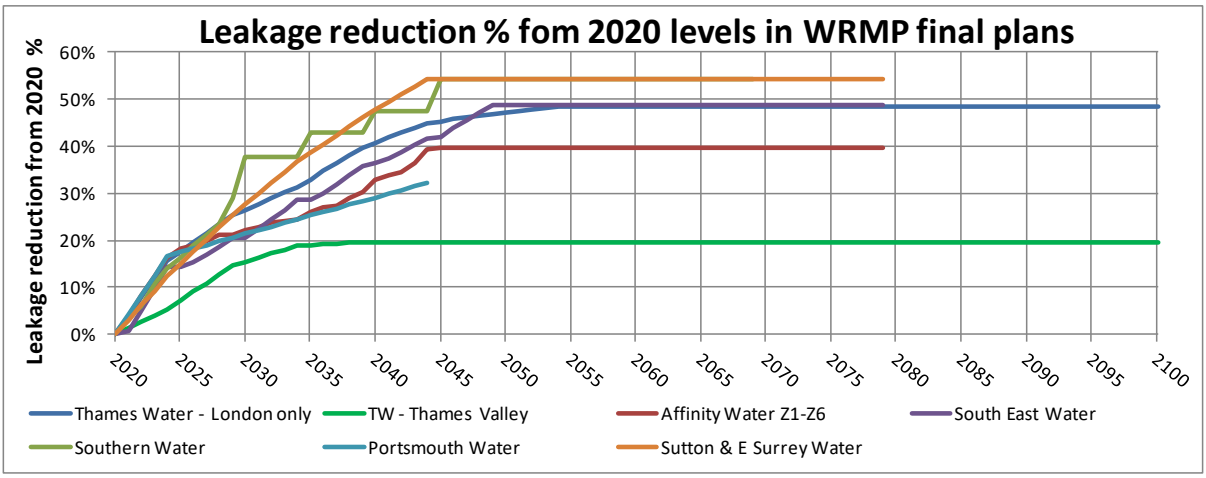


Figure 15 - Compliance with Government's 50% leakage reduction target

It is evident from Figure 15 that there are big differences in the ambition and effectiveness of the six companies' plans for leakage reduction:

1. Thames Water's Thames valley zones have much less planned leakage reduction than the reductions of other companies outside London, and fall far short of the Government's 50% leakage reduction target, maintaining leakage levels per property more than double the planned leakage per property of Southern Water, South East Water and Sutton & East Surry Water. Thames Water appear to justify this through least cost analysis[22], but this does not take account of:
    - Benefits of reduced abstraction for rivers, especially chalk streams
    - Additional water made available for chalk stream abstraction relief
    - Potentially more water available for London's supplies

[22] TW revised draft WRMP, Section 10, page 38

2. Portsmouth Water also show relatively small leakage reductions, well short of the 50% reduction target and retaining high levels of leakage per property.

3. Although Thames Water's London zone achieves the 50% reduction target (starting from a very high level of leakage), the final level of leakage per property is still about double the leakage of Southern Water, South East Water and Sutton and East Surrey

4. Affinity Water miss the 50% reduction target and continue with levels of leakage per property about 50% higher than Southern Water, South East Water and Sutton and East Surrey.

In our opinion, WRSE should challenge the water companies' leakage projections, aiming for a consistency of approach across the South East region. Target levels of leakage should be driven not merely by least cost, but should take into account the environmental benefits, particularly for chalk streams.

Table 2 shows the potential further leakage savings in the Thames valley, if Thames Water and Affinity Water's Thames valley zones match the 36 l/prop/day leakage planned by South East Water and Southern Water in 2050:

	Thames valley potential further leakage savings in 2050			
	WRMP planned leakage Ml/d	**2050 planned l/prop/day**	**Leakage at 36 l/p/d in Ml/d**	**Further saving Ml/d**
TW Thames valley zones	112.1	85.7	47.1	**65.0**
Affinity Central Region zones	87.9	50.6	62.5	**25.4**

Table 3 - Potential further leakage savings in the Thames valley

The combined leakage saving of 90 Ml/d in the Thames valley would go a long way towards solving the chronic problem of over-abstraction of chalk streams in the Thames valley, as well as generating more water in the lower Thames for supplying London.

2.6 Environmental reductions

The six water companies' WRMPs include only a modest amount of sustainability reductions as shown in Figure 16[23]:

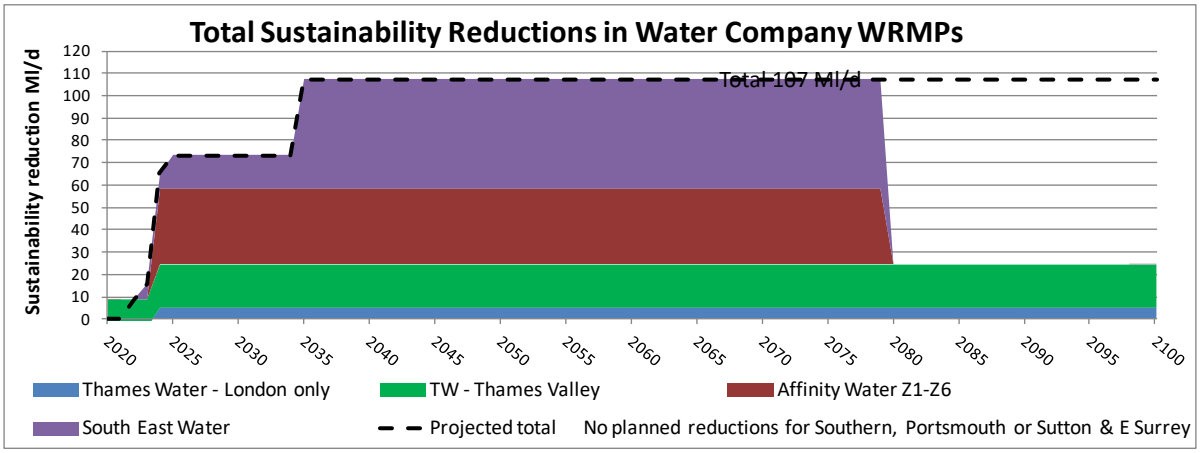


Figure 16 - Sustainability reductions included in the WRMPs

WRSE's Table 1 shows 274 Ml/d of Environmental Protection, starting in 2040. We assume that this would be in addition to the 107 Ml/d of Sustainability Reductions already in the WRMPS as shown in Figure 16 – about 380 Ml/d in total. This seems to us a very large allowance, which has not been justified by any supporting evidence in the WRSE's report. WRSE's report, page 13, suggests that the loss of supply could be up to 998 Ml/d – this seems highly improbable and WRSE should show evidence of its basis.

GARD fully recognises and supports the need for sustainability reductions. The concept for the 'Chalk Streams First' proposal[24], which is being pursued by a coalition of chalk stream interests, is similar to the proposal made by GARD in our response to Affinity's second WRMP consultation[25]. A fundamental part of the Chalk Streams First proposal is that perhaps 80% of the water needed by the sustainability reductions would be generated by the enhanced chalk stream flows becoming available to supply London, via abstractions from the lower Rivers Thames and Lea.

Therefore, we think it is incorrect and misleading for WRSE to show these large sustainability reductions as fully contributing to the forecast deficit in the South East region, without making allowance for the water resource benefits of the enhanced chalk stream flows, or even recognising that the amount of returns needs to be investigated in detail.

Aside from the Chilterns chalk sustainability reductions, there are other aspects of the sustainability reductions which need to be taken into account in evaluating their impact on the South East regional deficit:

[23] Sustainability reduction data from Tables '2. BL Supply' in WRMPs

[24] Chalk Streams First' report by Charles Rangeley-Wilson for Angling Trust, Rivers Trust, Salmon & Trout Conservation, Wild Trout Trust and WWF UK, February 2020 https://chalkstreams.files.wordpress.com/2020/04/chalk-streams-first-v3.5-final.pdf

[25] GARD response to Affinity's 2nd WRMP consultation, pages 59-74

1. Most of the 33 Ml/d of Affinity's planned sustainability reductions are enabled by the planned import of 25 Ml/d from Grafham reservoir in 2025. The consequent improved chalk stream flows would become available in the lower rivers Thames and Lea for supplying London – about 20 Ml/d. We understand this has not been taken into account in the WRMP supply-demand balances, so presumably not in WRSE's deficit forecasts.

2. Similarly, most of the chalk stream sustainability reductions already allowed for in the WRMPs for Thames Water's Thames valley zones and South East Water would create enhanced chalk stream flows that would become available for supplying London. We do not think this has been allowed for in the WRMP deficits or WRSE's Table 1.

3. Any part of WRSE's suggested 274 Ml/d of additional sustainability reductions that is in the Thames valley would create enhance flows available for London's supplies, so this needs to be allowed for in WRSE's deficit forecasts.

4. In 2040, when WRSE are forecasting the need for a further 274 Ml/d of sustainability reductions, the WRMP's planned total demand reductions in the South East region outside London total 403 Ml/d. We have suggested in Table 2 that there could be another 90 Ml/d of leakage savings in the Thames valley if leakage reductions planed by Thames Water and Affinity comply with the Government's 50% reduction target and match leakage rates planned by other companies. This would amount to a total regional demand saving of almost 500 Ml/d outside London, all of which would reduce impacts on river flows. Has this been taken into account by WRSE in postulating the need for a further 274 Ml/d of sustainability reductions, adding directly to the regional deficit?

5. For example, if planned leakage in Thames Water's Swindon and Oxford zone (SWOX) in 2040 is reduced from 78 l/prop/day to 48 l/prop/day, as targeted by Southern and South East Water by 2040, SWOX demand would be reduced by 18 Ml/d. The water saved would enable Swindon to be supplied entirely from Farmoor reservoir, eliminating the need for the present supply of about 12 Ml/d to Swindon from the upper Kennet chalk. There would then be an enhanced River Kennet flow of about 10 Ml/d which would become available in the lower Thames to supply London.

6. We presume that some of the 274 Ml/d of sustainability reductions will be in the upper parts of the Test and Itchen catchments. The enhanced chalk stream flows would become available in the lower Rivers Test and Itchen for supplying Southampton and Portsmouth. The planned construction of Havant Thicket reservoir by 2030 would help to maximise the potential benefits of the enhanced chalk stream flows, if operated conjunctively with the lower Test and Itchen abstractions. This should be taken into account in WRSE's deficit forecasts.

All of the above should be addressed in detail in WRSE's current work on assessing the regional deficit. The investigations should include the use of existing regional groundwater models to assess the amount and timing of chalk stream flow enhancements. Existing supply system models, like Thames Water's WARMS model, should be used to determine the consequent benefits to deployable output, taking account of seasonal variations in the enhanced chalk stream flows and their availability in droughts. There should be full transparency of these investigations.

2.7 Climate change allowances

Climate change allowances in WRMPs

The six water companies' climate change allowances in the WRMPs are shown below, as total allowances and as % of supply:

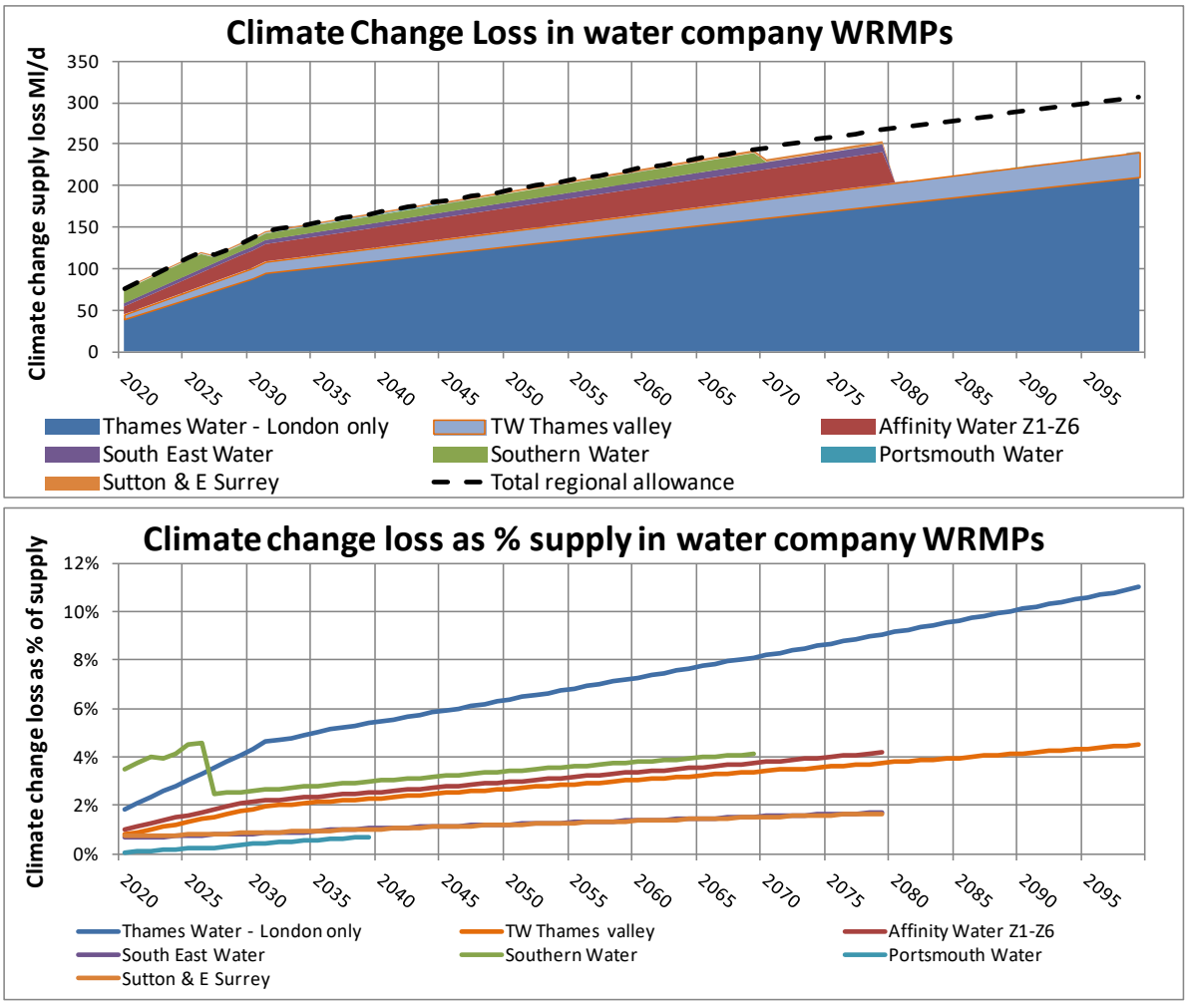


Figure 17 - Comparison of climate change allowances in water company WRMPs

The WRMPs are showing that regional supplies have already lost about 80 Ml/d due to climate change impacts to date. This rises to about 160 Ml/d by 2040 and 300 Ml/d by 2100. The sharp drop in Southern Water's allowance in 2027 is understood to be due to the planned availability of new supplies from Havant Thicket reservoir and Fawley desalination.

In addition to the WRMP climate change allowances which reduce the forecast supply deployable outputs, there are specific allowances in target headroom for climate change. The climate change target headroom allowances for the six companies are compared below:

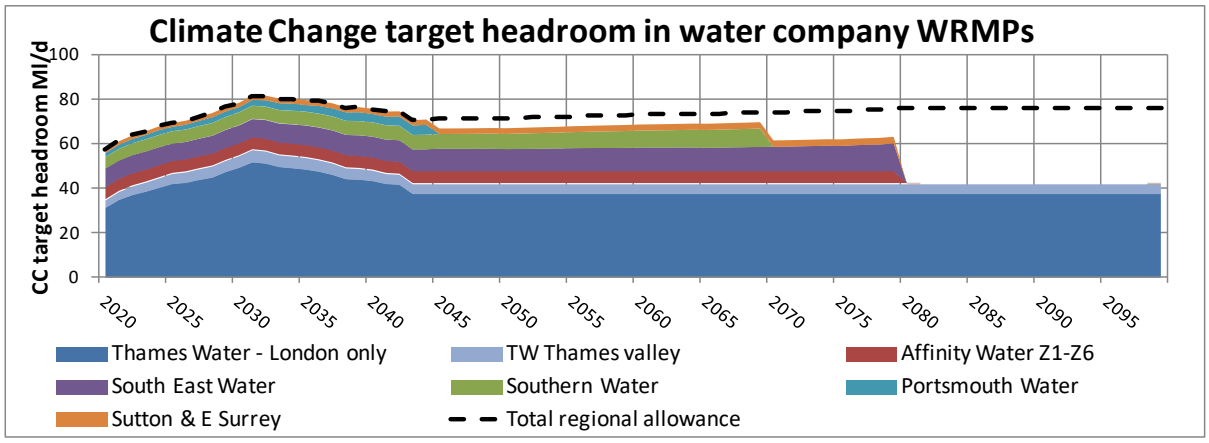


Figure 18 - Comparison of climate change target headroom in water company WRMPs

Thus in total the WRMPs are allowing for a loss of 380 Ml/d by 2100 across the region. Thames water's London zone has by far the largest WRMP allowances for both climate change itself and target headroom.

Evidence of climate change impacts on supplies in London and the Thames valley

There is evidence suggesting that climate change of the past 100 years might have increased the availability of water supplies for London and the flows that would have occurred in chalk streams, if they had not been affected by abstraction.

The plot below shows minimum remaining storage each year in London's reservoirs from Thames Water's WARMS2 modelling of existing supplies at 2305 Ml/d demand from 1920 to 2010[26]. Minimum storages from 2011 to 2019 are from CEH monthly hydrological reports:

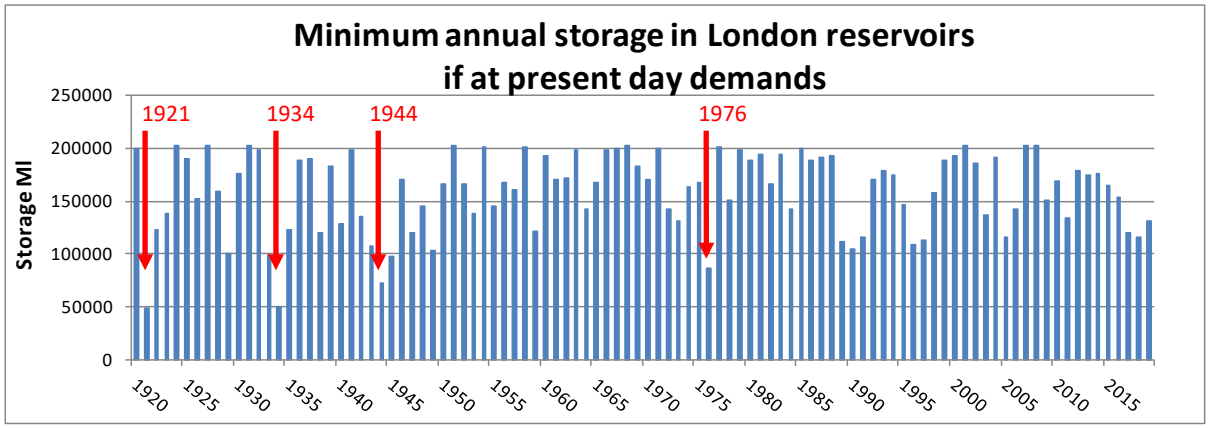


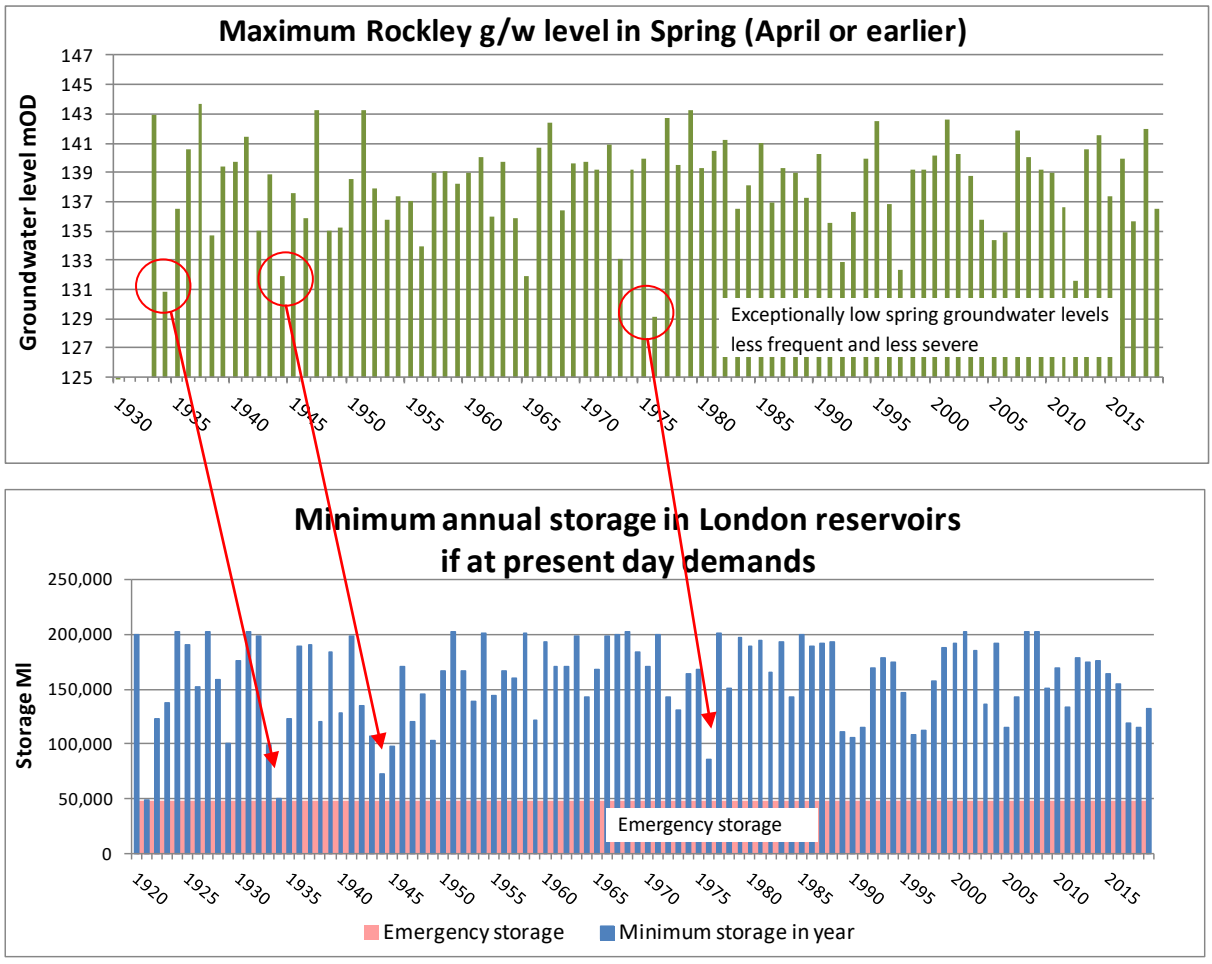
Figure 19 - Minimum London reservoir storage at full demand in climate since 1920

[26] Thames Water Excel file 'Copy of GARD AR17 London DO 2305 Mld 2017-4'

The three most severe droughts of the past 100 years, in terms of impact on London's supplies, were in 1921, 1934 and 1944 – all were in the first 25 years of the past century. The most severe drought of the past 75 years, 1976, was appreciably less severe than the earlier droughts, in terms of impact on London's supplies.

If the climate has been static for the past 100 years, it is unlikely that the three most severe droughts for London's supplies would have occurred in the first 25 years. The pattern of severe drought occurrence over 100 years suggests rather that climate change may have improved the ability of London's supplies to withstand severe droughts. These records show no evidence that London's supplies have been adversely affected by climate change to date.

The potentially beneficial impact of climate change to date on London's supplies can be explained by the records of rainfall and groundwater levels. Drought impacts for London's supplies are linked to low chalk groundwater levels in spring as shown below:



Note: Rockley is in the chalk downs near Marlborough, no data before 1932. Lower graph is repeat of Figure 19.

Figure 20 - Minimum London storages and maximum spring GWLs since 1920

Low groundwater levels in spring lead to low chalk stream flows feeding into the Rivers Thames and Lea. This means low availability of water for London's supplies throughout the following summer, unless the summer is unusually wet and allows some aquifer recharge, like 2012. If the groundwater level is normal at the start of summer, London's reservoirs are

not severely tested even in an extreme summer drought. This is because chalk stream flows are directly related to groundwater levels in the adjacent valley sides and recess only slowly, even in droughts, as groundwater levels fall from their relatively high levels at the start of summer. This is shown below for the rivers Kennet and Misbourne:

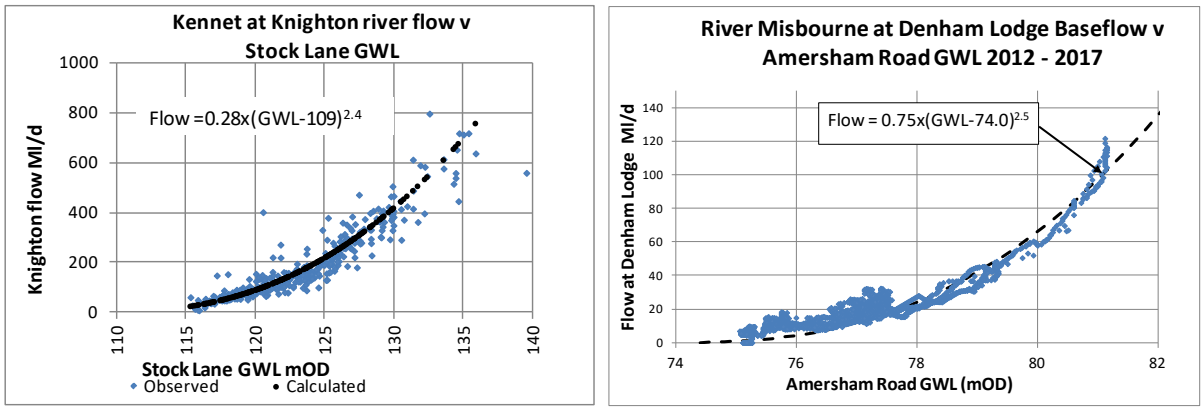
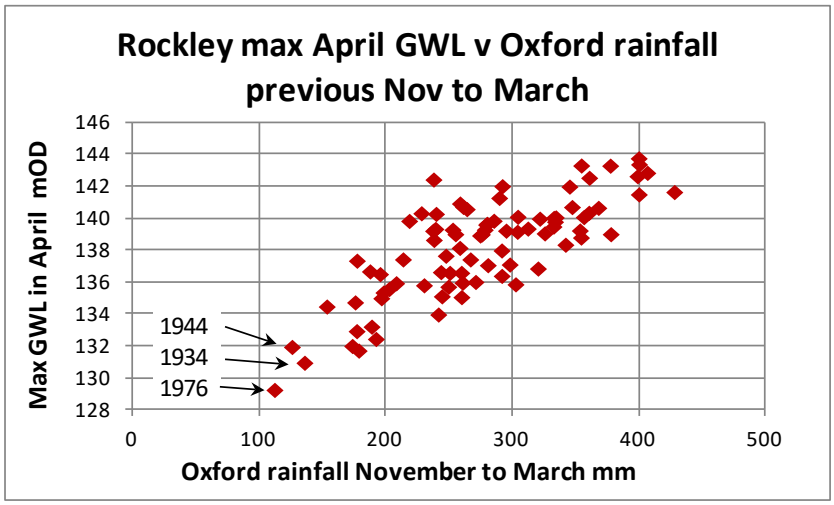


Figure 21 - Relationship between chalk stream flows and groundwater levels

The groundwater levels at the start of summer are determined by the rainfall in the previous winter, November to March, ie the period when most chalk groundwater recharge occurs. This is shown below for the Rockley 'max-in-April' groundwater levels since 1932, compared to the Oxford November to March rainfall (Oxford is about 40 miles north of Rockley, but indicative of rainfall in the Thames valley).



Note: Maximum spring GWLs are the highest recorded GWL in March/April. There were no GWL data at Rockley for the 1921 drought

Figure 22 - Relationship between Chalk groundwater levels and winter rainfall

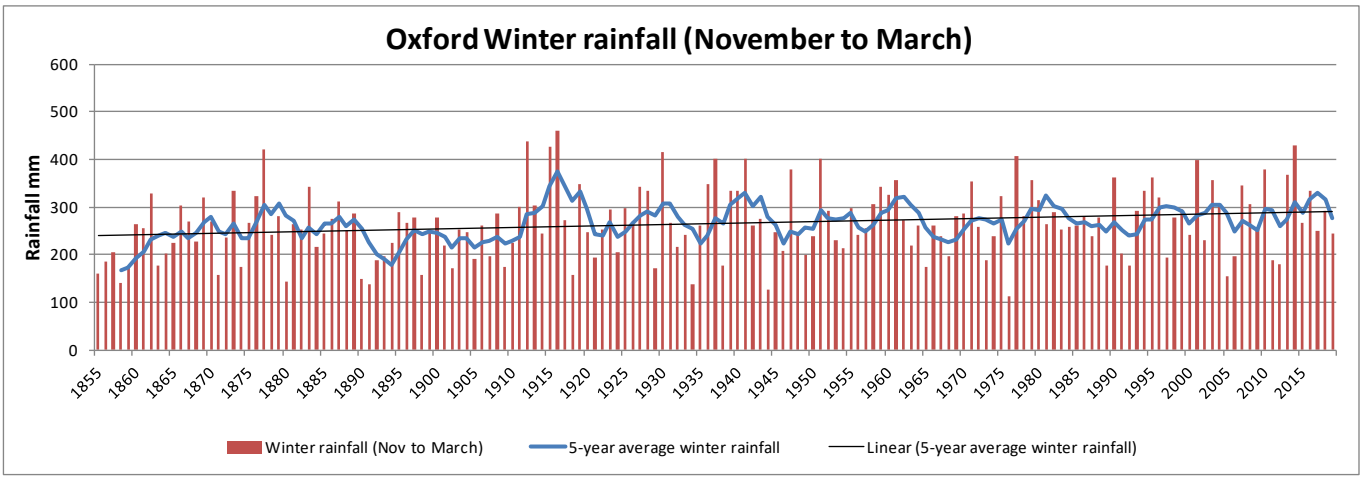
The major droughts for depleting London reservoirs – 1921, 1934, 1944 and 1976 – were all preceded by exceptionally dry winters, causing low chalk groundwater levels at the start of the summer drought.

There was no Rockley groundwater record in 1921 so it is not shown on the plot above. The winter of 1920/21 was only moderately dry – Oxford rainfall Nov-March 194 mm – but it was

very dry in February and March 1921, so the chalk groundwater levels would have been exceptionally low at the start of summer 1921.

Extreme depletion of London's reservoirs in severe summer droughts only occurs when there are very low chalk groundwater levels in the spring. In turn, chalk groundwater levels in spring are dependent on the amount rainfall in the previous winter, November to March. If climate change increases winter rainfall, it will boost the output of London's supplies, offsetting negative impacts of more severe summer droughts.

The plots below show the trends in Oxford rainfall in winter (taken as November to March) and summer (April to October), from 1855 to present.



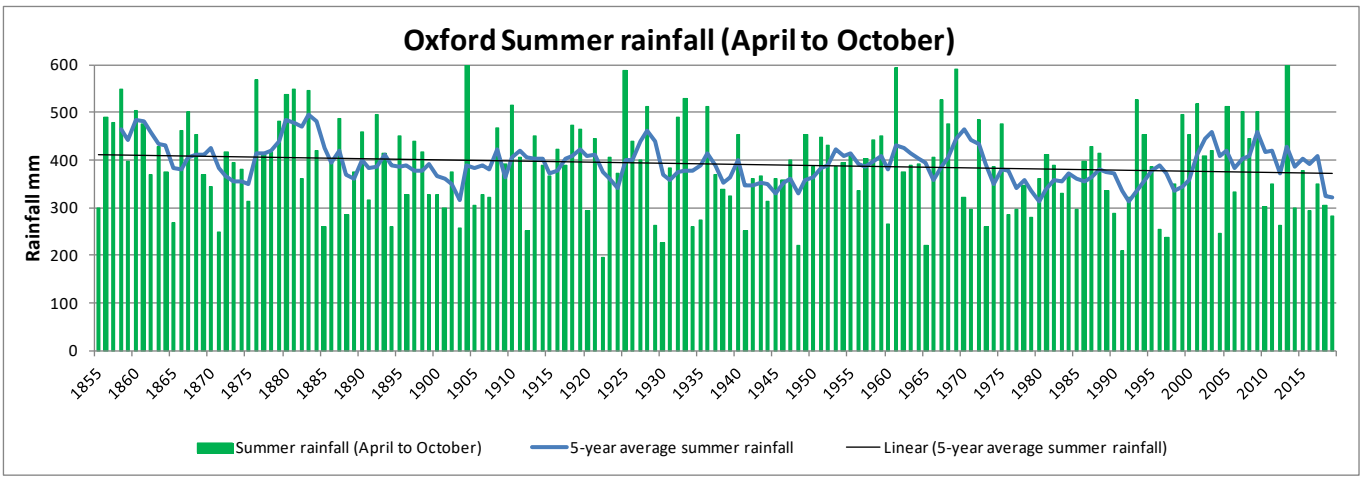


Figure 23 - Trends in Oxford rainfall since 1855 within and outside g/w recharge seasons

The Oxford rainfall in the November to March period of groundwater recharge shows an upward trend, offsetting a downward trend in the April to October period of groundwater depletion. This is consistent with the trend of increasing winter rainfall in England and Wales over the past 150 years shown below[27]:

[27]State of the UK climate 2017, Volume: 38, Issue: S2, Pages: 1-35, First published: 30 July 2018, DOI: (10.1002/joc.5798. Royal Meteorological Society

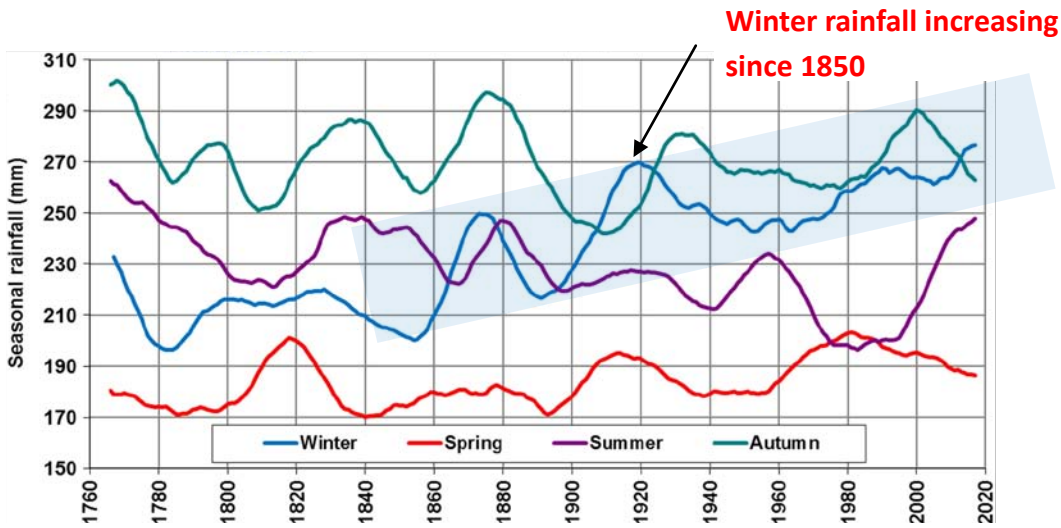


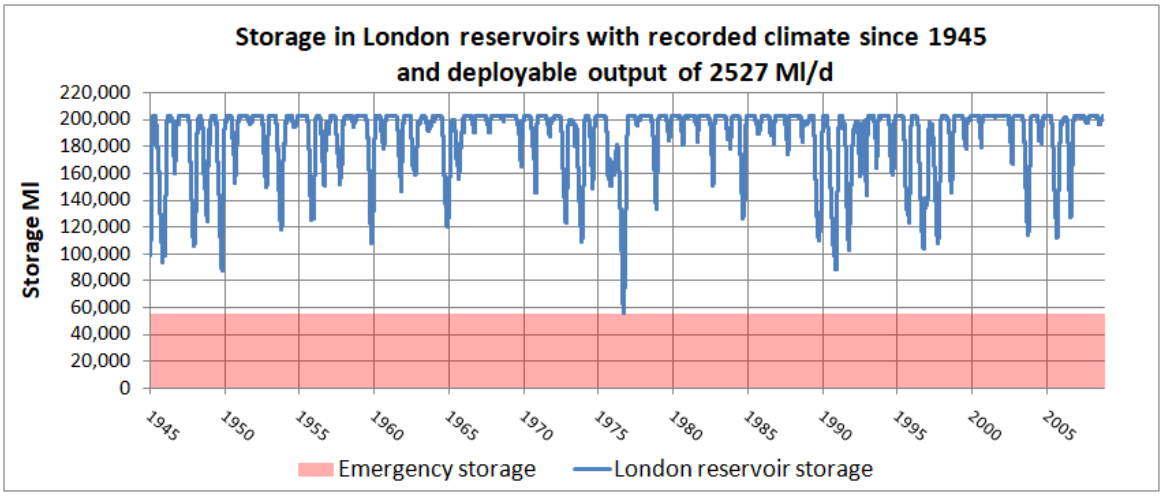
Figure 24 - Seasonal rainfall trends in England and Wales, since 1760

Increasing winter rainfall improves the drought resilience of London's supplies because:

- reservoir levels are higher at the start of summer droughts
- the winter rain stored in the chalk aquifer is released slowly through the summer, increasing flows in the lower rivers Thames and Lea for filling the reservoirs.

The falling trend in summer rainfall, as shown above, has less of an impact on London's supplies, because most of the summer rain is absorbed by evapo-transpiration or slowly into the porous chalk strata that cover a large part of the Thames catchment. The plot above shows no evidence of a trend of reducing autumn rainfall that might extend summer droughts and threaten London's supplies.

If the deployable output of London's existing supplies is determined only using the 70 years of river flow records since the 1940s, it rises to 2527 Ml/d, which is 222 Ml/d more than Thames Water's present-day base case of 2305 Ml/d. The modelled drawdown of London's reservoirs supplying 2527Ml/d since 1945 is shown in below:



Note: Storages from GARD modelling of existing supply system. Emergency storage increased by 6810 Ml, giving 30 days extra for 227 Ml/d DO increase, as per TW policy

Figure 25 - London storage with existing supplies, DO 2527 Ml/d and climate since 1945

With the climate since the 1940s, London's supplies could have sustained a supply 227 Ml/d more than Thames Water's currently assumed deployable output of 2305 Ml/d.

We do not propose that the present deployable output of London's supplies is assessed only using the records since 1945, ignoring the droughts of 1921, 1933 and 1934. However, the evidence above does suggest that that the acknowledged and substantial climate change to date has had no adverse effect on London's supplies and could actually have been beneficial.

Thames Water's allowance for climate change impact on the deployable output of London's supplies is shown below:

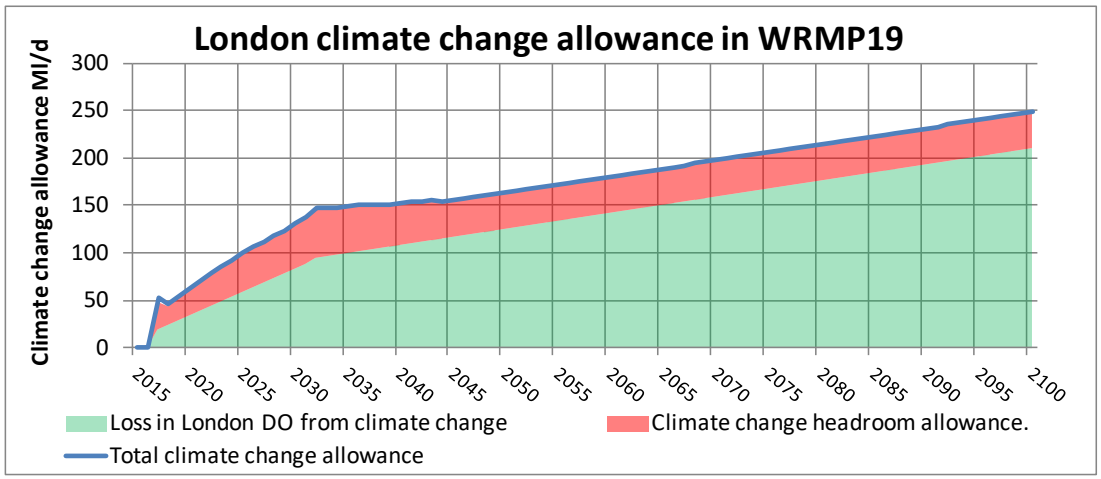


Figure 26 - Allowance for loss of London supply due to climate change in TW's WRMP

In view of the lack of any evidence of climate change to date reducing the output of London's supplies, Thames Water's WRMP allowance for a loss of deployable output of 150 Ml/d by 2032 appears unjustifiable. In particular:

- The total climate change allowance in 2020, including headroom, is 74 Ml/d. Why is there allowance for any climate change loss in 2020?
- Why do the allowances rise rapidly to 2032 and then much slower?
- Is it credible that London's output could be reduced by 150 Ml/d by 2032, noting the evidence of possible increase in output due to climate change up to now?
- It appears that Thames Water's allowances for climate change have not taken account of the potentially beneficial impact of higher winter rainfall on chalk groundwater levels at the start of summer, leading to higher river flows throughout summer droughts. There is a discrepancy between TW's showing negligible effects from climate change on groundwater sources, but substantial effects on 'surface water' sources, much of which has come from groundwater.

The climate change allowances in Thames Water's WRMP appear to be an improbable worst case for contingency planning, rather than a central estimate suitable for justifying investment in major schemes with irreversible environmental impacts.

Thames Water's response to GARD's criticism of their climate change allowances

Much of the above evidence on the impacts of climate change to date on London's supplies was included in GARD's response to Thames Water consultation on their revised WRMP[28] (we have now added more on the significance of winter rainfall and spring groundwater levels). Thames Water responded at length to GARD in their Statement of Response[29], in essence saying:

- The droughts of the past 100 years were clustered in the first 25 years by chance
- GARD's response shows *"a fundamental lack of understanding regarding the nature of the occurrence of drought and/or a biased representation of information"*
- Thames Water's approach *"goes beyond platitudes such as 'wetter winters, drier summers', and instead considers many possible futures"*
- Their analysis is a *"robust best estimate of climate change impact and a prudent allowance for uncertainty around this best estimate, not an 'improbable worst case'"*

GARD rebuttal of Thames Water's response

We challenge Thames Water's suggestion that the three most severe droughts for London occurred merely by chance in the first 25 years of the past century. Assuming that the occurrence of severe droughts falls under a Poisson distribution and there are on average 4 droughts per century, the chance of three droughts occurring in any 25 year period is about 6%. This is possible, but unlikely. We also note that the only major drought of the past 75 year, 1976, was considerably less severe for London's supplies than the earlier droughts (see Figure 20).

This evidence suggests that climate change to date has reduced the likelihood of the type of drought that can severely impact London's supplies. There is no evidence that climate change to date has reduced the reliability of London's supplies, and some evidence that supplies may have benefitted substantially.

Suggestions for WRSE's further work on climate change impacts

We propose that WRSE should independently review Thames Water and other companies' climate change forecasts, paying particular attention to:

1. The probability that the three worst droughts of the past 100 years for London occurred in the first 25 years "by chance", as Thames Water have said.
2. The need for any climate change reduction in present day supply output, noting the evidence of lack of impact to date.

[28] GARD response to TW's 2nd WRMP19 consultation, pages 36-40
[29] TW Statement of Response to revised dWRMP19, Appendix H, pages 130-135

3. The significance of chalk groundwater level in spring as an essential precursor to severe depletion of London reservoir storage at the end of droughts.

4. The dependence of spring groundwater levels on winter rainfall.

5. Trends in winter rainfall in the Thames catchment and elsewhere.

6. The reliability of the stochastically generated weather data used in Thames Water and Southern Water's models, particularly the validity of the modelling used to convert the stochastic weather data into river flows.

7. The reliability of the modelling of deployable output using the large data sets generated by the stochastic analysis, recognising the approximations needed to make the modelling feasible.

In our opinion, WRSE's assessment of the regional deficit should recognise the uncertainty in the climate change forecasts and the possibility that wetter winters would actually increase reliability of supplies because of the benefits to the chalk aquifers.

There should be transparent consideration of a range of scenarios, including the possibility that climate change could improve the reliability of sources dependent on chalk groundwater levels.

2.8 Allowances for uncertainty

The WRMPs already make large allowances for uncertainty and "safety factors" in the deficit forecasts. WRSE's assessment of deficits makes even more allowances. The allowances are:

In the WRMPs:

- Target headroom
- Climate change headroom
- Outage allowances
- Generous allowances for population growth
- Move to 1:200 year resilience, instead of worst historic drought
- Loss of supply due to climate change
- Supply loss due sustainability reductions, with no allowance for chalk stream returns
- Emergency storage retained in reservoirs
- Drought plans to provide more water if needed in emergency

WRSE have added:

- Move to 1:500 year resilience
- Suggestion of need for even bigger climate change allowances
- Suggestion of need for more sustainability reductions, with no allowance for returns

In our opinion, the allowances and safety factors have become excessive. The planned totals

of target headroom, climate change headroom and outage allowances for the six water companies are shown below:

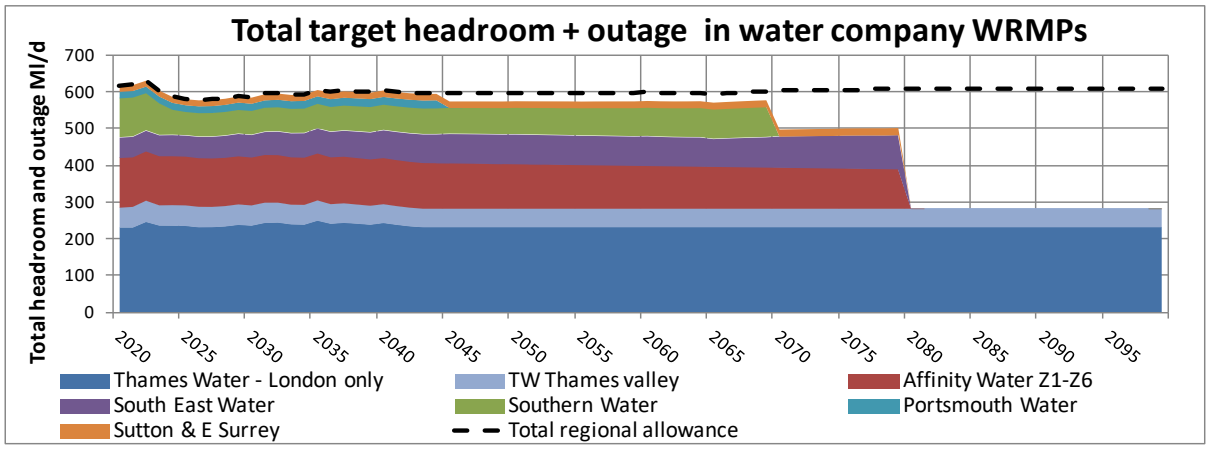
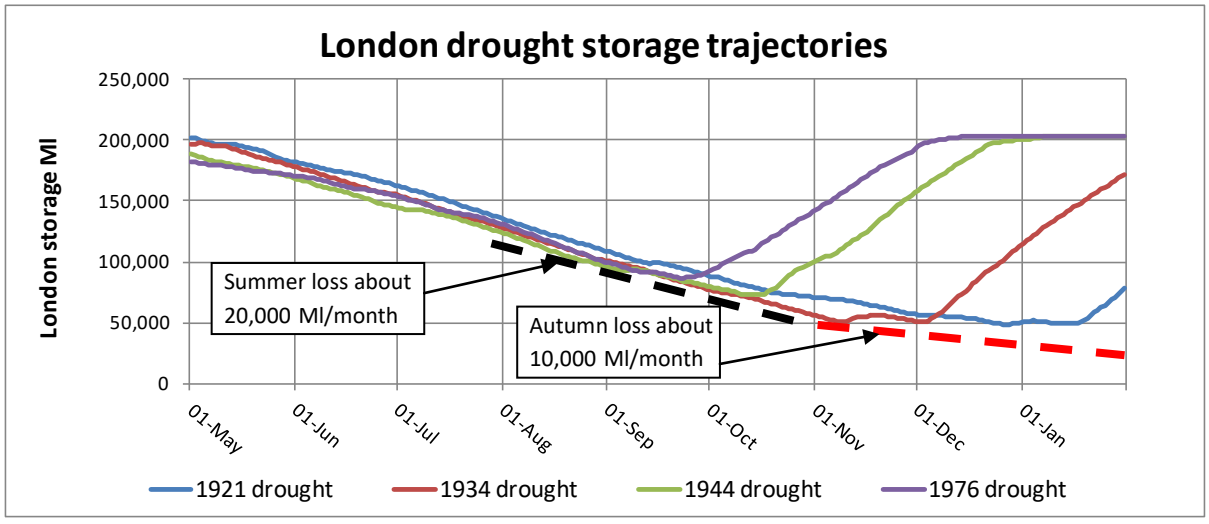


Figure 27 - Total headroom plus outage allowances in the water company WRMPs

The total regional headroom and outage allowances are around 600 Ml/d continuously to the end of the century – about 12%. In our opinion, this is an over-generous allowance, if other parts of the deficit forecast are already allowing for 1:500 year droughts and uncertainties like climate change and as yet unknown sustainability reductions.

There is more "hidden" safety factor in the emergency storage available in London's reservoirs. Thames Water say their policy is to allow 30 days emergency storage, so the 50,000 Ml of emergency storage in the London reservoirs is nominally justified as 30 days at a surface water supply output of about 1600 Ml/d (the balance of supply coming from groundwater and desalination).

However, in reality the emergency storage is much more than 30 days' supply as below:



Storage data from TW's WARMS2 modelling of 2305 Ml/d base case

Figure 28 - Rate of loss of storage in London reservoirs during droughts

During the peak of summer droughts, storage falls by about 20,000 Ml per month, so the

50,000 Ml of emergency storage is equivalent to 10 weeks' supply, much more than 30 days. However, the droughts that seriously test London's supplies are those that extend late into the year, like the droughts of 1921 and 1934. During these droughts, as the storage drops close to the emergency level, but still without Level 4 restrictions, storage only falls by about 10,000 Ml per month. This is equivalent to about 5 months' supply without any Level 4 demand restrictions, which is far more than Thames Water's 30 day standard.

The reason for the larger disparity between the reality of 5 months' emergency storage and Thames Water's 30 day design standard is that even during severe droughts most of London's 1600 Ml/d of surface water supply comes by pumping from the River Thames, not from reservoir storage.

This should be taken into account by WRSE in considering the regional deficit and scenario analysis. For example, if Thames Water plans to keep supplying without Level 4 restrictions in a 1:500 year drought, there is no need to retain 5 months' supply in emergency storage. In Section 3 of this response, we have suggested that the reduction of the emergency storage should be an option considered by the regional investigation.

WRSE's deficit forecasts and scenario planning should also consider:

- The unlikelihood of all the possible adverse circumstances occurring together
- Availability of inter-company transfers, if needs do not rise evenly across the region
- Population growth by movement out of London, rather than overall regional growth

We recognise that WRSE needs to determine the resources that might ultimately be needed in the event of the worst case scenario, because this could influence the choice of new sources and their phasing. However, if the South East region is to have a genuinely adaptive plan, avoiding unnecessary resource development, the central deficit forecasts need to be much more realistic and far lower than that suggested by WRSE's Table 1.

3. Resource options

On pages 20-21 of their report, WRSE provide a generic list the main option types under consideration for new resources. WRSE's Figure 3 shows their potential output. There is no other detail given. We agree that the generic list covers the main option types. In our WRMP consultation responses, we have commented at length on the options considered by Thames Water and Affinity Water http://www.gard-oxon.org.uk/downloads.html. We hope that WRSE will give proper consideration to the points raised in GARD's consultation responses, which have been largely ignored in the final WRMPs.

In particular, we would like WRSE to reconsider the following regarding the Severn-Thames Transfer (STT), which we believe to be the key strategic solution for bringing in "new water" to the Thames valley and London[30] [31]:

- The phased development of the STT, involving early construction of the Severn to Thames aqueduct (possibly as the first of two phases), followed by gradual introduction of support sources as the need arises.
- Consideration of options involving releases from Vyrnwy reservoir of up to 300 Ml/d, instead of the maximum 180 Ml/d considered by Thames Water
- Consideration of ultimate aqueduct capacities up to 500 Ml/d in later phases of the development.

In considering the option types, WRSE should focus on their suitability as components of an adaptive plan, recognising the large uncertainties in the future regional deficit. There should be a premium on options that can be developed in modest-sized phases with short lead times. The programme should include, where possible, moderate sized versions of some of the generic option types as pilot projects to gain experience of their possible more widespread use – for example, types of re-use and desalination project.

There should also be early systematic trialling of some of the demand management options like smart metering and tariff structuring, so that the demand savings can be known with more certainty for future plans.

With the move to 1:500 year resilience, there should be consideration of the option of reducing the amount of emergency storage required in the London reservoirs. If the drought has a 1:500 year return period, in terms of London reservoir depletion, it will inevitably extend deep into the winter when the rate of reservoir depletion is always much lower. For example, if the emergency storage is reduced from 48,500 Ml to 30,000 Ml, GARD's modelling shows the deployable output of London's supplies would increase by 86 Ml/d. At the typical winter depletion rate of 10,000 per month, as shown on Figure 28, 30,000 Ml of

[30] GARD response to TW's 1st dWRMP19 consultation, pages 86-110
[31] GARD response to TW's 2nd dWRMP19 consultation, pages 84-108

emergency storage would still be 3 months' supply.

The 'Chalk Streams First' proposal https://chalkstreams.files.wordpress.com/2020/04/chalk-streams-first-v3.5-final.pdf should be investigated in detail as an integral part of the options to meet Affinity Water's needs by transferring water from the Thames valley using their proposed Supply 2040 network, modified as and brought forward to 2030.

The Chalk Streams First project would entail shutting down most chalk groundwater boreholes in the upper parts of Chilterns chalk valleys which are at present used for continuous supply. However, this would open up the option of using the Chilterns chalk aquifer as occasional drought sources in the same way that the West Berkshire Groundwater Scheme is used to provide about 80 Ml/d of deployable output for London.

If WRSE are considering other sustainability reductions, possibly up to 998 Ml/d[32], there should be investigation of options similar to Chalk Streams First and allowing for the benefits of enhanced chalk stream flows becoming available for supplies taken from the lower reaches of rivers. The investigations should also consider the option of using the chalk aquifer as a drought source, like the West Berkshire Groundwater Scheme.

If there are to be large scale sustainability reductions in the Hampshire Avon catchment, there will be another option to use the chalk aquifer as a drought source like the WBGWS, with the enhanced Avon flows used for a transfer from the South West region into the South East.

[32] WRSE Report, page 13