GARD response to

WRSE's Consultation on their

Draft

Regional Plan for South East England

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GARD Response to WRSE Consultation on their Regional Plan

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Our overall conclusion on WRSE's plan

GARD's overall conclusion is that there is no need for Abingdon Reservoir and it should be abandoned at Gate 2, with no further money wasted on its continuing development.

Scope of this response

This response focuses on the South East region's need for new water resources, particularly the need for the proposed Abingdon reservoir, and how the needs might best be met, especially in the Thames valley.

GARD's response to Thames Water's draft WRMP will not be available until the consultation submission date of 20th March 2023, because of the delay in the consultation on TW's WRMP. If necessary, we will issue a revised version of this response to WRSE's regional plan soon after 20th March, including any up-dated information arising from our response to Thames Water's consultation.

WRSE's forecast of future needs for new water supplies

In GARD's opinion, WRSE have grossly over-estimated future water needs in the South East. In the areas that might be supplied by the proposed Abingdon reservoir, including Affinity Water's Central Region and Southern Water's Hampshire zone, we think that the needs in 2050 have been over-estimated by nearly 900 Ml/d, made up as follows:

All in Ml/d	**WRSE Estimate**	**GARD estimate**	**Difference**
DO losses due to Environmental Improvements			
Affinity sources in Colne and Lea	415	75	340
Thames Water in the Thames valley	170	50	120
South East Water and Sutton & East Surrey Water	60	30	30
Southern Water in Hampshire	63	0	63
Portsmouth Water	86	50	36
		Sub-total	589
Population growth			
Growth to 2050 (000s)	2,621	1,788	
Equivalent demand growth (Ml/d)	301	206	96
Climate change – medium instead of high scenario	123	42	81
Drought resilience - Test & Itchen drought permits	120	0	120
Total over-forecast of 2050 water supply need for areas potentially supplied from Abingdon reservoir			**886 Ml/d**

Summary of WRSE over-forecasting of 2050 deficits in Abingdon Reservoir supply areas

The magnitude of over-estimation of future needs undermines the credibility of WRSE's plan. It should not be used as the basis for water company plans.

Abstraction reductions for environmental improvements

Over half of WRSE's water needs arise from abstraction reductions for environmental improvements which are the source of 589 Ml/d of over-estimated need in the above table.

The conclusions from GARD's review of the need for environmental improvements are:

1. There is little transparency of the detail and justification of the colossal losses of deployable output arising from WRSE's "environmental improvements", which require about £9 billion investment in replacement sources.

2. WRSE's analysis shows that the costs of their proposed environmental improvements hugely exceed the value of benefits. GARD rejects WRSE's suggestion that the improvements can be justified by a legal requirement to comply with the Water Framework Directive.

3. In the Colne and Lea catchments, where WRSE plan loss of 415 Ml/d of deployable output, GARD agrees the need for 150 Ml/d of reductions in the upper chalk tributaries – "classic" chalk streams that have been hugely over-abstracted.

4. WRSE's planned loss of a further 265 Ml/d of deployable output from reductions in the lower River Colne and Lea are unjustified and should be abandoned.

5. About 50-60% of the 150 Ml/d of reductions in the Colne/Lea chalk streams would be recovered as deployable output of London's reservoirs. GARD considers the WRSE estimate of 17% recovery to be far too low. An insurance against deployable output recovery being less than expected should be provided by introduction of WBGWS-type drought support schemes in the upper Colne and Lea chalk streams.

6. Overall, GARD considers that the net deployable output loss from the Colne and Lea reductions should be only about 75 Ml/d rather than the 415 Ml/d planned by WRSE.

7. In total, GARD considers that it would be appropriate to allow for a total 255 Ml/d of loss from the Thames valley supplies of Thames, Affinity, South East and Sutton & East Surrey water companies. This compares with WRSE's allowance of 758 Ml/d.

8. GARD considers that none of WRSE's 63 Ml/d of deployable output losses from the Test and Itchen catchments (ie potentially supplied from Abingdon reservoir) can be justified, but agrees that there is a good case for a lot of the 107 Ml/d of WRSE planned reductions from Portsmouth Water's supplies.

9. There would be minimal benefit and about £2 billion cost through loss of 120 Ml/d of Southern Water's deployable output by abandoning Test and Itchen drought permits in 2040. The drought permits should be retained.

10. **In view of the scale and costs of environmental improvements in all regions across the country, no decisions should be taken on new resource schemes until the proper and transparent prioritisation of abstraction reductions has been completed, taking account of the costs of replacement sources and their environmental impacts.**

Population growth

In GARD's opinion, the population forecasting method used in the WRSE draft plan is not fit for purpose. We propose the following process would be simpler, more realistic and meet the needs and approval of a wider range of stakeholders (including regulators).

1. The latest ONS Principal Projection should be used to determine expected overall population growth for the region and as the basis for strategic level planning.

2. Local housing plan data should be used to determine the location and timing of future 'hotspots', allowing infrastructure plans to be finessed at the operational level.

This process would comply with the requirement to use both local planning data and other data and would resolve complaints about over-inflated population projections.

GARD's calculations show that the WRSE population estimates are over-stated by 1,445,000 by 2050 and 2,303,000 by 2075. At a 2050 PCC of about 115 l/head/day, that is equivalent to an over-forecast of the baseline deficit by 166 Ml/d in 2050 and 265 Ml/d by 2075.

Plans for PCC and leakage reduction

Thames Water and Affinity Water fail to achieve the Government target of 110 l/person/day in 2050 by a large margin (Affinity Water's PCC is incorrectly shown in WRSE's report). If both companies meet the Government's target, the need for new supplies in areas potentially supplied from Abingdon reservoir would be reduced by a total of:

• Thames Water, London zone	134 Ml/d
• Thames Water, Thames valley zones	26 Ml/d
• Affinity Water, Central Region	74 Ml/d
Total	234 Ml/d

Thames Water's planned leakage reductions are mostly in London, where there is a reduction of 60% by 2050, well ahead of the 50% reduction target – GARD welcomes this.

However, Thames Water's planned leakage reduction in their zones outside London is only 27% and well short of the 50% target. GARD proposes that leakage in these zones should be reduced to 40 l/property/day by 2050 to be in line with the leakages planned in all other regions outside London. This would give a total saving of 74 Ml/d in the Thames valley zones compared to Thames Water's plan

Overall, compliance with the targets for leakage and PCC reduction would reduce the need for new supplies by 308 Ml/d in areas potentially supplied by Abingdon reservoir.

The need for new water supplies in areas potentially supplied by Abingdon reservoir

For the areas potentially supplied by Abingdon reservoir, WRSE's planned major new sources amount to deployable outputs of 593 Ml/d by 2050 and 765 Ml/d by 2075.

GARD have assessed the need for new supplies in these areas to be 1,194 Ml/d less than WRSE's figures – 886 Ml/d less from over-estimation of need and 308 Ml/d less from failure to meet PCC and leakage targets. This reduces the water needed in 2050 to 1,056 Ml/d, compared to WRSE's figure of

2,250 Ml/d. This reduced need is about 600 Ml/d below the total of the 1,650 Ml/day of new sources in WRSE plan by 2049 (about 1,200 Ml/d of new supplies and 450 Ml/d of leakage and demand reduction). By 2075, the planned over-provision of major new supplies in WRSE's plan has risen to about 780 Ml/d.

On this basis there is a strong argument that there is no need for a *decision* on <u>any</u> new sources in the area potentially supplied by Abingdon reservoir before 2035. The potential needs of the area by 2050, from realistic population growth, prioritised environmental (sustainability) improvements and reasonably cautious allowance for climate change, can all be met if the South East water companies meet the Government's PCC and leakage targets, especially Thames Water and Affinity Water.

GARD recognises that there is uncertainty over the amount and timing of the leakage and PCC reductions, mainly arising from the performance of Thames Water in meeting targets in the past. GARD's view is that it is prudent to supply capacity to the Abingdon reservoir supply area *as early as possible*. This has the maximum strategic, environmental and drought resilience impact and would give some cushion against accelerating climate change effects. It would also bring forward the date at which 'true' 1 in 500 year Drought Resilience is achieved (not done until post-2040 in WRSE's plan).

On that basis, we propose the following schemes should go ahead, even if not strictly needed under our realistic assessment of reduced future needs:

By early 2030s:

- The Teddington DRA scheme (67 Ml/d), already planned to be due by 2031
- The first phase of the GUC transfer (50 Ml/d), already planned to be due by 2031
- The 50 Ml/d Thames to Affinity transfer to allow early chalk stream relief

By 2035/36:

- 1st phase of Severn-Thames transfer, only 300 Ml/d aqueduct, with Minworth support
- 2nd phase of GUC transfer, or possibly included in the first phase

Thus 360 to 395 Ml/d of our 780 Ml/d 'over-provision' has been deployed early to bring forward environmental benefit and climate change 'hedge'. Further considerations in the 2035-2039 AMP could decide on what, if anything, would be needed up to 2050.

In GARD's opinion, the Thames to Southern transfer will never be needed and it should be abandoned at Gate 2 due its minimal benefit and disproportionately high cost.

Comments on plans for major new water infrastructure

GARD will comment in detail on the plans for major new schemes in our response to Thames Water's consultation on their draft WRMP, due by 20th March. These comments may include:

1. For the Severn to Thames transfer, the planned 500 Ml/d aqueduct capacity seems unnecessarily large and a 300-400 Ml/d capacity should be evaluated. This would allow the possibility of the Cotswold canal being reinstated and used as the aqueduct, bringing very substantial leisure benefits and attracting strong public support.

2. Initially at least, the only required STT support source would be the Netheridge STW effluent diversion, and the first stage of the Minworth STW upgrade. The latter might not be necessary if the Cotswold canal is used as the aqueduct because no sweetening flow would be required.

3. The early implementation of the Thames to Affinity transfer should include 'Connect 2050' pipe network (re-naming it 'Connect 2030'), allowing all the planned upper Colne and Lea chalk stream reductions to be in place by the early 2030s.

4. The source of water for the Thames to Affinity transfer should be a direct connection to Thames Water's London supply system, via an existing reservoir. If flow recovery is realistically allowed for, the Thames to Affinity transfer doesn't need to wait for either Abingdon reservoir or the Severn to Thames transfer.

5. We consider that the 67 Ml/d Teddington DRA scheme could potentially be much larger and it does not need to be constrained by water temperature concerns. If more water was genuinely needed, we believe that a much larger version of the scheme should be reconsidered, making more use of the c. 400 Ml/d output of Mogden STW.

6. Our detailed commentary on the Abingdon reservoir proposal is likely to cover the adequacy of emergency storage provision, resilience to long duration droughts, reservoir safety issues, environmental impacts, supposed leisure benefits and cost/carbon comparisons with the Severn to Thames transfer.

Skewing of comparisons between major plan options

GARD's conclusion on the comparisons between major plan options ('*Best Value', 'Least cost', 'Best societal and environmental plan'*) is that these are done on the basis of metrics which are still in development and often badly compromised. The overall summary is that the plan comparisons are not yet fit for purpose, as summarised below.

Cost comparisons

Although it is said that excluding the Abingdon reservoir from the Best Value Plan, in favour of the Severn Thames Transfer results in a cost increase of £500m, this is an *overall Plan* cost (in plans costing around £50 billion). There is no straightforward cost comparison to justify the assertion: a major failing in transparency.

GARD has sought to make a direct comparison of total (NPV) costs for a first phase of STT and an Abingdon 125 Mm^3. These show that the cost comparisons unrealistically assume OPEX as if the scheme was at constant full flow. With more a realistic usage profile, the 'STT Phase 1' comes out slightly (0.5%) cheaper overall than Abingdon reservoir.

A further element of an individual scheme, or a plan, is the effect of including *Regulatory Capital Value (RCV)* of companies in the charges to water customers, according to Ofwat formulae. Such costs are a real cost of the scheme (have to be paid in water bills), yet are never covered in either Regional Plans, WRMP or the assessment of the strategic scheme options. GARD's financial model for the RCV effects for Abingdon reservoir show that the RCV costs to customers would be a

staggering £3.04 billion over the lifetime of the plan. GARD accepts that all major projects (though not demand management measures) carry an RCV price tag, but since CAPEX costs of schemes like STT are lower, and the write-off period shorter than a reservoir, the RCV burden is lower. GARD will return to this in more detail in the Thames Water and Gate 2 submissions.

Issues with Deployable Output from schemes

GARD has several issues with the deployable outputs used in the WRSE plan development, which we will deal with in WRMP and Gate 2 responses. The issues will include the emergency storage and drought resilience for Abingdon reservoir, the allowances for STT and Abingdon reservoir transmission losses, the Deerhurst hands-off flow, the deployable output from Vyrnwy reservoir support and the environmental restraints on output of the Teddington DRA scheme.

Environmental and Natural Capital and Biodiversity Net Gain Assessments

These assessments are essentially not fit for purpose in the WRSE draft plan. Strategic Environmental Assessments across major competing plans consider only schemes which are complete within '*water company boundary buffers*'. Thus the majority of the strategic schemes are not assessed. Only the Best Value Plan considers '*in-combination*' effects, when deriving the Natural Capital (NC) and Biodiversity Net Gain (BNG) metrics. The other comparable plans do not consider such effects, giving a faulty comparison between plans.

There is lack of consideration of *duration* of disturbance of an area, and lack of consideration of the *relevant scale length* associated with a disturbance, which both have major effects on the negative biodiversity impact.

We conclude that these *issues* should be addressed and the biodiversity metrics reconsidered *before the next stage*. The BNG and NC recreation and amenity scores need to be based on more detailed designs for the strategic resource options (but especially Abingdon reservoir) before being used in programme selection.

Carbon Footprint

GARD concludes that the WRSE analysis is not fit for purpose in establishing a Best Value plan using embodied, or capital carbon as an input metric. The analysis has the following failings:

- It is biased against demand management solutions, as no mitigation of embodied carbon is considered for this part of the programme, where at least there is an attempt to address mitigation by technical developments for supply schemes.

- It is over-optimistic where developments are envisaged on construction materials and plant. This ranges from over-optimism about the pace of developments for low-carbon concrete or pipeline materials, to being pure fantasy for the development of earthmoving, quarrying and transport for reservoir projects. Only in the case of cement for concrete is any concept of Technology Readiness and Commercial Readiness Levels (TRL and CRL) employed.

- The basis of operational carbon derivation is not clear, and particularly the *usage* of schemes is not explicit (with the hidden effects as discussed in OPEX costs for transfers above). Also, a TRL

Roadmap for developing low-carbon-embodied chemicals for use in schemes (a major source of operational carbon) must be identified.

Reservoir Safety Issues

The issue of reservoir safety is primarily for the individual companies, and GARD will be raising this with Thames Water in the dWRMP24. However, WRSE has a duty of care to establish the safety of schemes it promotes. GARD's view is that it is not carrying out this duty in the draft plan. In our opinion, this stage of the planning should address safety in the case of detected major fault in the dam wall, the extent of the emergency evacuation of the surrounding population, wave erosion protection and freeboard, and the threat from terrorism.

1. Introduction

1.1 GARD's role

Group Against Reservoir Development (GARD) is a community-based organisation representing 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.

GARD campaigns against this inappropriate reservoir solution and in favour of sustainable water resource options such as effluent reuse and raw water transfer from Severn to Thames. We also strongly support demand-side measures to reduce leakage of water and efficient use strategies, including metering. GARD's membership includes many technically-qualified people, and we are advised by Water Industry professionals. GARD's website is at http://www.abingdonreservoir.org.uk/.

1.2 Scope of Response

This response focuses on the need for new water resources in the South East and how the needs might best be met, in particular, in the Thames valley.

We have completed and submitted brief responses to WRSE's consultation via the WRSE web-site. These brief responses are cross-referenced to this document. Copies of our web-site responses are included in Appendix A.

GARD's response to Thames Water's draft WRMP will not be available until the consultation submission date of 20th March 2023, because of the delay in the consultation on TW's WRMP and in TW delayed responses to information requests. If necessary, we will issue a revised version of this response to WRSE's regional plan soon after 20th March, including any up-dated information arising from our response to Thames Water's WRMP consultation.

2. Deficit Forecasts for the South East

2.1 Overview of WRSE's deficit forecast

The WRSE assessment of future water needs are shown in Figure 5 of WRSE's plan and copied here as Figure 1:

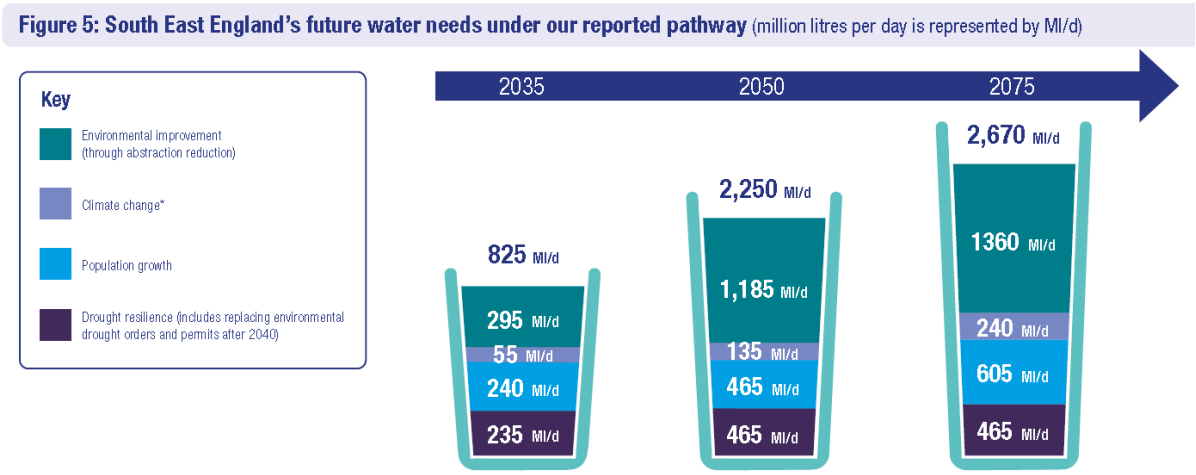


Figure 1 - WRSE's assessment of future water needs

GARD's comments on the four main sources of the needs are given in the following sections.

2.2 Environmental improvements

2.2.1 Lack of transparency for environmental improvements

The WRSE future needs are dominated by the huge abstraction reductions for "environmental improvements" – 1186 Ml/d by 2050 and 1360 Ml/d by 2075 as shown on Figure 1 above. The overwhelming significance and cost of the environmental improvements is also shown on Figure 7, page 36 of WRSE's main plan:

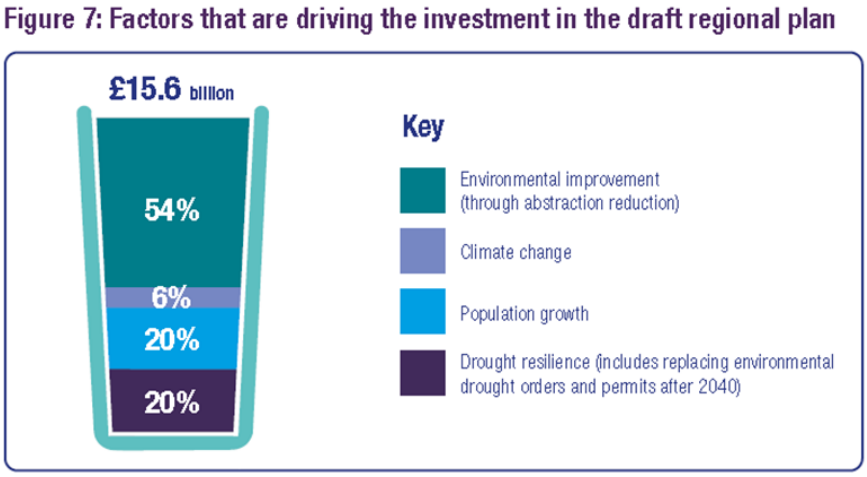


Figure 2 - Breakdown of drivers of investment costs in WRSE's plan

Therefore, WRSE are proposing investment of £8.4 billion in new resources to enable reduced abstraction to create environmental improvements in some rivers of the South East. In addition, the 120 Ml/d loss of deployable output through abandonment of Test and Itchen drought permits after 2040, would raise the total investment cost of environmental improvement to around £9 billion.

Some details of how the abstraction reductions were derived are given in WRSE's short (10-page) technical note "Environmental Ambition Technical Note"[1]. However, this only gives details of the Environment Agency's method of determining the required reductions – a mechanistic "handle-turning" exercise, using environmental flow indicators (EFIs) – and it only gives amounts of reductions in water supply zones. It doesn't give details of reductions for individual sources or rivers, or even for individual Water Framework Directive (WFD) water bodies.

WRSE have been helpful in responding to GARD requests for more information on the amounts and locations of the reductions, although the full details of rivers and sources originally requested on 21st November 2022 were not received until 16th February 2023[2]. This gave details of losses of deployable output at individual sources under 'High', 'Medium', and 'Low' scenarios, including the river locations. From the information provided, we can see that the loss of deployable output from environmental reductions in water company WRMPs correspond closely to the 'High' scenario in the data provided by WRSE. We have commented on these in Sections 2.2.3 and 2.2.4, suggesting that many of the proposed reductions are unnecessary and could not be justified either economically or in terms of net environmental impact after consideration of the impact of replacement sources.

The lack of detail of the abstraction reductions was the subject of complaint in WRSE's consultation on their emerging plan in spring 2022. WRSE responded as follows[3]:

> A recurring theme in comments on the emerging plan was the request for additional details and information on abstraction reductions proposals, including the specific changes that are being proposed, and the benefits that will be secured. WRSE's draft plan will set out its proposed approach and programme for achieving the abstraction reductions in the draft regional plan in Autumn 2022. This will be at a regional level, however the individual company draft WRMPs that are to be published for consultation will include more information at a company level. WRSE and the companies will also set out more information on the plans for prioritising catchments for abstraction reductions.

Despite WRSE's assurance, there is no detail or justification of individual abstraction reductions in WRSE's latest plan and generally little in water company WRMPs (more in Thames Water's plan). Unless other consultees have asked for and received similar information to that requested by GARD, there is no way that they can judge the reasonableness and efficacy of WRSE's planned environmental reductions and the consequent expenditure of about £9 billion on replacement sources. Although GARD is very grateful for the information provided on request in reference 3, the

[1] "Environmental Ambition Technical Note, February 2022: https://www.wrse.org.uk/media/4r3hrklb/wrse-environmental-ambition-technical-note-revd-002.pdf

[2] WRSE Excel file *'GARD-09 Additional Source Level Environmental Ambition Data.xlsx'*

[3] WRSE Consultation Response for Emerging Regional Plan, May 2022, paragraph 6.2, page 17

lack of its availability to others is a gross failing in transparency which, in GARD's opinion, invalidates any findings that WRSE might draw from the consultation on their plan.

2.2.2 Lack of justification of WRSE's proposed environmental improvements

In Technical Annex 2, WRSE attempt to justify their planned abstraction reductions through an assessment of the benefits of achieving Water Framework Directive 'Good' status in the rivers concerned, as shown in Table 12.1 on page 60, which is copied below as Table 1:

Table 12.1: Benefits of achieving good ecological status in South East

Catchments	Sum of Benefits (£m)	Sum of Risk adjusted benefits (£m)
Adur and Ouse	£ 129	£ 90
Arun and Western Streams	£ 178	£ 125
Cam and Ely Ouse (including South Level)	£ 6	£ 4
Cherwell	£ 52	£ 36
Colne	£ 344	£ 241
Combined Essex	£ 8	£ 6
Cotswolds	£ 92	£ 65
Cuckmere and Pevensey Levels	£ 51	£ 36
Darent	£ 85	£ 60
East Hampshire	£ 30	£ 21
Isle of Wight	£ 26	£ 18
Kennet and Pang	£ 55	£ 38
Loddon	£ 90	£ 63
London	£ 638	£ 446
Maidenhead to Sunbury	£ 156	£ 109
Medway	£ 355	£ 248
Mole	£ 195	£ 136
New Forest	£ 1	£ 1
North Kent	£ 9	£ 6
Roding, Beam and Ingrebourne	£ 15	£ 11
Rother	£ 113	£ 79
Severn Vale	£ 102	£ 71
Stour	£ 101	£ 71
Test and Itchen	£ 42	£ 29
Thame and South Chilterns	£ 146	£ 102
Upper and Bedford Ouse	£ 2	£ 1
Upper Lee	£ 187	£ 131
Warwickshire Avon	£ 2	£ 1
Wey	£ 190	£ 133
Grand Total	**£ 3,399**	**£ 2,379**

Table 1 - WRSE's assessment of benefits from environmental reductions

WRSE's commentary on this table (paragraphs 12.22 to 12.24) is as follows:

> *"Taking these values and applying them to the current status, lengths of the water courses and the duration of the regional plan, the resultant benefits are assessed to be between £2.3bn and £3.4bn, as explained in table 12.1. This indicates that achieving a good status across the region brings significant benefits. It is recognised that these benefits do not occur from abstraction reductions alone; other actions will be required by industries and people who work and/or operate within a catchment.*
>
> *The risk adjusted benefits assume that 30% of the measures put in place will not fully succeed in the catchment and therefore some of the water bodies for a specific health indicator do not reach 'good' status.*
>
> *The scale of environmental benefits that can be achieved through achieving 'good' ecological status is relevant to the consideration of the cost of the draft regional plan proposals. The cost to the plan as a whole, when including environmental ambition, is significant and one of the largest cost drivers that we have. On face value the increased cost does not balance out with the benefits. A significant part of the regional environmental ambition may become a legal requirement (to ensure that WFD status does not deteriorate) subject to any necessary cost benefit consideration of the licence changes required as part of sustainability reductions, or other legal mechanism that may be used."*

In other words, WRSE recognise in Technical Annex 2 (but not the Main Plan document) that the benefits of the abstraction reductions fall far short of their costs. As WRSE point out, the £9 billion cost only covers the abstraction reductions. If water quality improvements are also needed to achieve Water Framework Directive (WFD) compliance, there is likely be several £ billions of additional expenditure required for STW improvements and dealing with storm overflows.

WRSE seem to suggest that the huge excess of cost over benefit might be justified if the abstraction reductions are a legal requirement for Water Framework Directive compliance. However, this argument seems unlikely to hold as the Water Framework Directive provides allowance for relaxing objectives if WFD compliance is disproportionately costly.

It can be concluded that WRSE have totally failed to justify their planned "environmental improvements". The six water companies behind the WRSE group seem to have accepted the Environment Agency's "handle-turning" estimates of required abstraction reductions without question, despite being aware that they are grossly uneconomic.

It should also be noted that the CaBA chalk stream strategy, prepared by a group including environmental NGOs and rivers trusts, suggests prioritising chalk stream abstraction reductions to far lower amounts than allowed for in WRSE's plan[4]. The CaBA chalk stream strategy recommends as follows:

[4] CaBA chalk stream group, Chalk Stream Restoration Strategy, Main Report, October 2021 https://catchmentbasedapproach.org/wp-content/uploads/2021/10/CaBA-CSRG-Strategy-MAIN-REPORT-FINAL-12.10.21-Low-Res.pdf.

"A prioritisation of abstraction deficits is needed according to whether they are ecologically essential, ecologically desirable, or of limited ecological benefit. The total deficits identified by the EA and put forward to national framework groups are so considerable that it will be impossible to address them all. National framework groups are charged with looking at the water resources options that give 'best value to customers, society and the environment, rather than simply focusing on the lowest cost' (see Section 4.4) however, cost will come into the equation, at which point we need to ensure that the ecologically essential reaches of chalk streams benefit from the scale of abstraction reductions needed to properly facilitate their recovery (in conjunction with measures to address water quality and physical habitat)."

Although the CaBA strategy only considers chalk streams (for instance not including Cotswolds rivers) and did not look at all rivers in the South East, the prioritisation suggested by the CaBA plan would probably lead to far lower abstraction reductions being required in the South East. This is further considered in Sections 2.2.3 and 2.2.4.

2.2.3 Case study of environmental improvements in Colne/Lea chalk streams

Overall Environmental reductions in the Colne and Lea valleys

WRSE's total 1360 Ml/d of deployable output reductions for environmental improvements by 2075 include 415 Ml/d of reductions in the Colne and Lea valleys. About 230 Ml/d of these reductions are from Affinity Water's supplies and about 185 Ml/d from Thames Water's supplies.

Data on deployable output loss in individual sources have been obtained via an information request to WRSE[5]. Comparison of the WRSE data and the data in the water company WRMP tables shows that Affinity Water's planned environmental reductions align exactly with WRSE's 'High' scenario for abstraction reductions.

Reductions in the upper Colne and Lea chalk tributaries

The proposed abstraction reductions have been reviewed separately in a recent report for the Chalk Streams First (CSF) group of NGOs, which is available on the internet[6]. This report compared the abstraction reductions proposed by Chalks Stream First with the deployable output losses in Affinity Water's plan, as shown in Table 2:

[5] Data supplied by WRSE in file *'GARD-09 Additional Source Level Environmental Ambition Data.xlsx'*

[6] Dealing with the impacts of groundwater abstraction on the chalk streams of the Colne and Lea valleys, Chalk Streams First, January 2023 https://chalkstreams.org/flow-recovery-following-abstraction-reduction/

		CSF Proposal			WRSE/Affinity Water DO loss	
Colne catchment:	**Recent abstraction 2019-21**	**CSF proposed abstraction**	**Abstraction reduction**	**Reduction by 2034-35**	**Reduction by 2039-40**	**Reduction by 2049-50**
Misbourne	15.8 Ml/d	6.2 Ml/d	9.6 Ml/d	2.0 Ml/d	4.0 Ml/d	4.0 Ml/d
Chess	15.1 Ml/d	4.1 Ml/d	11.0 Ml/d	0.0 Ml/d	0.0 Ml/d	0.0 Ml/d
Gade	36.2 Ml/d	11.9 Ml/d	24.3 Ml/d	4.7 Ml/d	18.4 Ml/d	36.4 Ml/d
Ver	25.8 Ml/d	7.7 Ml/d	18.1 Ml/d	6.4 Ml/d	11.8 Ml/d	11.8 Ml/d
		Colne total	**63.0 Ml/d**	**13.1 Ml/d**	**34.2 Ml/d**	**52.2 Ml/d**
Lea Catchment:						
Upper Lea to Water Hall	48.4 Ml/d	7.2 Ml/d	41.2 Ml/d	4.1 Ml/d	8.9 Ml/d	38.7 Ml/d
Mimram	10.4 Ml/d	6.1 Ml/d	4.3 Ml/d	1.7 Ml/d	3.2 Ml/d	3.2 Ml/d
Beane	24.9 Ml/d	9.8 Ml/d	15.2 Ml/d	14.0 Ml/d	14.0 Ml/d	21.6 Ml/d
Rib	22.8 Ml/d	7.3 Ml/d	15.5 Ml/d	7.1 Ml/d	7.1 Ml/d	15.5 Ml/d
Ash	1.2 Ml/d	0.0 Ml/d	0.0 Ml/d	0.7 Ml/d	0.7 Ml/d	0.7 Ml/d
Stort	25.0 Ml/d	13.5 Ml/d	11.5 Ml/d	8.4 Ml/d	8.4 Ml/d	15.8 Ml/d
		Lea total	**87.6 Ml/d**	**36.0 Ml/d**	**42.3 Ml/d**	**95.6 Ml/d**
		Total	**150.6 Ml/d**	**49.1 Ml/d**	**76.5 Ml/d**	**147.8 Ml/d**

Table 2 - CSF and WRSE/Affinity abstraction reduction proposals in upper Colne/Lea tributaries

The figures in Table 2 show that the CSF proposed reductions align quite well with the losses of deployable output losses assumed in WRSE's 'High' scenario and Affinity Water's WRMP. The CSF and WRSE figures are not directly comparable because the CSF figures are reductions from recent abstraction and WRSE figures are losses in deployable output. This will explain some of the differences in figures for the individual chalk streams.

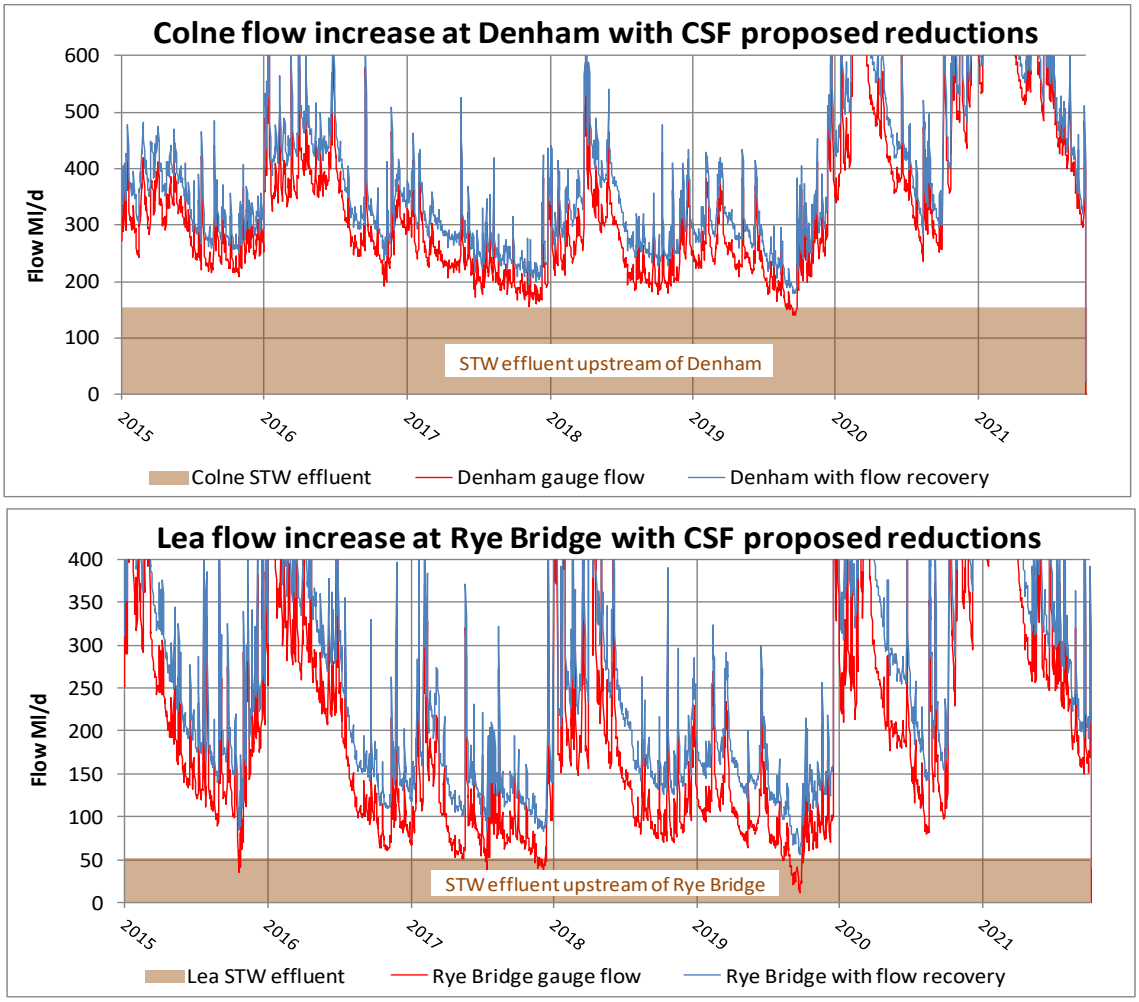
The comparison in Table 2 shows that WRSE/Affinity Water's proposed reductions in the upper chalk streams of the Colne and Lea valleys are similar in overall amount to the Chalk Streams First proposals – a total of about 150 Ml/d. Therefore, GARD supports these proposed reductions in the upper chalk streams. However, we note that the timing of the reductions in WRSE/Affinity's plan delays most of these urgently needed improvements until after 2040, because of a perceived need to wait for a major new source like Abingdon reservoir or the STT – a major weakness in WRSE and Affinity Water's plans.

Reductions in the Lower Colne and Lea

In addition to the 150 Ml/d of deployable output losses due to environmental improvements in the upper Colne and Lea chalk streams shown in Table 2, all from Affinity Water's supplies, WRSE's plan includes 86 Ml/d of deployable output loss from Affinity Water abstraction reductions in the lower Colne and 185 Ml/d of deployable output loss from Thames Water supplies in the lower Lea. This amounts to 264 Ml/d of deployable output loss from the lower river reductions, as compared with only 150 Ml/d of planned reductions from the upper catchment chalk streams.

Without any abstraction reductions in the lower Rivers Colne and Lea, the lower river flows would benefit substantially from the planned reductions in the upper catchment chalk streams. The effect of the upper catchment reductions on flows in the lower River Colne at Denham and the lower River Lea at Rye Bridge is shown in Figure 3 below. The Denham gauging station is located downstream of the Misbourne confluence and includes about 150 Ml/d of effluent flows from Maple Cross sewage treatment works and a number of smaller STWs in the upper Colne tributaries. The Rye Bridge gauging station on the River Lea is located downstream of the River Ash confluence but upstream of the River Stort. The gauged flows at Rye Bridge include about 50 Ml/d of effluent from a number of STWs in the upper Lea catchment, mainly about 35 Ml/d from Luton STW, but does not include effluent from Rye Meads STW, which discharges downstream of the gauge.

The CSF modelled flow recoveries from the proposed abstraction reductions in four case study rivers (Chess, Ver, Mimram and Beane) have been extrapolated to simulate the total flow recoveries at Denham and Rye Bridge from all the CSF proposed abstraction reductions shown in Table 2 excluding the Stort, ie total abstraction reductions of 63 Ml/d in the Colne and 76 Ml/d in the Lea. The flow recoveries that would have occurred in 2015 to 2021 are shown in Figure 3:



Note: the plotted STW effluent amounts are 'recent actual' data in 2015 from EA File *'HERTS Artificial Influences overview.xlsx'*

Figure 3 - Lower Colne and Lea flow recoveries from proposed upper catchment reductions

The abstraction reductions in the upper catchments would substantially increase flows in the lower rivers, which are at present mainly STW effluent flows in droughts. The upper catchment reductions would provide a large increase in STW effluent dilution. The plotted 2015 'recent actual' effluent amounts in Figure 3 exceed the gauged flows at times, partly because actual effluent discharges may have been lower than 'recent actual', but perhaps mainly because of losses from the river beds at times of drought flows.

At the historic Amwell Magna fishery on the River Lea (about 3 km upstream of Rye Bridge gauge), summer flows would increase by about 30-50% and would no longer be almost entirely STW effluent. This would be a substantial benefit without any contribution from lower Lea abstraction reductions.

Whereas the abstraction reductions in the upper Colne and Lea catchment are easily justified in terms of restoring near-natural flows in iconic chalk streams, the benefits of the larger reductions in the lower rivers are highly questionable. The lower River Colne river weaves between gravel pits and forms part of the Grand Union Canal for a lot of this reach. It is classified as Heavily Modified from downstream of the Gade confluence. Flows from Denham down are largely effluent from Maple Lodge STW which returns much of the water abstracted further up the Colne catchment

The lower River Lea below Feildes Weir is also classified as Heavily Modified. It is highly urbanised, canalised and unrecognisable as a chalk stream. The lower Rivers Colne and Lea are not and never will be "classic" chalk streams.

The WRSE's planned 185 Ml/d of deployable output loss from the lower Lea reductions is equivalent to the deployable output of the 100 Mm^3 Abingdon reservoir, which has a cost of about £2 billion. In addition to the £2 billion cost of the replacement water source, achievement of WFD good status would probably require a comparable expense in sewerage improvements. The risk adjusted benefit for achieving WFD good status in all London catchments is only £446 million, as shown in Table 1. Therefore, the planned 185 Ml/d reductions in the lower Lea are grossly uneconomic and cannot be justified.

Similarly, Table 1 shows that the risk adjusted benefit for achieving good ecological status in the Colne valley is only £241 million, whereas the cost of replacement sources for the planned 79 Ml/d of lower River Colne reductions would be of the order of £ 1 billion and achievement of WFD Good status would also require substantial investment in sewerage improvements.

Noting Ofwat's concerns over increases in customer bills and nationwide concerns over sewage pollution, it is suggested that the £3 billion needed for replacement sources for the lower Colne and Lea reductions would be much better spent on sewerage improvements. Therefore, GARD concludes that the planned 264 Ml/d of deployable output losses from "environmental improvements" in the lower Colne and Lea are unjustifiable and should be deleted from WRSE's plan.

Flow and deployable output recovery from upper Colne and Lea reductions

The amount and timing of chalk stream flow recovery from abstraction reductions is crucial to avoid excessive cost and long delays in flow re-naturalisation. If the amount of recovery is high and a good proportion of extra water from the chalk catchments is available to refill the existing downstream reservoirs in droughts, there will be comparatively little additional water resource development

needed for replacement supplies. This would allow flows in the Chilterns chalk streams to be re-naturalised within a few years and at relatively low cost.

Affinity Water's plan assumes that only 17% of the flow recovery from abstraction reductions converts to increased deployable output from the London reservoirs[7].Consequently, the plan delays most of the environmental abstraction reductions until after 2040, because of the supposed need to wait for replacement supplies from Abingdon reservoir, which cannot deliver water to Affinity Water's supply zones until after2040.

The Chalk Streams First report "Dealing with impacts of groundwater abstraction on the chalk streams of the Colne and Lea valleys"[8] examined in detail the evidence of measured flow recovery from abstraction reductions and the results of groundwater modelling. From reviews of measured flow recoveries, the main conclusions were (with reference to the relevant pages in the CSF report):

1. Given sufficient time for flows to recover after genuine and maintained total abstraction reductions in a catchment, the measured flow gains will average about 80% of the abstraction reduction, varying from less than 30% recovery at the end of severe droughts to well over 100% recovery at times of high groundwater levels and flows (page 45).

2. This pattern of measured flow recovery is seen consistently in examples in several rivers:

    - The Friars Wash reduction in the River Ver in 1993 (pages 33 to 36)
    - Comparative flow and abstraction changes in the Rivers Chess and Ver (pages 37 to 39)
    - Comparative flow and abstraction changes in the Rivers Beane and Rib (pages 39 to 41)

3. Lack of river flow recovery during short term abstraction shut downs ('signal tests), does not mean lack of flow recovery from permanent abstraction shut downs and should not be used as evidence of lack of flow recovery from long term reductions (page 24).

4. There are no instances of flow recoveries failing to materialise when they might reasonably be expected after genuine and maintained abstraction reductions – several examples of supposedly "disappointing" flow recoveries can be explained by the reductions being too small, insufficiently maintained, or too recent for measurable recovery to have materialised.

The CSF report reviewed modelled flow recoveries shown by the Environment Agency's Herts Regional Groundwater Model and from its own lumped parameter models. These models all validate reasonably well when comparing modelled and measured historic groundwater levels and river flows (details in Appendices A to D in CSF report). As described in Chapter 4 of the CSF report, pages 46 to 52), both models show very similar patterns and amounts of flow recovery from abstraction reductions:

1. The patterns and amounts of modelled flow recoveries are similar to the measured flow recoveries described above.

[7] Affinity WRMP24, Annex 5.6, page 13

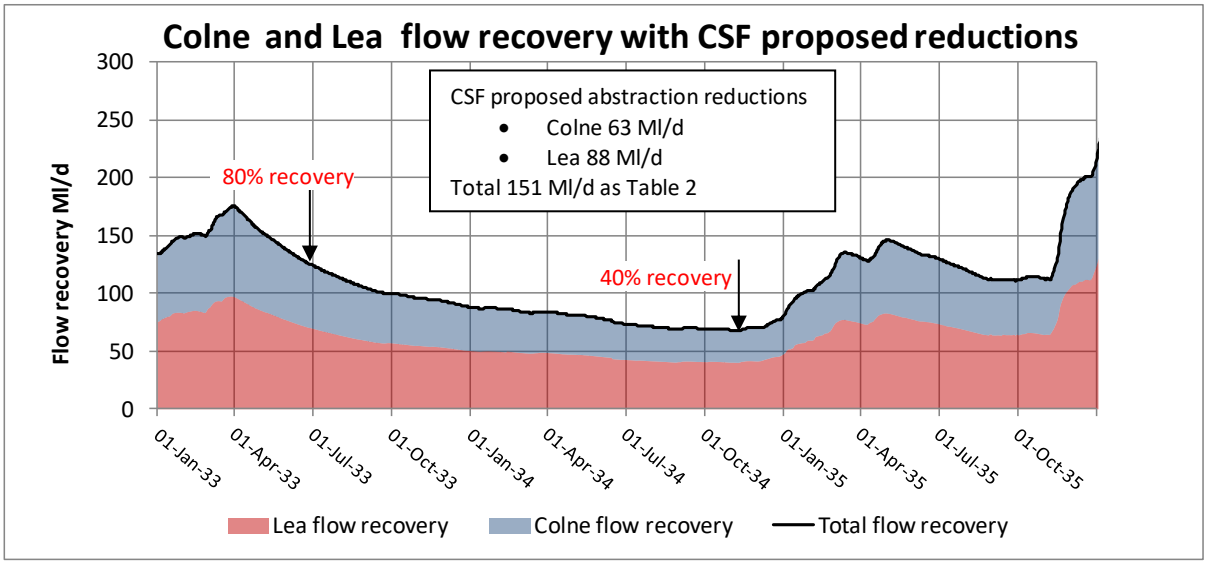
[8] Dealing with the impacts of groundwater abstraction on the chalk streams of the Colne and Lea valleys, Chalk Streams First, January 2023 https://chalkstreams.org/flow-recovery-following-abstraction-reduction/

2. At average river flows, modelled river flow recoveries are in the region of 80% of the abstraction reductions. At extreme low flows, modelled flow recoveries are typically around 30-40% of abstraction reductions.

3. These conclusions are equally true in all four case study rivers (Chess, Ver, Mimram and Beane).

The modelled and measured flow recoveries are similar. They are far more than the 17% flow recovery assumed in WRSE's plan and Affinity Water's WRMP.

The Chalk Streams First Report, page 60, shows modelled flow recoveries from the total 151 Ml/d of CSF proposed abstraction reductions shown in Table 2. The modelled daily Colne and Lea flow recoveries since 1920 have been added to the Teddington and Feildes Weir gauged flow records to assess the increase in London deployable output, using the GARD model of the London supply system. Details of GARD's London supply model are given in Appendix F to the CSF report. In the 100-year period 1920-2019, with the enhanced reservoir inflows, the critical drought which governs London deployable output is July 1933 to November 1934 as shown in Figure 4:



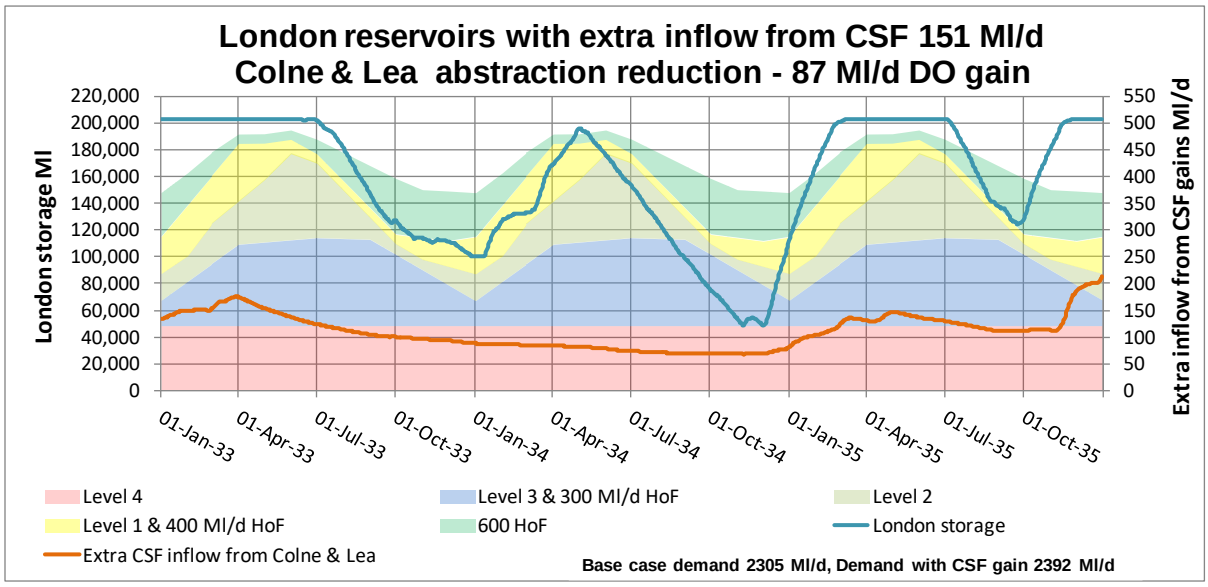


Figure 4 - Modelling of London DO gain from CSF proposed reductions in 1933-34

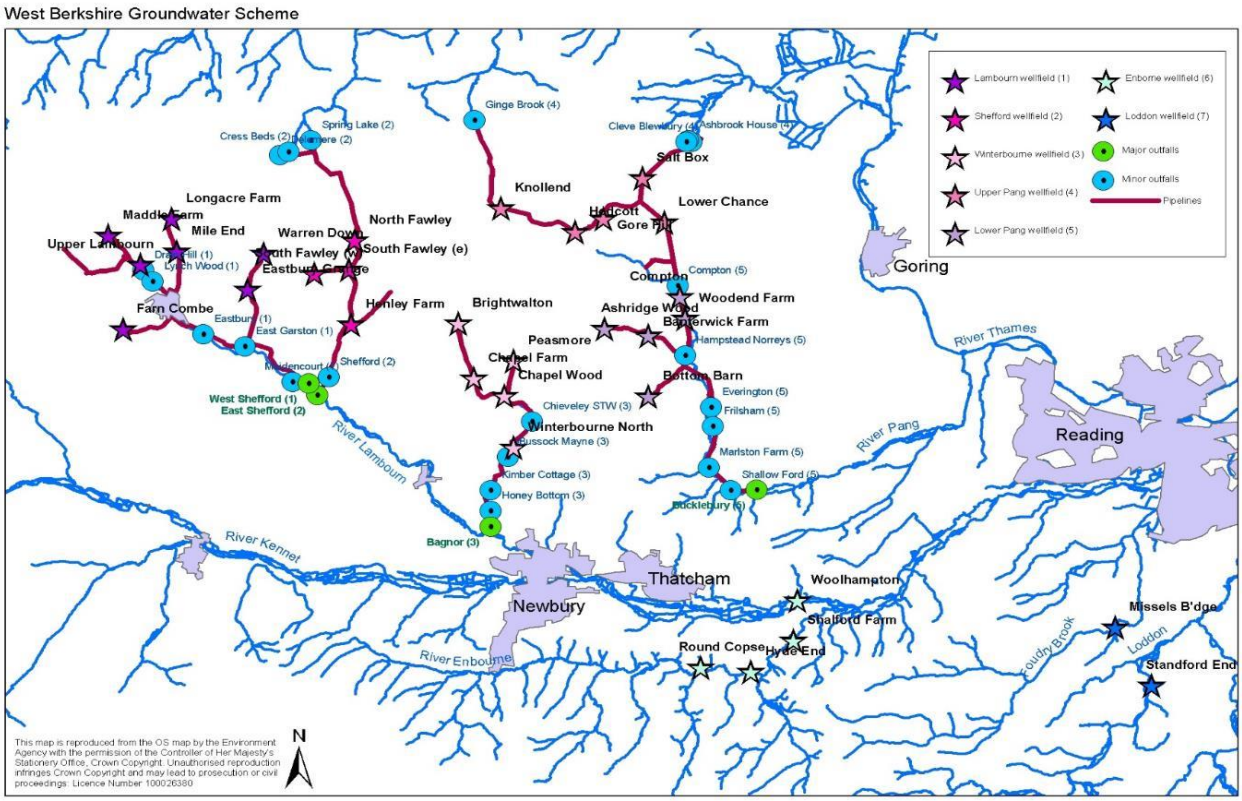
The modelled flow recovery in the 18-month drought starts at over 80% of the 151 Ml/d abstraction reduction at the start of the drawdown of the London reservoirs in July 1933. The modelled flow recovery percentage drops to around 40% when London storage starts to recover in November 1933. The modelled 87 Ml/d gain in deployable output is 58% of the 151 Ml/d abstraction reduction – a far higher gain than the 17% assumed in current draft water company WRMPs.

It is concluded that when considering the amount of replacement sources needed for the planned abstraction reductions in the upper Colne and Lea chalk streams, the assumed deployable output recovery in the London reservoirs should be around 55-60% and not the 17% assumed in WRSE's plan. If the deployable output recovery is, say, 55%, the 151 Ml/d of gross deployable output loss from Affinity Water's supplies would only require about 70 Ml/d of replacement sources – ie 45% of 151 Ml/d.

WBGWS-type scheme for the upper Colne, Lea and Ouse chalk streams

GARD recognises that there is uncertainty in the amount of flow recovery from chalk stream abstraction reductions that can be converted into additional deployable output from downstream reservoirs. However, this uncertainty can be managed, with a possible net increase in deployable output from downstream reservoirs, if the chalk aquifer is used for drought support schemes similar to the existing West Berkshire Groundwater Scheme.

The West Berkshire Groundwater Scheme (WBGWS) was constructed in the 1970s to augment London's water supplies during severe droughts – its planned use is about once in 25 years. The scheme abstracts water from boreholes in the chalk aquifer in the upper Lambourn, Pang, Enbourne and Loddon valleys, discharging water into those rivers from where it flows down into the River Thames for later abstraction to fill London's reservoirs. It contributes about 90 Ml/d to London's deployable output. The layout and components of the existing WBGWS are shown in Figure 5:



Map copied from Environment Agency presentation to Action for the River Kennet in January 2020

Figure 5 - Layout of the existing West Berkshire Groundwater Scheme

In general, the scheme abstracts groundwater in the upper parts of the chalk valleys, where there is little if any perennial river flow, and transfers water via pipelines to discharge into the lower parts of the valleys where there is perennial river flow even in severe droughts. This avoids discharging the water into a dry river bed where it would quickly sink back to the water table. There are some intermediate discharge points to augment drought flows further up the valleys, simulating a natural flow accretion profile.

In a drought, the scheme is allowed to be used for a maximum of 8 months. The maximum daily release in each donor catchment corresponds to roughly 20-30% of average catchment recharge. The total release from the donor catchments gradually reduces from 126 Ml/d to 67 Ml/d, as the drought progresses. The scheme is triggered in periods of extremely low flows in the River Thames, when the London reservoir storage falls below a control line.

Thames Water's WARMS2 modelling of the London supply system for their 2019 Water Resource Management Plan showed that, in the past 100 years, the WBGWS would only have been used significantly in the droughts of 1921/22, 1933/34, 1943/44 and 1975/76. The scheme would also have been triggered briefly in 1949.

The recent Chalk Streams First report shows how the chalk tributaries of the Colne and Lea could be used in a WBGWS-type scheme, providing an insurance against flow recovery being less than

expected[9]. Drought support releases from the Colne tributaries could be used for filling the existing lower Thames reservoirs and support from the Lea tributaries would feed into the Lea valley reservoirs. An indication of the potential scale of adopting the WBGWS concept across all the Lea and Colne tributaries is shown in Table 4. The suggested maximum releases for each of the tributaries are in the region of 20-30% of average recharge, as is the case for the Lambourn, Enbourne, Pang and Loddon:

	Colne chalk streams				
	Misbourne	Chess	Gade/ Bulbourne	Ver	Totals for Colne
Catchment area km²	95 km2	105 km2	184 km2	132 km2	516 km2
Av. annual recharge	74 Ml/d	82 Ml/d	144 Ml/d	103 Ml/d	403 Ml/d
Continuous PWS abstraction					
Abstraction in 2019-21	15.8 Ml/d	15.1 Ml/d	36.2 Ml/d	25.8 Ml/d	92.9 Ml/d
Abstraction as % recharge	21.2%	18.4%	25.2%	25.0%	23.0%
CSF proposed abstraction	6.2 Ml/d	4.1 Ml/d	11.9 Ml/d	7.7 Ml/d	29.9 Ml/d
Reduction to achieve A10%R	9.6 Ml/d	11.0 Ml/d	24.3 Ml/d	18.1 Ml/d	**63.0 Ml/d**
WBGWS-type support					
Suggested maximum release	20 Ml/d	20 Ml/d	40 Ml/d	25 Ml/d	**105 Ml/d**

	Lea Chalk streams					
	Upper Lea (to Water Hall GS)	Mimram	Beane	Rib & Quin	Stort	Totals for Lea
Catchment area km2	150 km2	136 km2	175 km2	152 km2	280 km2	893 km2
Av. annual recharge	87 Ml/d	79 Ml/d	102 Ml/d	88 Ml/d	163 Ml/d	518 Ml/d
Continuous PWS abstraction						
Abstraction in 2019-21	48.4 Ml/d	10.4 Ml/d	24.9 Ml/d	22.8 Ml/d	25.0 Ml/d	131.5 Ml/d
Abstraction as % recharge	55.6%	13.1%	24.5%	25.9%	15.4%	25.4%
CSF proposed abstraction	7.2 Ml/d	6.1 Ml/d	9.8 Ml/d	7.3 Ml/d	11.5 Ml/d	43.2 Ml/d
Reduction to achieve A10%R	41.2 Ml/d	4.3 Ml/d	15.2 Ml/d	15.5 Ml/d	13.5 Ml/d	**89.6 Ml/d**
WBGWS-type support						
Suggested maximum release	25 Ml/d	20 Ml/d	25 Ml/d	20 Ml/d	40 Ml/d	**130 Ml/d**

Table 3 - Potential for WBGWS concept in the Colne and Lea catchments

Reduction of abstraction to achieve acceptable flows across all of the Colne and Lea tributaries would require about 63 Ml/d of replacement supply, potentially from Thames Water's lower Thames reservoirs. The impact on London's supplies could be offset by up to 105 Ml/d of drought support releases from the upper Colne chalk. The equivalent figures for the Lea catchment could be 90 Ml/d of replacement sources and up to 130 Ml/d of drought support releases from the upper Lea chalk.

GARD model simulation of the abstraction reductions and WBGWS-type support releases shown in Table 4 suggests that they could give a net gain to London deployable output of in the region of 55-60 Ml/d after allowing for 87 Ml/d of flow recovery from the total 153 Ml/d of abstraction reductions, as shown on Figure 10.

[9] Dealing with the impacts of groundwater abstraction on the chalk streams of the Colne and Lea valleys, Chalk Streams First, January 2023 https://chalkstreams.org/flow-recovery-following-abstraction-reduction/

The CSF report's conclusions from this assessment of the potential for use of the WBGWS concept in the Chilterns chalk streams were:

1. If the concept was adopted in all the upper Colne and Lea chalk streams, abstraction could be reduced by 150 Ml/d as proposed by EA, with replacement supplies as from London reservoirs and a net gain to London's supplies of possibly 60 Ml/d.

2. The drought support would only be needed about once in 25 years. Flows in the chalk streams in drought years would be increased by the WBGWS-type releases and would be slightly less in the following year (but still much more than with abstraction at recent levels).

3. Although the net gain in London supplies requires much more investigation, the introduction of the WBGWS concept would remove much of the doubt that currently exists over the amount of flow recovery from abstraction reductions.

4. In principle, the conjunctive use of the chalk aquifer and the reservoirs downstream appears a much better way of using the chalk water resource, with far less impact on chalk streams than continuous pumping of water supplies directly from the chalk.

5. The concept should now be investigated as a matter of urgency, with the aim of implementing one or more pilot schemes in AMP8 and full implementation in AMP9.

A similar proposal for using the WBGWS concept at a pilot scale has been put forward for the River Ivel catchment (an upper Ouse chalk tributary on the northern scarp of the Chilterns). This would entail much reduced existing abstraction for day-to-day supplies, replacement supplies brought in from Grafham reservoir, enhanced Ivel flows into the River Ouse used to augment Grafham reservoir refilling and use of the existing Ivel groundwater storage as a drought source in a similar fashion to the WBGWS. A pre-feasibility study of this proposal is currently being undertaken jointly by Affinity Water and Anglian Water, with a report due in summer 2023.

The Ivel investigation can point the way for investigation of the WBGWS concept at a larger scale in the Chilterns, including the upper Colne and Lea chalk streams. If the concept is found to be viable, it removes most of the uncertainty surrounding river flow recovery and maintaining supplies if recovery is found to be less than expected. This would allow the proposed upper Colne, Lea and Ouse abstraction reductions to proceed quickly with more confidence, being in place by 2034, without any need for a major new source like Abingdon reservoir or the Severn to Thames transfer.

Conclusions from the Colne/Lea case study

The following conclusions can be drawn from the case study on WRSE's assessment of the need for new resources in the Colne and Lea catchments:

- WRSE's total need of 415 Ml/d, comprises 150 Ml/d of deployable output loss in the upper chalk streams and 265 Ml/d in the lower river.

- The upper catchment reduction of 150 Ml/d aligns with the CSF report findings and is supported by GARD.

- The 265 Ml/d of reductions in the lower rivers have questionable benefits and are disproportionately costly – they cannot be economically justified and GARD proposes they should be deleted.

- WRSE's estimate of only 17% deployable output recovery from the enhanced chalk stream flows is a gross underestimate – measured flow recoveries and modelling shows recoveries of about 55-60%.

- The 150 Ml/d of reductions in the upper chalk streams would only require about 70 Ml/d of replacement sources, after allowing for 55% deployable output recovery from the enhanced chalk stream flows.

- The uncertainty in deployable output recovery can be managed by an "insurance" scheme similar to the West Berkshire Groundwater Scheme – if deployable output recovery is only 17%, this scheme would make up the shortfall; if recovery is 55-60%, as concluded in the CSF report, the scheme could give a 60 Ml/d deployable output increase in London's supplies.

The overall conclusions from the case study is that WRSE's assessed need of 420 Ml/d of new resources for the Colne and Lea catchments should only be 70 Ml/d and there should be an urgent investigation of WBGWS-type of insurance schemes to guard against flow recovery being less than expected.

2.2.4 Review of environmental improvements outside the Colne/Lea catchments

The abstraction reductions in the Colne and Lea catchments, as described in Section 2.2.3, include most of the cases of severe over-abstraction in the South-East, as identified by the CaBA chalk stream group's independent analysis based on abstraction as a percentage of average catchment recharge, abbreviated to A%R[10].

The Environment Agency assesses chalk abstraction acceptability using Environmental Flow Indicators (EFIs). Compliance with EFIs is measured using regional groundwater models and then requires further modelling to determine the abstraction reductions needed to comply with the EFIs. The A%R method has the potential to be a faster, more accessible and more readily understandable measure of abstraction acceptability.

The assessed values of A%R for recent and licensed abstraction are shown below:

[10] A%R, Abstraction as a % of recharge in chalk streams, December 2021 https://chalkstreams.org/ar-abstraction-as-a-of-recharge-in-chalk-streams/

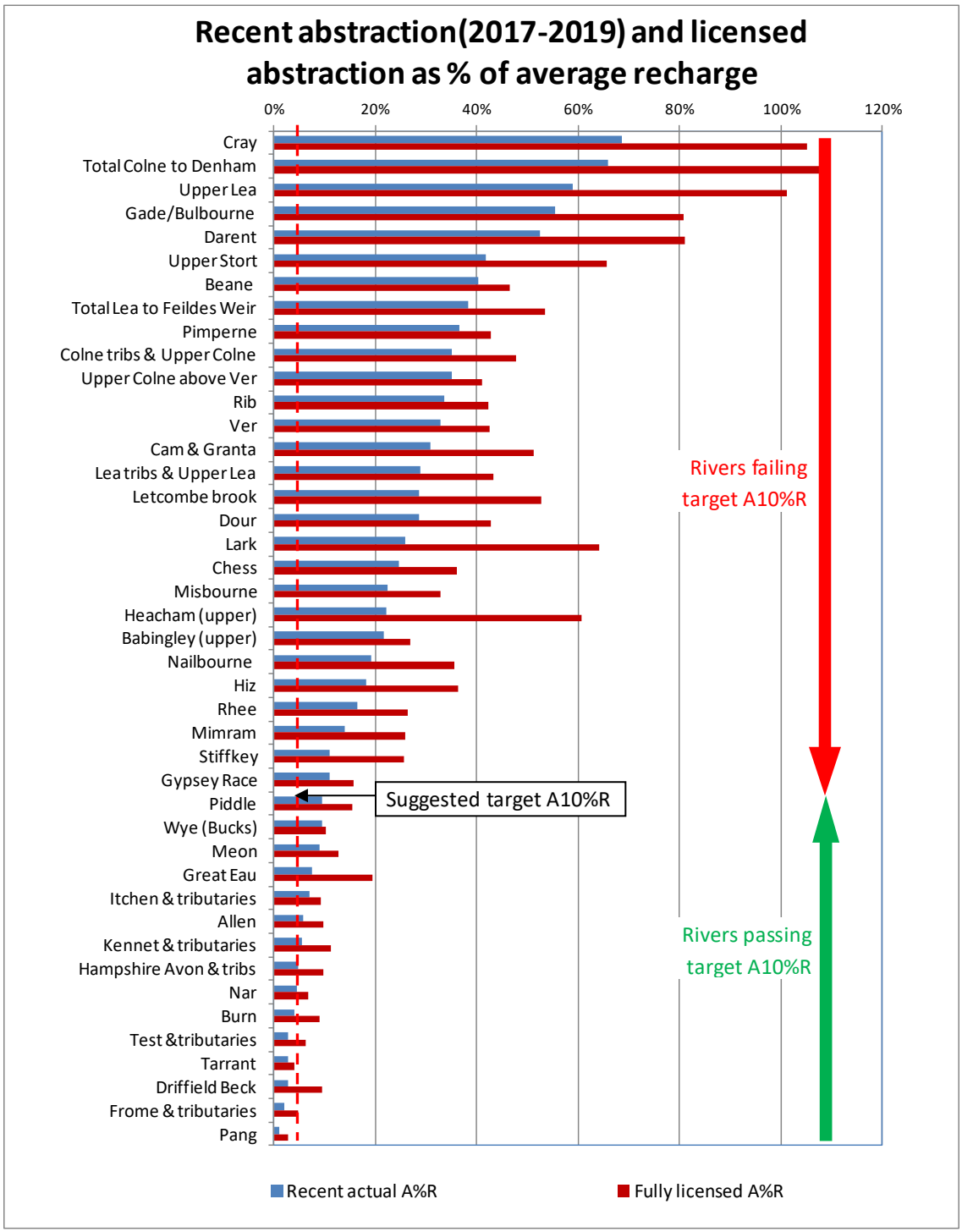


Figure 6 - Abstraction as % of Recharge for selected chalk streams

The Environment Agency's environmental flow indicator (EFI) targets for the most sensitive chalk streams (abstraction sensitivity band ASB3) allow no more than 10% reduction at times of low river flow and 15-20% at higher flows. Chalk Streams First modelling of abstraction impacts in the upper Colne and Lea chalk streams suggests that these targets would be broadly achieved if groundwater

abstraction is limited to 10% of average recharge[11]. This is suggested as an initial, pragmatic target if A%R is used as an indicator of acceptable abstraction in chalk streams.

As shown on Figure 6, the A%R report identified the Darent/Cray catchment south-east of London as a major case of chalk stream over-abstraction. The A%R report suggested abstraction reduction of about 110 Ml/d of reduction from recent actual amounts[12]. WRSE's data in file *'GARD-09 Additional Source Level Environmental Ambition Data.xlsx'* shows a planned deployable output loss of 105 Ml/d for the Darent/Cray abstraction reductions. GARD agrees with this assessment and recognises that a connection to Thames Water's London supply system is likely to be the only realistic means of enabling an abstraction reduction of this scale.

WRSE's data in file *'GARD-09 Additional Source Level Environmental Ambition Data.xlsx'* shows a loss of deployable output of 170 Ml/d from Thames Water's supplies in the Thames valley upstream of London – equivalent to almost the whole deployable output from Abingdon reservoir. GARD's comments on this are:

- None of these reductions were identified in the A%R report, suggesting that they are a much lower priority than the Colne, Lea and Darent reductions.
- About 70 Ml/d the reductions are from surface water or river-side gravel abstractions (Farmoor, Medmenham, Bourne End and Datchet), so there would be a high percentage recovery of deployable output for the London reservoirs and minimal overall loss of deployable output.
- For the remaining c. 100 Ml/d of proposed reductions for Thames Water's Thames valley groundwater sources, if they are genuinely necessary, there could be about 50-60% deployable output recovery at the London reservoirs, based on the CSF assessment for the Colne/Lea chalk streams. There would also be scope for WBGWS-type drought support schemes in the affected chalk streams, further limiting the loss of deployable output.

For the South East Water and Sutton and East Surrey supplies in the Thames valley, WRSE's data in file *'GARD-09 Additional Source Level Environmental Ambition Data.xlsx'* shows a planned deployable output loss of about 60 Ml/d mostly from chalk groundwater sources. As for Thames Water's Thames valley groundwater sources, GARD queries the priority of these reductions and suggests that, even if the reductions are justified, most of the deployable output loss would be recovered at the London reservoirs, with potential for further recovery from WBGWS-type drought schemes (in the same valleys as the abstraction reductions).

For Southern Water *'GARD-09 Additional Source Level Environmental Ambition Data.xlsx'* shows a total loss of 247 Ml/d of deployable output, of which 170 Ml/d are in Kent and Sussex, so would not be supplied by the Thames to Southern transfer. These reductions are not, therefore, of concern to GARD, although we observe that the planned replacement sources, several new reservoirs and

[11] Dealing with impacts of groundwater abstraction on the chalk streams of the Colne and Lea valleys, page 53 https://chalkstreams.org/flow-recovery-following-abstraction-reduction/

[12] A%R, Abstraction as a % of recharge in chalk streams, page 46, December 2021 https://chalkstreams.org/ar-abstraction-as-a-of-recharge-in-chalk-streams/

coastal desalination plants would be very costly and have large environmental impacts, throwing doubt on the justification of the reductions.

WRSE's data in file *'GARD-09 Additional Source Level Environmental Ambition Data.xlsx'* shows about 62 Ml/d of reduction in Southern Water's Hampshire zones – 43 Ml/d from the Itchen and 19 Ml/d from the Test. The analysis of abstraction as a % of recharge for the Test and Itchen catchments is shown in Table 4:

	Test catchment					Itchen catchment		
	Anton	Bourne Rivulet	Upper Test to Chilbolton	Test to Anton confluence	Test to Timsbury	Candover Brook	Upper Itchen to Winchester	Itchen to Chandlers Ford
Catchment area	185 km2	131 km2	453 km2	638 km2	978 km2	72 km2	280 km2	360 km2
Baseflow index	0.96		0.97		0.95			
Av. annual recharge	190.0 Ml/d	134.5 Ml/d	465.3 Ml/d	655.3 Ml/d	1004.5 Ml/d	73.7 Ml/d	469.8 Ml/d	604.1 Ml/d
Abstraction in 2017-19	12.9 Ml/d	0.9 Ml/d	5.9 Ml/d	18.8 Ml/d	24.8 Ml/d	2.8 Ml/d	13.8 Ml/d	41.6 Ml/d
A%R in 2017-19	6.8%	0.7%	1.3%	2.9%	2.5%	3.8%	2.9%	6.9%
Reduction to achieve A10%R	**0.0 Ml/d**	**0.0 Ml/d**	**0.0 Ml/d**	**0.0 Ml/d**	**0.0 Ml/d**	**0.0 Ml/d**	**0.0 Ml/d**	**0.0 Ml/d**
GW consumptive licence total	0.0 Ml/d	5.7 Ml/d	27.9 Ml/d	33.6 Ml/d	61.5 Ml/d	4.5 Ml/d	18.2 Ml/d	55.7 Ml/d
Licence A%R	0.0%	4.2%	6.0%	5.1%	6.1%	6.2%	3.9%	9.2%
Licence reduction for A10%R	**0.0 Ml/d**	**0.0 Ml/d**	**0.0 Ml/d**	**0.0 Ml/d**	**0.0 Ml/d**	**0.0 Ml/d**	**0.0 Ml/d**	**0.0 Ml/d**

Table 4 - Analysis of abstraction as a % of recharge for Test and Itchen catchments

The CaBA chalk stream group's A%R report concluded that no groundwater abstraction reductions were needed in the Itchen and Test catchments[13]. In the Itchen catchment, recent abstraction is only 2.9% of the average upper catchment recharge down to Winchester and 6.9% of the recharge of the catchment down to Chandlers Ford. In the Test catchment, recent abstraction is only 2.5% of the average catchment recharge. For both rivers, licensed abstraction is less than 10% of average recharge – the CaBA group proposed benchmark for acceptable abstraction. GARD concludes that the 62 Ml/d of deployable output loss planned for Test and Itchen groundwater sources is un-needed and should be dropped, or at the very least, be given a low priority.

WRSE's data in file *'GARD-09 Additional Source Level Environmental Ambition Data.xlsx'* shows 107 Ml/d of reductions for Portsmouth Water, which is about 60% of their current supplies. WRSE's file gives no clear indication of their locations. Portsmouth Water's WRMP document says their "*abstractions influence the Itchen, Meon, Ems and Lavant chalk streams and rivers.*[14]" The CaBA group's A%R report concluded that no abstraction reductions were needed for the Itchen and Meon groundwater sources. However, the report did not look at the Rivers Lavant (groundwater abstraction about 60 Ml/d in a small winterbourne catchment) or the River Ems, which is recognised as heavily over-abstracted (abstraction about 20 Ml/d)[15]. GARD recognises that there probably is a good case for substantial environmental reductions for Portsmouth Water's supplies.

[13] A%R, Abstraction as a % of recharge in chalk streams, Figure 2, pages 52 and 63, December 2021 https://chalkstreams.org/ar-abstraction-as-a-of-recharge-in-chalk-streams/

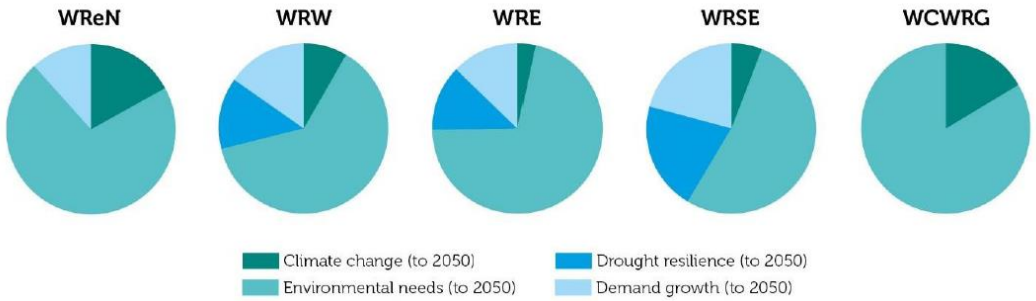
[14] Portsmouth Water main WRMP document, page 22

[15] Friends of the Ems, presentation, June 2021 https://e-voice.org.uk/greening-westbourne/assets/documents/presentation-slides-june-2021

2.2.5 Allowances for environmental improvements in other regions

Deficits due to abstraction reductions for 'environmental improvements' also dominate the deficit forecasts for other regions as shown by Figure 6:

Figure 6: Key upward pressures contributing to further supply-demand shortfalls by 2050 (from 2025)



Note Copied from page 10 of WRSE's Regional Reconciliation report[16]

Figure 7 - Allowances for environmental improvements in other regions

GARD has not looked into the detail of environmental ambitions for regions outside the South East, but it seems likely that they would be subject to the same criticisms as those in WRSE's plan – excessive reductions arising from the Environment Agency's 'handle-turning' methodology and gross excess of cost over benefit due to disproportionate costs of supposed compliance with the Water Framework Directive.

The significance of the large abstraction reductions outside the South East is that they limit the water available for transfer into the South East and drive up the cost of the replacement sources in transfer donor regions. Replacement source costs in the donor regions will be higher if less costly new sources are used to replace supplies lost from abstraction reductions – see later comments on selection of Abingdon reservoir ahead of the Severn to Thames transfer.

GARD appreciates that the huge allowances for abstraction reductions in all regions are driven by the Environment Agency and not the free choice of WRSE and the water companies. Evidence of this is shown by this statement on page 11 of the regional reconciliation report:

> *"Across the regions, the scale and nature of shortfalls has been most influenced by including the latest position on licence capping and environmental destination (using the latest clarifications and guidance from regulators). This has particularly impacted WRW and WReN, increasing the scale of deficit, whilst in WRSE updates altered the distribution of deficit in the region."*

The scale of groundwater abstraction reductions in the various regional plan is causing alarm with professional hydrogeologists and engineers who are aware of the huge cost and environmental impacts of replacement sources. For example, a recently published paper by Dr Rob Soley, a leading hydrogeology consultant, entitled "Enormous cuts to Groundwater Abstraction in England are Unwise"[17] says this:

[16]Inter-regional reconciliation of regional plans – Spring 2022
[17] Enormous cuts to Groundwater Abstraction in England are Unwise, Dr Rob Soley, CIWEM 2023, https://chalkstreams.org/2023/01/31/the-green-elephant-in-the-room-is-really-a-straw-man-in-the-room/

"There's a large green-washed elephant in the room. Hydrogeologists working on the ground can see the elephant. The regulator and water-company leaders know it's there but choose not to think or talk about it. Yes, groundwater is complex, but our industry is avoiding the science and the evidence because it fears being branded un-environmental. We must consider more broadly the real ecological benefits of reducing groundwater abstraction. And before we abandon such valuable assets, we must consider the costs, sustainability and environmental impacts that come from sourcing water elsewhere."

As well as the financial and environmental costs of replacement sources, there is the opportunity cost of the capital used. Water companies have a limited capacity to borrow for raising capital for infrastructure. Customers have limited ability to pay increased water charges, so Ofwat applies strict limits to water company investments and consequent price rises. Therefore, expenditure of large sums on replacement sources for abstraction reductions restricts the ability of water companies to finance wastewater improvements, especially to deal with the much publicised and scandalous amounts of sewer flooding and storm overflows.

Therefore, GARD proposes a national review of the environmental improvements in all the regional plans with the aim of prioritising the improvements which are genuinely needed and eliminating improvements which have minimal benefits and will be disproportionately costly. This review needs to be carried out transparently with the engagement of rivers trusts and other NGOs.

In view of the dominance of environmental improvements in the resource needs of every region, as shown in Figure 6, no decisions should be taken on the need and choice of new resource schemes until the proper and transparent prioritisation of abstraction reductions has been completed.

2.2.6 Avoidance of drought permits and orders, especially the Test and Itchen case

The 1360 Ml/d of "environmental improvements" doesn't include the 165 Ml/d of additional resource needed to avoid drought permits and orders, see WRSE plan page 16:

"In total, an additional 465 million litres of water is needed by 2040 to make the region's water supplies more resilient to a one in 500 year drought. This includes replacing 165 million litres of water currently provided through environmental drought orders and drought permits."

This 165 Ml/d loss of deployable output is mainly 120 Ml/d of drought permits for the Test and Itchen – see Southern Water WRMP summary page 24 and 27:

"However, we rely on drought orders and drought permits that allow us to continue abstracting water during dry weather. Our aim is to reduce our reliance on these measures and stop using them by 2040 at the latest. To do this, we need to find 120 million litres of extra water per day (page 24).

Additionally, we are investigating a strategic pipeline which could transfer up to 120 million litres per day from Thames Water. This depends on new sources being developed in Thames Water's area, all of which are being considered through the SRO process. One of the new sources in Thames Water's area is the South East Strategic Reservoir, or SESRO. We've based our best value plan on WRSE's regional plan which includes an option for SESRO at 100Mm3, which would

enable the strategic transfer into Hampshire. If the size and timing of SESRO changed it would impact our wider plans. For example, a larger reservoir could mean we need a smaller water recycling plant supplementing Havant Thicket reservoir. However, if SESRO was smaller or delayed, we may need to invest in alternative sources such as desalination or water recycling elsewhere in Hampshire (page 27)."

In other words, up to 2/3rds of the Abingdon reservoir deployable output will be used via the Thames to Southern transfer to reduce drought impacts on Test and Itchen salmon, perhaps once in 50 years and to enable the 63 Ml/d of abstraction reductions in the Test and Itchen catchments which the A%R analysis shows are unnecessary (see Table 4 and accompanying text).

The capital cost of the Thames to Southern transfer is £1.25 billion with total Opex costs of £1.1 billion, as quoted in Southern Water's draft WRMP, downloaded from Annex 13 https://www.southernwater.co.uk/our-story/water-resources-management-plan/draft-wrmp-24-technical-documents:

Thames to Southern transfer

Metric	
Capex [£m]	1,247
Financing Cost [£m]	2,071
Opex [£m]	1,139
Embodied Carbon [tCo2e]	192,811
Average operational carbon emissions [tCo2e/yr]	2,368
Total Carbon Cost [£m]	187
Average Incremental Cost (AIC) [p/m3]	105

Table 5 - Costs of Thames to Southern Transfer

GARD recognises the importance of the Habitats Directive protected chalk streams and their salmon, but there must surely be an issue of disproportionate costs and environmental impacts, if precious Thames valley water is to be exported to Southern Water via Abingdon reservoir. WRSE's options appraisal summary report states the following on page 18 https://www.wrse.org.uk/media/2xzjw425/wrse-options-appraisal-summary-report-with-appendices.pdf :

"The Water Resource Planning Guideline recognises that in the short term companies may need to increase use of drought management options to achieve a 1:500 year level of resilience, but in the medium and longer term the guidance is that companies should, where appropriate, use drought permits and orders less frequently, particularly in sensitive areas. Water companies have engaged with the Environment Agency around those supply side drought options to include as options to achieve the 1:500 level of resilience."

In other words, abandonment of drought permits is discretionary, not compulsory. The same point was made by Ofwat and referred to in WRSE's response to their emerging regional plan in Spring 2022[18]:

[18] WRSE response to Consultation on Emerging Regional Plan, May 2022, paragraph 13.4, page 40

"Ofwat noted the commitment to not use drought orders or permits as options after 2040, except for events in excess of the 1 in 500 year return period. It considered that WRSE should explore the cost, benefit and option selection impact of retaining the use of some drought orders and permits beyond 2040. It stated this was important to avoid unnecessary costs from resource development and to avoid the associated environmental impact that the additional development likely to arise from ruling out the use of drought orders and permits could bring."

In response to this, WRSE said *"WRSE will look to provide additional information on the decision making around the drought options for the draft regional plan*.[19]" No such information has been provided in the latest plan.

Therefore, GARD concludes that the Test and Itchen drought permits should be maintained and there should be no planned 120 Ml/d reduction of Southern Water's deployable output in 2040.

2.2.7 Conclusions on WRSE's planned deficit from environmental improvements

By far the largest driver of the need for new water supplies in WRSE's plan is the loss of 1360 Ml/d of deployable output due to environmental improvements and a further loss of 120 Ml/d of deployable through abandoning existing drought permits on the Rivers Test and Itchen. Replacement water sources would cost in the region of £9-10 billion.

The conclusions from GARD's detailed review of the need for environmental improvements are:

1. Despite WRSE's assurances when responding to their consultation on the Emerging Regional Plan in May 2022, there continues to be a lack of transparency of the detail and justification of the colossal losses of deployable output arising from "environmental improvements" in WRSE's plan.

2. WRSE's own analysis shows that the costs of their proposed environmental improvements hugely exceed the value of benefits. GARD rejects WRSE's suggestion that the improvements can be justified by a legal requirement to comply with the Water Framework Directive, because the WFD allows compliance to be waived in the event of disproportionate cost.

3. In the Colne and Lea catchments, where WRSE plan losses of 415 Ml/d of deployable output, GARD agrees the need for 150 Ml/d of reductions in the upper chalk tributaries – the "classic" chalk streams which have been grossly over-abstracted and which are the subject of many years of complaint by the public, rivers trusts and environmental NGOs.

4. However, WRSE's planned loss of a further 265 Ml/d of deployable output from abstraction reductions in the lower River Colne and Lea are unjustified and should be abandoned.

5. The enhanced chalk stream flows from the 150 Ml/d of reductions in the upper Colne and Lea chalk streams would result in an increase in deployable output of London's reservoirs. GARD supports the Chalk Streams First view that 50-60% of the lost deployable output would be recovered and considers the WRSE estimate of 17% recovery to be far too low. An insurance against deployable output recovery being less than expected should be provided

[19] Ibid paragraph 3.13, page 41

by introduction of WBGWS-type drought support schemes in the upper Colne and Lea chalk streams.

6. Overall, GARD considers that the net deployable output loss from the Colne and Lea reductions should be only about 75 Ml/d rather than the 415 Ml/d planned by WRSE.

7. Elsewhere in the Thames catchment GARD considers that allowances for these net losses in deployable output reductions would be justified:

    - 105 Ml/d in the Darent/Cray catchment, with no means of downstream recovery
    - About 50 Ml/d for other Thames Water reductions, after allowing for recovery
    - About 30 Ml/d for South East Water And Sutton & East Surrey, after recovery

8. In total, GARD considers that it would be appropriate to allow for a total 255 Ml/d of net deployable output loss from the Thames valley supplies of Thames, Affinity, South East and Sutton & East Surrey water companies. This compares with WRSE's allowance of 758 Ml/d deployable output loss for these four companies from their Thames valley supplies.

9. GARD considers that none of WRSE's 63 Ml/d of deployable output losses from the Test and Itchen catchments (ie potentially supplied from Abingdon reservoir) can be justified.

10. GARD agrees that there is a good case for a lot of the 107 Ml/d of WRSE planned reductions from Portsmouth Water's supplies.

11. GARD concludes that the Test and Itchen drought permits should be retained and there should be no planned 120 Ml/d reduction of Southern Water's deployable output in 2040.

Overall, GARD concludes that, in view of the scale and costs of environmental improvements in all regions across the country, no decisions should be taken on the need and choice of new resource schemes until the proper and transparent prioritisation of abstraction reductions has been completed, taking account of the costs of replacement sources and their environmental impacts.

2.3 Population growth and the increase in consumption

Headlines:

- GARD believes the population methodology used in the WRSE draft plan is not fit for purpose.

- GARD has proposed a simple methodology that complies with the need in the WRPG to use local planning data modified by other projection data that would be simpler, easier, more widely acceptable to stakeholders and better manage risk.

- Our calculations show that the WRSE population estimates may be over stated by 1,445,000 by 2050 and 2,303,000 by 2075. At a 2050 PCC of about 115 l/head/day, that is equivalent to an over-forecast of the baseline deficit by 166 Ml/d in 2050 and 265 Ml/d by 2075.

In its main draft regional plan, WRSE presents a range of population growth outcomes that range between 2% and 33% over the next 50 years. Given the extensive range of possible outcomes we

would expect to see considered discussion on the reasons for the differences, the most likely outcome, and where the chosen projection sits in relation to this and other projections. There is no such detail in the consultation document and only elements are covered, obliquely, in the supporting WRSE Technical Annex and the Edge Analytics Technical Annex. In fact, the whole consultation and Annexes appear to be an exercise in making it difficult for the reader to understand the justification for the figures chosen.

The adaptive plan presented on page 20 of the consultation is particularly confusing, to the point of being misleading. Initially, it appears reasonable, with low, medium, and high population growth scenarios presented, with the chosen plan proceeding along the medium population growth scenario. It is not explained, however, why the upper branch of this pathway has been chosen post 2035.

The range of extra water needed for all of the scenarios varies between 1 billion and 2.8 billion litres per day. Yet, the 'sensible' medium pathway chosen is higher than two of the high population branches by up to 69%. This makes no sense, as both pathways are reported as using the same high environmental and high climate assumptions. In the end, the expected requirement shown is effectively, within rounding errors, the same as the very highest, high growth scenario.

Confusingly, page 20 shows the extra requirement in 2030 as being 825 Ml/d while page 21 shows this as being the amount required in 2035. Which is correct? Regardless, page 21 shows the population element of this requirement as being 240 Ml/d which at an assumed pcc of 145 l/p/d[20] equates to an expected population increase by 2030/2035 of 1.7 million. From the same diagram the figure for 2050 is an expected population increase of 4.0 million[21] and by 2075 5.3 million[22]. None of these figures are realistic.

Page 21 also gives the first clue as to why the figures are so high. The projection chosen is local authority housing plans - one of the very highest scenarios.

The Edge Analytics technical annex[23] on population and property forecasts and Technical Annex 1[24] provides useful extra data. Nevertheless, both remain a master class in obfuscation and hiding of key decisions. The Affinity Water WRMP is much clearer in explaining its decision-making process. At para 4.52 of its report, it is made clear that the decision was made to use local plan data simply because that is the guidance contained in the WRPG. The Affinity WRMP also makes it clear that a common approach to this was taken across WRSE and other water companies, supported by Edge Analytics. Given the common decision to use local planning data, it is hard to see why other projections are presented in tables and diagrams throughout the annexes. It is apparent that they have not been used to adjust the local planning figures and seem to be present to disguise the fact that no useful analysis has been conducted. More mysterious is the continued inclusion of superseded data, particularly the older ONS projections.

[20] Page 26 pcc for the region in 2017/18 is 145 l/p/d
[21] Page 26 pcc for the region in 2050 is 115 l/p/d
[22] Assuming no improvement in pcc after 2050
[23] Population & Property Forecasts, Methodology & Outcomes, edge analytics, July 2020
[24] Draft Regional Plan Water Resources South East Technical Annex 1, November 2022

Previously, GARD has criticised the use by water companies and WRSE of out-of-date data. Yet, Edge Analytics places great store in ONS 2014 projections, now nearly a decade old. It notes at para 3.19 that *"the inclusion of the 2014-based projection is important, as a considerable portion of the Local Plan evidence published by LPAs across England has been formulated using this growth scenario as a starting point in the housing need calculation."*

All this statement does is to confirm that the local population projections used are from an outdated and superseded projection and thus are no longer valid. Using local plans based on this superseded data simply compounds the errors. One would expect the counter argument to be presented, noting that later projections clearly show that using local housing plan data based on ONS 2014 outcomes is not credible. Further, we believe that previous ONS projections should be removed completely from the tables and graphs. This is illustrated by Figure 8 from the Edge Analytics report. This uses only the latest projections from all sources, except for ONS, which for no obvious reason includes ONS 14 and ONS 16 as well as ONS 18. Another issue is the timeliness of the Edge Analytics report which is dated July 2020. Given that we are considering plans presented in 2023, at the very least ONS 2020 data should be included, and an updated Edge Analytics report could add useful real-world data.

The only conclusion that can be drawn from the inclusion of outdated ONS data is that as the projections were high, when graphed alongside the WRSE projection, it doesn't look so ludicrous.

The Edge Analytics report continues to undermine its use of ONS 2014/Local plan levels of growth at numerous points throughout the narrative. For example, it notes that "*A return to higher rates of fertility and/or an upturn in the rate of improvement in life expectancy, would reverse the trend towards lower growth suggested by the ONS-18 outcomes*". All the recent data indicates that growth rates are falling even more quickly than previously expected – particularly in western-style, technology-based economies. No evidence is provided to support the idea that recent falls will be reversed and return to 2014 projection levels. In the 2020-based ONS Principal Projection - England,[25] which covers out to 2120, the expected growth rate falls to 0.1% by 2051 and continues to fall to around 0.04% by 2057, before finally becoming negative by the end of the century. This includes net migration. The BBC has reported that latest studies now expect the UK population to peak in 2063 and fall thereafter.[26] Worldwide estimates of when different countries will move from positive to negative population growth are being constantly revised forward. Figure 15 on page 46 of the Edge Analytics report clearly shows the 2018 based ONS projection indicating a fall in the natural population from around 2036, yet this is not discussed. The implications of a steady or falling UK population, as raised by leading statisticians and analysts, are profound, but are not even mentioned in this plan. Instead, growth appears to continue unhindered to the end of the century and beyond.

Edge further undermines the local plan data by noting at para 4.17 that "*In all cases, the housing-led growth outcomes detailed below are substantially higher than the latest, 2018-based trend projections published by the ONS. (*and even higher than the 2020 figures not included in the report) *The amalgamated WRSE Local Plan evidence suggests an unprecedented level of housing growth to 2030.* Substituting 'impossible' for 'unprecedented' would give a more accurate description of what is likely. GARD has previously made the case that local plans are unreliable because, as other organisations such as CPRE have noted, only 40% of planned development is delivered. Para 4.29 of

[25] 2020-based Interim National Population Projections, England, Principal, published 12th January 2022
[26] https://www.bbc.co.uk/news/health-53409521, accessed 12 Feb 2023

the Edge report clearly tries to counter this by noting that, for the WRSE geography, there has been a 23% higher dwelling delivery than that associated with the previous 5 years of data. Assuming this is true (the source is not stated), a 23% improvement on 40% would still only give a 49% completion rate, leaving the projection used by WRSE still meaningless.

Throughout the Edge document it is hard to determine what actual population figures have been used as inputs to the final WRSE plan. However, combining Figure 8 with para 4.45 appears to give a starting 2020 figure of around 19.3 million, a 2050 figure of 22.6 million and a 2100 figure of 25.5 million. These are similar to the figures given in the WRSE Technical Annex at Table 6.2.

The Edge report notes many points arising from the ONS 2018 figures without refuting them. These include:

- A relatively high assumed nationwide net migration rate of +190k per year. This is above government targets, but probably realistic. Since GARD supports the use of ONS projections, we can only accept this, noting only that at such a rate, including extra headroom for what Edge refers to in the Affinity WRMP as 'hidden addresses' should be unnecessary and dealt with by a final overall headroom calculation.
- ONS projections suggest parts of the WRSE region will experience population declines. This is not mentioned anywhere in the WRSE consultation.
- A note that the data suggests a lower than previously expected housing requirement over the WRMP horizon.

More generally, the Edge report makes much of comparing old ONS projections since 1955 (!) to determine their accuracy. Despite this it is clear (and noted) that recent projections have converged on, or are close to, actual growth rates.

A far more useful exercise would be for Edge to use some of the data the water companies already hold to provide real world data to compare to their outlandish projections. For example, water companies know exactly how much extra supply has been provided, year on year, and could develop their own model of growth. Similarly, rather than plot ancient ONS projections against actual growth, a plot of previous water company forecasts against actual growth would be far more useful as this would highlight to the regulators how the water company interpretation of the WRPG is forcing them to adopt unrealistic growth scenarios.

So, what is a realistic growth rate for the WRSE region? Table 6 below includes, at column 2, the WRSE chosen projection, Housing Plan P, taken from Table 6.2 of the Technical Annex. At column 5, ONS 2020 (I) England annual growth rates, applied to a WRSE 2020 baseline of 19.3 million have been used to calculate the increases shown in Columns 5 and 6. The numbers calculated above from the diagram on page 21 of the consultation document are shown at column 4 which appear odd, even compared to the House Plan P figures. Presumably these differ because WRSE have not used the pcc figures they have themselves provided in the consultation. A suggested headroom factor of 20% has been applied as an illustration and is shown in Column 7. Overall, it can be seen that the WRSE produced figures are simply not credible.

1	2	3	4	5	6	7
Year	WRSE House Plan P Increase (000)	WRSE House Plan P %	Diagram on Page 21 of consultation document	ONS 2020(I) England Increase (000)	Increase % ONS 2020 (I)	ONS Figure with 20% headroom (000)
2040	1,985	9.5%		1,396	7.2%	1,675
2050	3,349	16.0%	4,000	1,904	9.8%	2,285
2060	4,078	19.5%		2,194	11.3%	2,633
2075	4,909	23.4%	5,300	2,606	13.5%	3,127

Table 6 - Comparison of different population forecasts

It is particularly striking that the WRSE planning figures rapidly grow larger than what is expected to be the entire growth in the English population. By 2075, the WRSE projected increase of 4,909,000 is 26% larger than the ONS expected 3,894,000 growth for the whole of England.

Previously, South East water companies and WRSE have argued that the South East is a special case and that growth in the region is greater than in the rest of England, but this argument is not supported by the ONS Sub-national population projections for England.[27] These show a growth projection across the regions of England between 2018 and 2028 of between 2.3% and 7%, with an average of 5%. The projection for the South East is 4.4% and for London 4.9%; both are below the average.

As a general comment, the documents provided are hard to critique. Some projections run from 2020, others 2025 and the cover different time periods. Without the underlying data it is impossible to check these - particularly where different documents present slightly different facts

Following the WRPG

While WRSE makes much of the need to follow the WRPG and use local housing data, the rest of the guidance seems to have been ignored.

The WRPG[28] states that:

'You should consider an adaptive plan where there is a significant difference in projections, particularly where this might affect your investment decisions in the first half of your plan. You should ensure your plan does not lead to over-investment or constrain planned growth. You should set out how you have developed and used alternative scenarios in your plan and the impact they have had on your plan.'

(GARD highlighting)

[27] Table 1: Projected population change for English regions, mid-2018 and mid-2028, ONS Subnational population projections for England: 2018 based, Published 24th March 2020

[28] Water Resources Planning Guideline Version 10, Environment Agency, Ofwat, Natural Resources Wales.

The guidance has a clear requirement for the plan to consider alternative projections where this might affect early investment decisions. By adopting a single projection, at the higher end of forecasts, WRSE has not followed this guidance.

By pursuing an inflated population projection and failing to develop a 'most likely' population projection, or even a 'mean of different projections', both of which would be considerably below the chosen projection, WRSE has failed in its duty to ensure that their plan does not lead to over investment.

The WRPG further states that water companies should :

- *demonstrate how you have included other information sources and amended your forecast accordingly*
- *demonstrate that you understand the uncertainty associated with your forecasts and how you will manage it*
- *If you are using a planning period beyond 25 years and are basing decisions on this forecast, you should explain the range of uncertainties this long-range forecast will have. You should explain in your plan how you will manage this uncertainty.*

To deal with each requirement in turn:

There is no evidence that other information sources have been used to amend the chosen projection. The adoption of the Housing-Plan-P as principal scenario is based on a certain understanding of the WRPG, rather than any analysis of the other projections listed. Further, there is no analysis presented to show that WRSE have understood the uncertainty in its choice of projection. Or rather, they do understand that there is a difference, but this fact has not been used to adjust the plan. Simply listing other projections that are very different, without exploring why and how this might affect the plan is not analysis. Including outdated and superseded projections because they support the plan is not analysis. Many organisations besides GARD have raised this issue in previous consultations, so WRSE cannot claim to be unaware of the issue.

To discharge the wider duties imposed by the WRPG, it is incumbent on WRSE to demonstrate understanding of the uncertainty around its chosen projection and how this will be managed. Given the very large differences between the chosen projection and ONS 2020 why are alarm bells not ringing at WRSE as well as at Ofwat/RAPID?

The third point is not addressed at all in the plan as presented. The imminent fall in population growth expected in the UK (2052)[29] and already experienced by many countries, including Germany (2022) and Italy (since 2017) is not even mentioned.

As such, GARD believes that the population calculations and assumptions as presented are unfit for purpose. Instead, we believe the following process would be simpler, more realistic and meet the needs and approval of a wider range of stakeholders (including regulators).

1. The latest ONS Principal Projection should be used to determine expected overall population growth for the region and used as the basis for strategic level planning of water provision.

[29] https://worldpopulationreview.com/countries/united-kingdom-population

2. Local housing plan data should be used to determine the location and timing of future 'hotspots', allowing the timing and development of infrastructure to be finessed at the operational level.

    - These 2 steps comply with the requirement to use both local planning data AND other data and would resolve historical complaints about companies planning being based on over-inflated population projections. By conducting more focused analysis, as detailed above, it would be easy to demonstrate compliance with all elements of the sometimes-conflicting guidance in the WRPG.

3. Agree a methodology for the development of single high and low variant projections, to give context to decisions on investment and risk management. This would enable a proper risk-based approach to be adopted.

4. The above should be used in regular discussions between regulators, water companies and key stakeholders to enable and support collective decision making.

    - This should result in an agreed headroom calculation to be applied to the output of Step 1. Currently, headroom seems to be added at every input to the calculation, for example including high environmental change figures, or high population. The process should develop a 'most likely' input at every stage, before adding a final headroom figure. This could be as simple as applying a multiplying factor to the ONS projection. This might vary over time, depending on stakeholders perceptions of uncertainty, but 20% would seem to be an ample starting point for consideration.

    - This process would produce an open, debated output with buy in from stakeholders. It would underpin decisions on cost, customer value, shareholder value, environmental issues, and risk. It is not acceptable for the regulator to make the water company responsible for this. The company has conflicting responsibilities to customers and shareholders. The regulator must take a more active part in this process and include other stakeholders in the process.

    - This would correct the current system that forces companies to over provide, while simultaneously encouraging financial gaming of the 'system'.

2.4 Climate Change

WRSE's plan assumes a loss of regional deployable output due to climate change of 240 Ml/d by 2075 as shown in Figure 1. From WRSE's table below, it appears that this corresponds to their 'High' climate change scenario[30]:

[30] WRSE Technical Annex 1, page 45

Table 7.1 Changes to supplies resulting from climate change scenarios (from 2025)

Climate Change Scenario		Year >>> Planning Scenario	2040 change (Ml/d)	2050 change (Ml/d)	2060 change (Ml/d)	2075 change (Ml/d)
6	High	DYAA	- 82.08	- 123.32	- 164.57	- 226.41
		DYCP	- 65.37	- 105.15	- 144.87	- 204.52
7	Low	DYAA	7.33	19.96	2.62	- 23.43
		DYCP	50.06	33.36	16.73	- 8.28
Median	Medium	DYAA	- 14.05	- 41.69	- 69.32	- 110.77
		DYCP	- 5.52	- 33.32	- 61.08	- 102.77

Table 7 – WRSE climate change impact scenarios

From the WRMP tables in water company WRMPs, we can see that most of this loss is in Thames Water's London region as shown in Figure 8[31]:

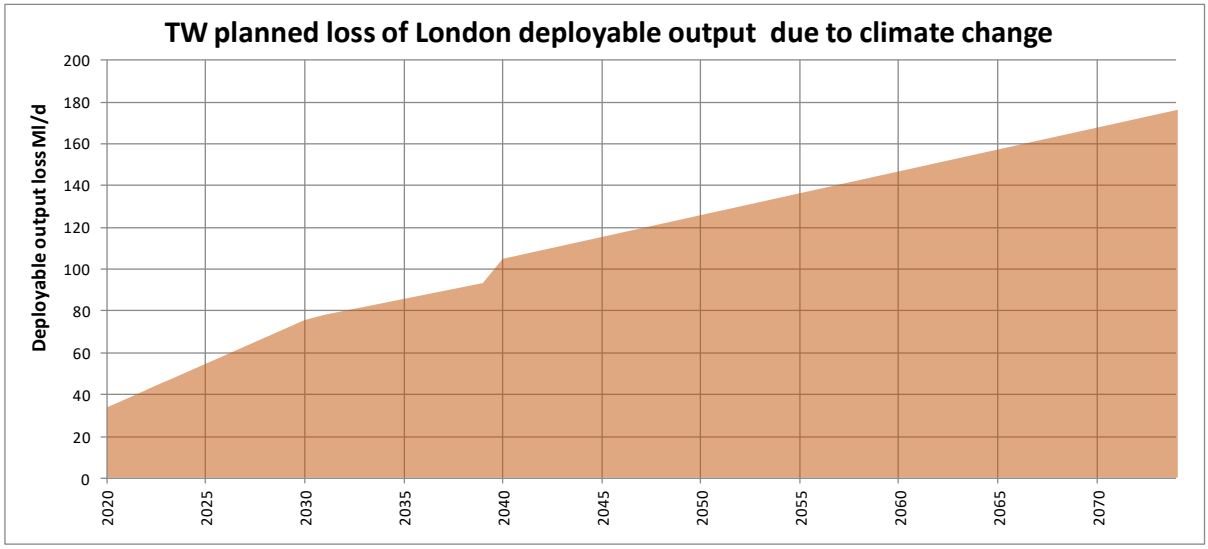


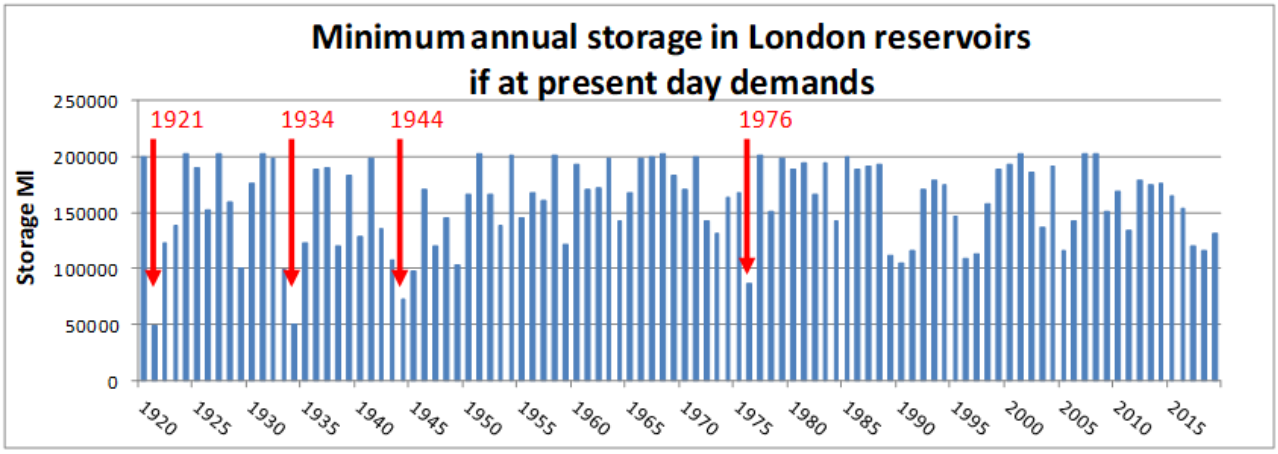
Figure 8 - Thames Water assumed deployable output loss due to climate change

Elsewhere, supplies are largely from groundwater from which deployable outputs are not expected to be significantly affected by climate change.

In GARD's response to WRSE's consultation on future water requirements[32] and in our response to the emerging regional plan in spring 2022, we proposed that the London climate change forecasts should recognise the evidence suggesting that climate change of the past 100 years has not adversely affected the deployable outputs of supplies in the South East to date. Indeed the evidence suggests that climate change to date (which GARD does not dispute) has increased the availability of water supplies for London. For example, we show below the minimum storages that would have occurred in London reservoirs since 1920, if operated at present day demand levels:

[31] Data from Thames Water WRMP tables, baseline deficit for London zone

[32] GARD response to WRSE consultation on Future Water Resource Requirements, Section 2.7, April 2020 https://www.gard-oxon.org.uk/downloads/Final%20response%20to%20WRSE%20consultation%2017%204%202020-1.pdf



Note: data from 1920 to 2010 are from TW WARMS2 modelling of London supplies at 2305 Ml/d demand. Data from 2011 to 2019 are recorded data from CEH monthly hydrological summaries.

Figure 9 - Minimum London reservoir storage at full demand in climate since 1920

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. Droughts since 1976 have all had relatively little impact on London's supplies. For example the drought of 2022, considered to be a 1:500 year event in some parts of the country and elsewhere in Europe, storage in London's reservoirs never fell below 60% full[33].

Since 1997, the base date against which the climate change impacts have been assessed, there has been a substantial and widely recognised increase in the frequency of flooding and wet winters[34]. In striking contrast, since 1997 there have been no severe droughts of anywhere near the severity of the droughts of 1921, 1934 and 1944, which would be a genuine threat to the supplies of London and the South East. Although there have been several moderate droughts since 1997, the most severe for London's supplies was 2018 when the minimum storage in the London reservoirs was 57%. This is well above the minimum 43% storage in the drought of 1976 and far in excess of the minimum 24% storages that would have occurred in the droughts of 1921 and 1934.

We think that Thames Water's climate change deployable output losses for London, including the allowance for 46 Ml/d loss of deployable output by 2023, 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. We have made this point repeatedly in our response to previous WRSE consultations and it is disappointing that no acknowledgement of the criticism was made in WRSE's response to the Emerging Plan consultation in May 2022. All WRSE's response says in relation to widespread criticism of excessive deficit forecasts, including climate change allowances, is[35]:

> *"WRSE accepts that there are considerable uncertainties, particularly the further into the future the forecasts look. However, it considers that the forecasts produced and the scenarios that have*

[33] CEH Monthly Hydrological Summary, October 2022
[34] Flood risk and the UK https://eciu.net/analysis/briefings/climate-impacts/flood-risk-and-the-uk
[35] WRSE response to consultation on emerging regional plan, May 2022, paragraph 5.11, page 14

been developed for the regional plan as a result are valid and robust representations of the range of futures that the South East could experience."

It seems to us that the 'Low' climate change impact scenario shown in our Table 7 above is much more likely than WRSE's 'High' scenario, based on the historic evidence. We can see no justification for the 'High' climate change scenario being the central planning assumption for the climate change allowance in WRSE's plan or the water company WRMPs. We propose that it would be reasonable (ie reasonably cautious) to assume the 'Medium' scenario as the central planning assumption, with an allowance of 110 Ml/d loss of deployable output by 2075, as shown in Table 7. This would reduce the SE regional need for new resources by 130 Ml/d in 2075.

2.5 GARD summary of WRSE over-forecasting of water supply needs

The preceding sections show our analysis of WRSE's assessment of water supply needs arising from environmental improvements, population growth, climate change and drought resilience. We have concluded that WRSE's estimates of future needs are grossly exaggerated, as shown in Table 8, showing the extent the extent of WRSE's over-forecasting in 2050 in areas potentially supplied by Abingdon reservoir (Thames Water, Affinity Central, Southern Water Hampshire and Portsmouth):

All in Ml/d	WRSE Estimate	GARD estimate	Difference	Comments
DO losses due to Environmental improvements				
Affinity sources in Colne and Lea	415	75	340	As Section 2.2.3 and allowing 50% DO recovery
Thames Water in the Thames valley uptream of London	170	50	120	As Section 2.2.4 and allowing 50% DO recovery
South East Water and Sutton & East Surrey in Thames valley	60	30	30	As Section 2.2.4 and allowing 50% DO recovery
Southern Water for Test and Itchen	63	0	63	As Section 2.2.4 and Table 4
Portsmouth Water	86	50	36	As Section 2.2.4
	Sub-total difference in DO losses		589	As potentially supplied by Abingdon resevoir
Population growth				
Growth to 2050 (000s)	2,621	1,788		
Equivalent demand growth	301	206	96	As Section 2.3
Climate change	123	42	81	Medium instead of High as Section 2.4
Drought resilience - Test & Itchen drought permits	120	0	120	DPs only as Section 2.2.5 (1:500 standard accepted)
Total over-forecast of 2050 water supply need			**886 Ml/d**	

Table 8 - Summary of WRSE over-forecasting of 2050 deficits in Abingdon Reservoir supply areas

By 2075, the equivalent over-forecasting of the deficit is 1010 Ml/d. The effect of this over-forecasting on the need for new water supply sources in the Thames valley will be shown in Section 3.3, after consideration of plans for leakage and demand management.

3. Proposals for new water resources

3.1 Proposed per capita consumption reductions

The six SE water companies' planned reductions in PCC are shown in WRSE's plan as below[36]:

Company	2017/18 Normal year PCC (l/person/d)	2050 Normal Year PCC (l/person/d)
Affinity Water	155	113
Portsmouth Water	147	109
SES Water	147	106
South East Water	144	107
Southern Water	129	106
Thames Water	146	121
WRSE	**145**	**115**

This is an error. The final plan PCC for the Central Region zones in 2050 is 127 l/person/day in Affinity Water's WRMP tables.

Table 9 - WRSE planned PCC reductions by 2050 for the six SE water companies

Thames Water fails to achieve the Government target of 110 l/person/day by a large margin and is largely responsible for the overall WRSE failure to meet the target. Most of Thames Water's failure to achieve 110 l/p/day occurs in their London Zone. This is shown in more detail below and compared with the planned performance of United Utilities' Strategic Zone, covering a comparably large and heavily urbanised region, including Manchester and Liverpool (data from WRMP tables):

[36] WRSE Technical Annex 2, Table 5.2

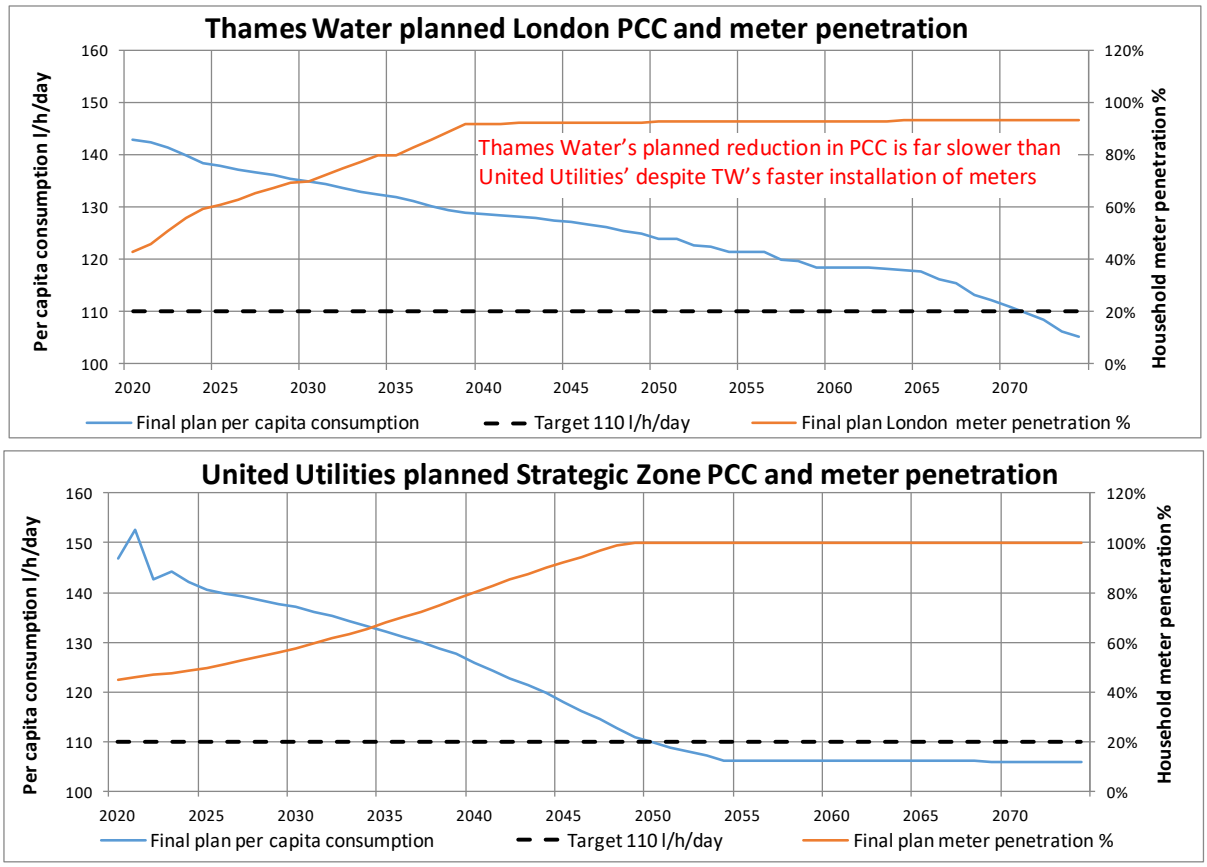


Figure 10 - Comparison of Thames Water and United Utilities planned urban PCC reductions

Figure 9 shows a large disparity in the planned achievement of the 110 l/person/day target despite the similarity of the zones in terms of size and urbanisation. United Utilities plan to meet the target by 2050, whereas Thames Water's London PCC is still at 124 l/person/day in 2050 despite planned meter penetration of 90% by 2040.

If Thames Water achieves the 110 l/person/day target in London by 2050, the need for new sources in 2050 is reduced by 134 Ml/d (assuming Thames Water's forecast London zone population of 9.55 million). Outside London in Thames Water's Thames valley zones, achievement of the 110 l/person/day target by 2050 would save a further 26 Ml/d compared with Thames Water's plan.

In GARD's response to Affinity Water's draft WRMP[37], we have shown that, if the Central Region PCC is reduced to 124 l/h/d by 2040 and 110 l/h/d by 2050, the Central Region demand savings would be 48 Ml/d by 2040 and 74 Ml/d by 2050 (assuming Affinity Water's population forecasts).

Thus if both Thames Water and Affinity Water meet the Government's target for reducing PCC to 110 l/person/day by 2050, the need for new supplies in areas potentially supplied from Abingdon reservoir would be reduced by a total of:

- Thames Water, London zone 134 Ml/d
- Thames Water, Thames valley zones 26 Ml/d
- Affinity Water, Central Region 74 Ml/d

[37] GARD response to Affinity Water draft WRMP24, Section 3.2

Total 234 Ml/d

3.2 Proposed leakage reductions

The planned reductions in leakage by 2050 for the SE water companies are shown in Table 7[38]:

Company	Total Leakage (% reduction)	2017/18 Leakage (l/property/d)	2050 leakage (l/property/d)
Affinity Water	53%	121	42
Portsmouth Water	50%	101	39
SES Water	56%	89	32
South East Water	51%	103	39
Southern Water	51%	90	36
Thames Water	50%	176	66
WRSE	**51%**	**140**	**52**

Table 10 - WRSE planned leakage reductions by 2050 for the six SE water companies

Although Thames Water plan overall to meet the Government's target of 50% leakage reduction by 2050, there is a wide disparity in the reductions in leakage/property/ day in their zones as shown in Figure 10[39]:

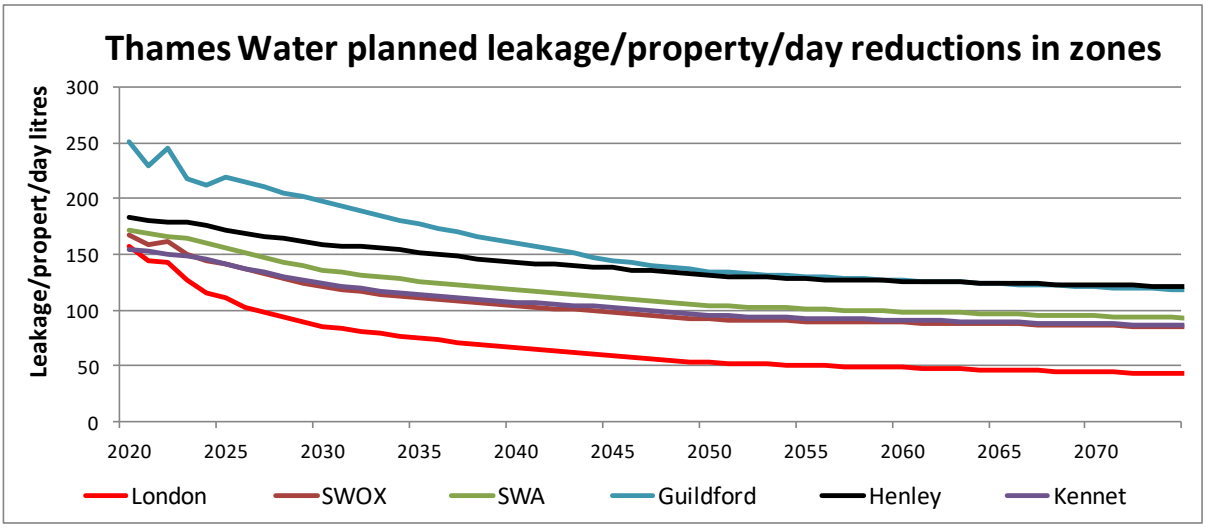


Figure 11 - Thames Water leakage reductions in zones

This shows that most of the planned leakage reductions are in London, where the planned gross leakage reduction is from 566 Ml/d in 2017-18 to 225 Ml/d in 2050, a reduction of 60% and well ahead of the Government's 50% reduction target. GARD welcomes this and notes that the planned leakage of 53 l/property/day in 2050 is slightly less than United Utilities' planned 56 l/property/day in their similarly urban Strategic Zone.

However, Thames Water's planned total leakage reduction in their zones outside London is only from 169 Ml/d in 2017-18 to 124 Ml/d in 2050 – a reduction of only 27% and well short of the 50% target. The planned leakages in the zones outside London in 2050 are in the range 90 to 135

[38] WRSE Technical Annex 2, Table 5.1
[39] Leakage per property per day from Thames Water WRMP24 tables

l/property/day and far higher than the typical 40 l/property/day elsewhere in the South East, as shown on Table 7.

GARD proposes that leakage in Thames Water's zones outside London should be reduced to 40 l/property/day by 2050 to be in line with the leakages planned in all other regions outside London. This would give a total saving of 74 Ml/d in the Thames valley zones compared to Thames Water's plan.

In the Thames valley outside London, if Thames Water meets the targets of 50% leakage reduction and 110 l/person/day by 2050, the total saving would be 100 Ml/d.

3.3 GARD review of need for new water supplies in the South East

For the areas potentially supplied by Abingdon reservoir, WRSE's plan includes the provision of the following new major water supplies in by 2075[40]:

Major new water sources	Deployable Output	In use by
• Havant Thicket reservoir	21 Ml/d	2029
• Havant recycling	60 Ml/d	2030
• Teddington DRA	67 Ml/d	2031
• GUC transfer Phase 1	50 Ml/d	2031
• GUC transfer Phase 2	50 Ml/d	2040
• Abingdon reservoir	185 Ml/d	2040
• Severn to Thames transfer, Phase 1	160 Ml/d	2050
• Severn to Thames transfer, Phase 2	130 Ml/d	2060
• Deephams recycling	42 Ml/d	2061
Total new sources	**765 Ml/d**	

New transmission pipelines	Pipeline capacity	In use by
• Havant to Southern transfer	90 Ml/d	2030
• Thames to Affinity transfer (T2AT)	100 Ml/d	2040
• Thames to Southern Transfer(T2ST)	120 Ml/d	2040

The planned new sources amount to deployable outputs of 198 Ml/d by 2031, 433 Ml/d by 2040, 593 Ml/d by 2050 and 765 Ml/d by 2061.

GARD's assessment of the need for new resources, as summarised in Section 2.5, is that WRSE have over-forecast the need for new supplies (in areas potentially supplied by Abingdon reservoir) by 886 Ml/d in 2050 and 1,010 Ml/d in 2075. Furthermore, in Sections 3.1 and 3.2 we have shown that if

[40] Deployable outputs and completion dates are as shown in WRSE's main document, pages 28, 29, 30 and 34

Thames Water and Affinity Water comply with Government's leakage reduction and PCC targets, the need for new supplies in areas potentially supplied by Abingdon reservoir would be reduced by 308 Ml/d in 2050 (234 Ml/d by meeting the PCC target and 74 Ml/d by meeting leakage reduction targets in the Thames valley).

Therefore, the total reduction in the need for new sources in 2050 would be 886 Ml/d due to over-forecasting the need, plus 308 Ml/d if Thames Water and Affinity Water meet the Government's PCC and leakage targets, reducing the total need by 1194 Ml/d. This would give a residual (to be supplied by new sources) need of 1056 Ml/day by 2050 (with reference WRSE's 2250 Ml/d deficit shown in Figure 1). This reduced need is far below the total of the 1650 Ml/day of new sources in WRSE plan by 2049 (about 1200 Ml/d of new supplies[41] and 450 Ml/d of leakage and demand reduction). This does not include any supply by STT deemed available from 1.1.2050 in the draft Plan.

These figures are over the whole WRSE region. On this basis, with the STT first phase (as defined by WRSE) coming into operation at 160 Ml/day in 2050, there is then about 780 Ml/d over-provision of supplies after 2050. It should also be noted that the population figures already have 20% cushion above ONS (see section 2.3) and there is also the 'normal' water company 'headroom' figure taken into account.

On this basis there is a strong argument that there is no need for a *decision* on <u>any</u> new sources in the area potentially supplied by Abingdon reservoir before 2035. The potential needs of the area by 2050, from realistic population growth, prioritised environmental (sustainability) improvements and reasonably cautious allowance for climate change can all be met if the South East water companies all meet the Government's PCC and leakage targets, especially Thames Water and Affinity Water.

If we take the definition of the '*areas potentially supplied by Abingdon reservoir*' to be essentially the Thames Water, Affinity Water and Southern Water zones, ie. we accept for one moment WRSE/Southern Water's view that the Thames to Southern Transfer is needed,[42] then the new resources would total 765 Ml/day and the two transfers. Both the RAPID Gate 2 documents on the T2AT and T2ST schemes are clear[43][44] that the supply to the pipelines could be done inter-changeably by either the Abingdon Reservoir or the STT. In fact, with transfers, the STT Phases and the Abingdon Reservoir are entirely interchangeable in the criterion of '*geographical reach'*. In what follows below we therefore use the phrase *'Upper Thames strategic source destinations*' to refer to this area (UTSSD).

GARD's view is that it is prudent to supply capacity to this UTSSD area *as early as possible.* This has the maximum strategic, environmental and drought resilience impact and would give some cushion against accelerating climate change effects.

GARD recognises that there is uncertainty over the amount and timing of the leakage and PCC reductions *beyond the Government targets*, mainly arising from the performance of Thames Water in meeting targets in the past. It accepts that a balance of Risk Mitigation is needed to address those

[41] https://_WRSE_Draft_Regional_Plan_Technical_Annex_2_%28Nov_2022%29.pdf -page 11
[42] Although GARD does not agree this view – as expressed in 2.2.6.
[43] https://T2AT__Gate_2_Main_Report_v3_FINAL.pdf
[44] https://www.southernwater.co.uk/media/7747/t2st-rapid-gate-2-report.pdf

elements of the source/demand balance, and the possibility of accelerating climate change and so concludes that it would be prudent also to proceed immediately with:

- The Teddington DRA scheme (67 Ml/d), already planned to be due by 2031
- The first phase of the GUC transfer (50 Ml/d), already planned to be due by 2031

Early implementation of these two schemes would ensure that the upper Colne and Lea chalk stream abstraction reductions could proceed as soon as the Thames to Affinity transfer and associated pipe network are completed (see below)

Our other recommendation is to 'front load' the Risk Management and to bring forward the date at which 'true'[45] 1 in 500 year Drought Resilience is achieved[46] (not done until post-2040 in WRSE's plan) Thus the following further sources should be completed by 2035-36.

- Second phase of the GUC transfer (50 Ml/d), ie. bring forward the completion date in the WRSE plan by 5 years.

- 'First phase' of the Severn to Thames transfer, as defined by GARD in section 4.1. This uses only the Netheridge and Minworth Treatment works supplies, and does not involve a connection to United Utilities sources and Lake Vyrnwy. It has the major attribute of very robust climate change resilience, as the support for the transfer is supplied by Recycled water sources. Dependent on whether the total upgrade to Minworth WTW is implemented for this (70 Ml/d DO) or just the first stage (35 Ml/d DO)[47], this option can provide a deployable output of 193-228 Ml/d for use either by the London Thames Water zone, or Affinity's Chiltern zones (with the T2AT) or to Southern Water (with T2ST).

Thus 360 – 395 Ml/d of our 780 Ml/d 'over-provision by 2050' has been deployed early to maximum environmental and climate change 'hedge'. This retiming and rearrangement of the Thames and Affinity zones' supplies, and associated transfers delivers roughly half of the WRSE major sources for the areas (360-395 Ml/d) by 2035, and allows time for further forward planning in a '*no regrets*' plan. The further considerations in the 2035-2039 AMP would decide on what, if anything would be needed up to 2050.

GARD also suggests that, even if the rest of the STT scheme were to be added post 2050, the 500 Ml/d connection from Severn to Thames would never be needed, leading to scheme cost and embedded carbon reduction. The relative issues behind a smaller 400 Ml/d or 300 Ml/d connector should be examined in a 'within plan' optimisation. The smaller connector would also make the canal transfer feasible, bringing large secondary benefits and attracting popular support. As presently ruled out by WRSE, the Natural Capital benefits of the Canal Transfer scheme have not been assessed.

Outside of these schemes, the only essential new water supply infrastructure is the Thames to Affinity transfer and associated 'Connect 2050' pipe network (which GARD recommends should be brought forward to 2030). This is needed to connect Affinity Water's Central Region supplies to

[45] ie. with no potentially damaging Drought Permits.
[46] For all except the case of the Test and Itchen.
[47] See section 4.1.2

London's supplies, including the London reservoirs. This would enable the high priority abstraction reductions in the upper Colne and Lea chalk streams, as described in Section 2.2.3, with the required replacement water becoming available through demand management and leakage reduction.

In GARD's opinion, the Thames to Southern transfer will never be needed. The 63 Ml/d of Itchen and Test abstraction reductions are unnecessary, as explained in Section 2.4. The proposed abandonment of Test and Itchen drought permits would bring minimal and rare benefits. The £2 billion T2ST scheme would generate a benefit of just £29 million according to WRSE's assessment shown in our Table 1. ***The T2ST scheme should be abandoned at Gate 2 due its minimal benefit and disproportionately high cost.***

Outside the UTSSD area, GARD agrees that the Havant Thicket reservoir, Havant recycling scheme and Havant to Southern transfer should all proceed as planned, aiming for completion by 2031 and enabling Portsmouth Water's planed abstraction reductions from various South Coast chalk streams. If these sources are insufficient for genuinely needed abstraction reductions, we suggest another South Coast desalination scheme should be developed, alongside the other nine South coast desalination schemes totaling 155 Ml/d already in WRSE's plan[48].

GARD's view is that the likely outcomes will show that, as the 1 in 500-year drought resilience will have been delivered, two of the main uncertain trends – population growth and effects and scope of sustainability reductions – will provide concrete evidence by 2035 of our present assertions. ***If the evidence bears out the third assertion, that the effects of climate change are moderate for the South East, due to the annual rainfall patterns and regional hydro-geology, then there will be essentially no need for any further new resource before 2050.*** If, on the other hand, any of the above assumptions are not borne out in a way which is non-remediable, then a truly Adaptable plan must be able to deliver benefits on an acceptably-short timescale. Given the 15-year lead time of a Major Reservoir like the Abingdon proposal (at anything like the 75+ Mm^3 levels considered by Thames-Affinity, WRSE or RAPID), it is hard to see how such a scheme could ever be part of the way forward.

GARD's overall conclusion is that there is no need for Abingdon Reservoir and it should be abandoned at Gate 2, with no further money wasted on its continuing development.

3.4 Overview assessment of major water infrastructure plans

3.4.1 Water transfers into the South East (GUC and STT)

Although GARD's analysis in Section 3.3 has shown that there is no theoretical need for any new water supplies in areas that might be supplied from Abingdon reservoir, we recognise that this depends on achievement of planned leakage and PCC reductions, and that some climate change scenarios move the analysed surplus (in normal, non-extreme drought years) to a lower value. We also acknowledge that early re-naturalisation of flows in the Colne and Lea chalk streams could require additional water sources if leakage and PCC reductions come into effect later than planned, and that some (much more modest than WRSE's draft Plan) new resources should be implemented

[48] WRSE main plan, page 31

as Risk Mitigation and that these schemes should comprise a portfolio that can be delivered at an early date securing 1 in 500 year drought resilience and priority environmental improvement.

Therefore, GARD welcomes the plan to complete at least Phase 1 of the GUC transfer by 2031. This would bring "new water" into the catchments feeding Thames Water's London's reservoirs. Much of the water coming in via the GUC transfer would end up in Thames Water's London reservoirs, either via enhanced chalk stream flows or through STW effluent returns.

Although our analysis shows that a 50 Ml/d GUC transfer would be more than enough for Affinity Water's needs and re-naturalising chalk stream flows, there would be additional security if the GUC carrying capacity can be increased to 100 Ml/d at relatively little additional capital cost, via the 'Phase 2' of the scheme, as implemented in WRSE's plan by 2040. Our view is that this phase should be brought forward for completion by 2035. Operating costs would only be on an as needed basis.

Similarly, and as suggested in Section 3.3, a first phase of the Severn to Thames transfer (STT) would bring added security to Thames valley and London supplies to guard against the same risks discussed above. We also note that in an extreme drought emergency, perhaps 1:500 years or worse, the Severn to Thames aqueduct would give access to residual flows in the Severn which are protected by the high hands-off flow at Deerhurst. If London was facing the disaster of Level 4 supply cuts, this would be a viable emergency source.

We suggest that the planned 500 Ml/d aqueduct capacity would be unnecessarily large and a 300-400 Ml/d capacity should be evaluated. This would allow the possibility of the Cotswold canal to be reinstated and used as the aqueduct, bringing very substantial leisure benefits and strong public support.

Initially at least, the only required support source would be the Netheridge STW effluent diversion, and the firsts stage of the Minworth STW upgrade. The latter might not be necessary if the Cotswold canal is used as the aqueduct because no sweetening flow would be required.

We will say more about STT options in our response to Thames Water's WRMP consultation, but we have made comments on the cost-evaluations of STT made in the present documents. These are discussed in section 4.1

3.4.2 Thames to Affinity transfer

GARD proposes that 50 Ml/d of the Thames to Affinity transfer should be brought forward to the early 2030s, connecting Affinity Water to Thames Water's London supply system. Combined with early implementation of 'Connect 2050' (re-naming it 'Connect 2030'), the Thames to Affinity transfer would allow all the planned upper Colne and Lea chalk stream reductions to be in place by the early 2030s.

The Concept Design Report for the Thames valley component of the T2AT describes the source of water for the transfer as follows[49]:

> *"The source of water for the LTR option is the River Thames. The natural flow in the river will need to be supported, especially during drought years, by the South East Strategic Reservoir*

[49] T2AT Concept Design Report, Lower Thames Reservoir Version, paragraph 1.11

(SESRO) SRO and possibly the Severn Thames Transfer (STT) SRO. SESRO is a pre-requisite for the LTR option because without SESRO the LTR option would leave Thames Water with a reduced volume of strategic storage."

In GARD's opinion, the source of water or the Thames to Affinity transfer should be a direct connection to Thames Water's London supply system, via an existing reservoir, probably the Queen Mary reservoir. The 50 Ml/d transfer to Affinity would become an additional 50 Ml/d demand on London's supply system. The existing reservoir system can provide support to the natural River Thames flows when needed in a drought, as it does for all other demands on the London supply system. By the time the T2AT transfer comes into operation in the early 2030s, the demand on London's supplies will have been reduced by about 120 Ml/d due to planned leakage and PCC reductions, and there will be additional 67 Ml/d of deployable output from the planned Teddington DRA scheme. There will be no need for any water from Abingdon reservoir or the Severn to Thames transfer.

GARD does not accept the argument "*SESRO is a pre-requisite for the LTR option because without SESRO the LTR option would leave Thames Water with a reduced volume of strategic storage."* The 50 Ml/d demand from Affinity Water on the London supply system is no different to any other London demand. If the London supply system deployable output can cover the demand, as it can with planned demand savings, leakage reduction and Teddington DRA scheme, there is no need for additional London storage.

If flow recovery is realistically allowed for, the Thames to Affinity transfer doesn't need to wait for either Abingdon reservoir or the Severn to Thames transfer. We will be providing more evidence for this in our response to Thames Water's draft WRMP, due on 20th March.

3.4.3 Thames to Southern transfer

Our analysis of deficits in Section 2.4 and Section 3.3 shows that this transfer is not needed. Even if additional supplies were needed by Southern Water, GARD considers that they should not come from Abingdon reservoir because:

1. The £2 billion Thames to Southern transfer is disproportionately costly, with its own environmental impacts.

2. The Fawley desalination scheme, which had been approved by Defra in Southern Water's previous WRMP, should not have been abandoned without proper consideration of the alternatives.

3. There is no "spare" water in Thames valley water so it should not be exported to other regions.

3.4.4 London Area Recycling schemes (including Teddington DRA)

GARD welcomes the planned Teddington DRA scheme delivering 67 Ml/d of deployable output for London. Although our analysis in Section 3.3 shows that this would not ultimately be needed if the Government's leakage and PCC targets are met, the early construction of this scheme would ensure

water availability from London's supplies to be transferred to Affinity Water, allowing early re-naturalisation of Colne and Lea chalk stream flows.

We note that, in our response to Thames Water's draft WRMP19 in November 2018, we criticised at length the abandonment of the Teddington DRA scheme and the environmental evidence on which that was based (largely temperature effects)[50]. We are, therefore, pleased to see that the scheme has now been reconsidered and put forward again, albeit in a much smaller form than we consider its ultimate potential. If more water was genuinely needed for London, we believe that a much larger version of the Teddington DRA should be reconsidered, making better use of the c. 400 Ml/d output of Mogden STW.

GARD recommends that the 67 Ml/d capacity Teddington DRA scheme now proposed should be planned as the first stage of a potentially larger scheme.

3.5 Abingdon reservoir

In Section 2 and Section 3.3 of this response, we have shown that Abingdon reservoir is not needed now and is unlikely ever to be needed.

GARD will be commenting in detail on the proposed reservoir in our response to Thames Water's plan. We anticipate the issues we will cover are:

- The adequacy of emergency storage provision
- The resilience to long duration droughts
- Reservoir safety issues (expanding on the following Section)
- Freeboard provision (as already discussed in the following Section 4.5.5)
- Costs, especially in comparison with the STT
- Understatement of carbon footprint (expanding on following Section 4.4)
- The understatement of environmental impacts and overstatement of bio-diversity net gain (expanding on following Section 4.3)
- The overstatement of leisure and natural capital benefits (expanding on Section 4.3 and 4.5)

[50] https://www.abingdonreservoir.org.uk/downloads/GARD%20%20response%20to%202nd%20Consultation%20on%20TW%20draft%20WRMP%20Rev%2029.11.18.pdf pages 65 to 79

4. Criticism of "Least Cost" and "Best Value" Assessments

4.1 Criticism of "Least Cost" evaluations

4.1.1 Overview

Our aim here is to summarise the problematic and erroneous aspects of producing a 'cost' for a plan, which feed through to a 'Least Cost' evaluation. We identify assumptions which lead to bias against certain solutions, and to favouring of 'big infrastructure' programs against, for example Demand Management options.

The issue of costing is complex, and is not helped by the lack of transparency in the WRSE plan, coupled with its lack of synchronization (in time) with the 'alternative' documentation sources – those of the RAPID Gate 2 process and the Thames Water dWRMP24 plan. By the admission of WRSE[51] to GARD, the more up-to-date costs are to be found in the RAPID Gate 2 documentation. In spite of this, in what follows we use the WRSE or dWRMP24 costs, or mainly the latter, as WRSE are particularly opaque, but note where we are aware of divergences from the RAPID Gate 2 costs.

The methodology recommended for use by RAPID, Ofwat and Environment Agency (EA) to compare the costs of different projects is called ***Net Present Cost (NPC)***. Its use is mandated by the EA in its '*Water resources planning guideline*'[52] and by the EA and OFWAT in the '*WRMP24_Template-tables_Fina*l' spreadsheet[53]. The use of the method is illustrated in a simple example in tab 5c of that spreadsheet. We will refer to this methodology as *Net Present Cost* to be consistent with WRSE terminology, even though its implementation here differs greatly from other methodologies which are also referred to by the same name. As implemented in the example, it is a very unusual method to use to compare the costs of different projects. The differences between using this methodology and more conventional approaches are particularly marked for projects with long life assets, including specifically SESRO which has a 250-year asset. The difficulties around the use of NPC are covered in Appendix B.

However, in spite of specific instruction from RAPID,[54] in all documentation seen by GARD the quantity ***Net Present Value (NPV)*** is used in the cost tables. We make our detailed analysis on this basis in this section.

In the work below, we concentrate on the cost evaluation of the largest two Strategic schemes for water provision, the Abingdon Reservoir (SESRO) and the Severn Thames Transfer (STT). In a very real sense, these are competitor schemes, especially in evaluation as to which is implemented first.

[51] Email WRSE to John Lawson, 7th February 2023 – note this was in response to a request from John Lawson of GARD on 7th January2023. Very typical of WRSE delays.

[52] https://www.gov.uk/government/publications/water-resources-planning-guideline/water-resources-planning-guideline

[53] https://www.ofwat.gov.uk/publication/water-resources-planning-tables-wrmp24/

[54] RAPID, *Strategic Regional Water Resource Solutions guidance for gate 2,* Section 8.1, February 2022

4.1.2 Cost Evaluation of Abingdon Reservoir against STT

There is a lot of cost data available in the Gate 2 reports on each strategic option, presented in separate cost and carbon appendices to the reports, which can be found via these links:

https://www.thameswater.co.uk/about-us/regulation/strategic-water-resource-solutions
https://affinitywater.uk.engagementhq.com/strategic-resource-options
https://www.severntrent.com/about-us/our-plans/sro-plans/gate-2-documents
https://www.unitedutilities.com/corporate/about-us/our-future-plans/water-transfers/
https://www.southernwater.co.uk/our-story/our-plans/water-for-life-hampshire/other-strategic-regional-options

There are also cost data presented in the WRMP tables for each company, giving the strategic option costs attributed to each company. For Abingdon reservoir, the total costs in the WRMP tables are split consistently 41/30/29 between the WRMP tables for Thames Water, Affinity Water and Southern Water. The presentation of costs in the WRMP tables is much more detailed than in previous WRMPs and is in a similar format to that previously proposed by GARD. We note this with satisfaction, and are grateful for RAPID's efforts to make this happen.

However, there is a £90 million discrepancy between 100 Mm^3 Abingdon Reservoir capital costs in the Gate 2 cost report[55] and the data shown in the water company WRMP tables:

Item	In Gate 2 cost report	In WRMP tables
Initial construction cost	£1,244 million	£1,169 million
Costed risk	£286 million	£292 million
Optimism bias	£347 million	£326 million
Total capital cost	£1,877 million	£1,787 million

Table 11 - Differences between Abingdon reservoir costs in Gate 2 reports and cost table

Following the WRSE admission above, we will use the RAPID Gate 2 costs for all of our own comparisons of costs.

4.1.3 Transparency

Initially, all the STT costs have were deleted from the WRMP tables, and following interventions by stakeholders and RAPID, this was reversed, but, there has always been a lot of STT cost information in the Gate 2 cost reports, including some tables presented as annual costs spread over the 80-year planning period, in the same format as the WRMP tables. For the '*North West strategic transfer*' option (the new United Utilities supplies needed to replace their supply from Vyrnwy reservoir), there is substantial redaction in the cost report and no presentation of costs in the WRMP table format, but still sufficient detail to get a reasonable view of these costs.

Although there is now a fair amount of cost detail available for the strategic options, there are no option cost comparisons to justify the selection of options and their sequence of development. These comparisons might be expected to be prominently available in regional plans and the WRMPs, but there are none to be seen. In addition, as noted above there is confusion between NPC and NPV

[55] https://www.thameswater.co.uk/media-library/home/about-us/regulation/regional-water-resources/south-east-strategic-reservoir/gate-2-reports/A-2---SESRO-Cost-Report.pdf

and a further lack of information on what the number is that is used to evaluate the cost of each option as well as information as to how that number is calculated. We requested information to allow us to understand the option costs for SESRO and STT on 15th January 2023, but have not received information to allow us to understand and confirm the correctness of the calculation of option cost. ***This appears to be a major failing in transparency.***

From a number of perspectives, the selection of Abingdon reservoir ahead of the STT is the major outcome of the regional plans and WRMPs. WRSE's plan page 29[56] says:

Our work shows both SESRO and STT are needed but the reservoir is a better first option. This is because the reservoir has lower running costs. The plans with the reservoir developed first are less expensive and have lower carbon emissions[57].

And also on page 29:

For the reported pathway, a plan without SESRO would cost £500 million more than the best value plan and have significantly higher carbon costs.

GARD can find no further justification anywhere in WRSE's main report or technical annexes. There is simply no cost information supplied. Even a 1566-page technical annex titled "*Investment model draft regional plan results*" and an 83-page technical annex titled "*Option Appraisal*" are totally devoid of costs of options and there are no cost comparisons presented as evidence to show the supposed lower cost of Abingdon reservoir.

Thames Water's summary of the WRMP, page 25[58], justifies the selection of Abingdon reservoir ahead of the STT as follows:

A new reservoir has lower running costs than a regional water transfer, so it makes sense for it to come first. Also, the plans with a reservoir first are less expensive and have lower carbon emissions overall.

4.1.4 Indirect cost comparisons

As for the WRSE report, there are no direct comparisons of option costs, but there are some comparisons of overall WRSE programme costs as shown by sensitivity tests in Section 10 'Programme Appraisal' of Thames Water's WRMP,[59] as shown below:

[56] https://www.wrse.org.uk/media/va1bz21z/10306a_wrse-bv-plan-2022final_online.pdf
[57] GARD does not accept the OPEX carbon costs argument – see section 4.4
[58] https://thames-wrmp.co.uk/assets/images/documents/non-technical-summary.pdf
[59] https://thames-wrmp.co.uk/assets/images/documents/technical-report/10-Programme-Appraisal-and-Scenario-Testing.pdf

Table 10 - 12: Sensitivity run outputs – option availability (SESRO and Teddington DRA)

Metric	Least Cost	No SESRO	SESRO 125 Only	SESRO 100 Only	SESRO 75 Only	No Teddington DRA
	Pathway 4					
Cost	15.37	15.94	15.45	15.44	15.67	15.82
Carbon	5,610,401	6,041,727	5,532,038	5,676,794	5,501,756	5,756,145
Natural Capital	7,494,195	6,477,558	6,094,152	10,847,786	9,678,647	7,736,003
Bio Net Gain	-258,496	-351,987	-294,132	-305,256	-296,398	-252,201
SEA Env +	84,475	85,359	85,461	85,385	84,836	83,795
SEA Env -	115,629	122,912	118,090	115,662	119,687	118,320
Cust_preference	32,452	32,894	32,472	32,457	32,532	32,225
Reliability	38	36	38	37	36	37
Adaptability	19	18	19	19	18	18
Evolvability	27	27	27	27	26	26
Large Options First Utilisation Date	Teddington (2031)	Teddington (2031)	Teddington (2031)	Teddington (2031)	Teddington (2031)	Beckton Reuse 50 (2031)
	SESRO 150 (2040)	STT300 (2038-49)	SESRO 125 (2040)	SESRO 100 (2040)	SESRO 75 (2040)	SESRO 150 (2040)
	STT300 (2050-60)	Desalination Beckton 150 (2050)	STT500 (2050-61)	STT500 (2050-60)	Desalination Beckton 150 (2040)	Desalination Beckton 150 (2050)
	Deephams (2061)	Re-use Beckton 150 (2060)		Deephams (2060)	STT300 (2050-61)	Beckton Reuse 100 (2058)
						STT300 (2060)

Table 12 - Sensitivity analysis on size of Abingdon Reservoir

Table 10 - 13: Sensitivity run outputs – option availability (STT)

Metric	Least Cost	STT300 in 2040	STT400 in 2040	STT500 in 2040
	Pathway 4			
Cost	15.37	15.64	15.93	16.04
Carbon	5,610,401	5,731,952	5,810,849	5,842,753
Natural Capital	7,494,195	7,473,972	7,340,154	7,349,998
Bio Net Gain	-258,496	-252,253	-260,667	-264,743
SEA Env +	84,475	85,251	85,011	85,611
SEA Env -	115,629	114,815	119,684	119,211
Cust_preference	32,452	32,333	32,749	32,616
Reliability	38	38	38	38
Adaptability	19	19	19	19
Evolvability	27	27	27	28
Large Options First Utilisation Date	Teddington (2031)	Teddington (2031)	Teddington (2031)	Teddington (2031)
	SESRO 150 (2040)	SESRO 150 (2040)	STT400 (2040-61)	STT500 (2040-63)
	STT300 (2050-60)	STT300 (2050-65)	SESRO 150 (2045)	SESRO 150 (2045)
	Deephams (2061)			

Table 13 - Sensitivity analysis on STT option availability

The 'cost' shown in these tables is the total NPV cost in £ billions *for the entire WRSE programme, ie the costs of all six SE water companies and all new sources and other measures, including metering and leakage control*. '*Pathway 4*' is the second highest future deficit scenario considered by TW (see Figure 10-7) and is the preferred scenario assumed in TW's plan. It corresponds to local authority housing plans, '*high*' environmental ambition (principally referring to the level of Sustainability

Reductions) and '*high*' climate change assumption. Under this scenario, both Abingdon reservoir and STT would be needed. Under the scenario which GARD will advocate – ONS population growth, prioritised Sustainability Reductions and realistic climate change – probably only one or the other of STT and Abingdon reservoir would be needed.

We can draw the following limited conclusions that can be drawn from TW's option comparisons in their Tables 10-12 and 13:

- Without Abingdon Reservoir, the programme would be £500 million more costly (£15.94 billion less £15.44 billion for the 'SESRO 100' cost in Table 10-12). This corresponds to the £500 million extra cost which WRSE say will be the result of excluding Abingdon Reservoir. However, there is a difference in the accompanying programmes (Beckton Desalination and Re-use schemes, and STT300 in the 'No SESRO' case vs STT500 and Deephams re-use in the 'SESRO 100' case) which makes direct comparison problematic to say the least.

- Constructing the 300 Ml/d or 400 Ml/d STT versions instead of the 500 Ml/d STT would save £400 million or £110 million respectively (see Table 10-13). That being the case, it is difficult to understand why TW have assumed the eventual construction of the 500 Ml/d STT rather than the smaller versions.

However, the information provided in TW's Tables 10-12 and 10-13 gives no explanation of why the STT is said to be £500 million more costly than Abingdon reservoir.

4.1.5 Direct Cost comparison of versions of Abingdon Reservoir and STT

Due to the lack of information just described, we are unable to compare directly the costs of WRSE's preferred STT and SERSO options. We have therefore done the closest we can with the available information. As an example, we use a version of STT which we will define as '*STT Phase* 1'. This concentrates on a configuration which relies for support on:

- the Minworth STW Strategic Option with 115 Ml/d max capability (see section 3.4.1);
- the Netheridge STW (see section 3.4.1)

This combination gives a deployable output of 228 Ml/d, as derived from Table 4-2 of the STT Gate 2 feasibility report [60]

- 134 Ml/d for the unsupported transfer
- plus 70 Ml/d from Minworth and 24 Ml/d from Netheridge,

GARD's modelling of this option gives a similar deployable output gain.

This option is compared with the 125 Mm^3 option for Abingdon ('SESRO 125'). Which has a stated deployable output of 230 Ml/d.[61]

[60] https://www.thameswater.co.uk/media-library/home/about-us/regulation/regional-water-resources/water-transfer-from-the-river-severn-to-the-river-thames/gate-2-reports/STT-G2-S1-001-STT-Detailed-Feasibility-and-Concept-Design.pdf

[61] Note GARD would dispute this amount in our response to Thames Water's WRMP, as we believe that the Emergency storage allowance in all SESRO concepts is too low

It is appreciated that neither of these options appear in TW or WRSE sensitivity tests, but GARD believes they form a fair comparison, as they are close in deployable output, and one option, if taken first, rules out the other for at least a decade. The choice of 'STT Phase 1' has the following advantages:

- the costs of the Vyrnwy replacement sources is omitted, as some of these are still redacted, and there is not complete certainty from United Utilities as to when Vyrnwy support will be available;
- GARD also believes that replacement sources will be much less costly than stated by United Utilities, if a realistic view is taken of the need for environmental reductions in the North West – this would make less expensive local sources available for transfer, instead of being needed as replacement sources for unjustified environmental reductions. See more on this in Section 2.2.5.
- the choice of the Minworth STW support has the advantage of being 100% resilient against climate change or extreme droughts;
- the option to upgrade Minworth to 115 Ml/d STT support in one go in combination with the upgrade to support Grand Union Canal (which GARD supports as an early part of the WRSE and Affinity Plans) is expected to save some £40 - £50million in CAPEX costs, as shown in table 8.1 of the Minworth SRO Gate 2 report[62]; the inclusion of the 500 Ml/d pipeline option ensures maximum future upgradeability, although GARD's modelling shows that the 400 Ml/d option would take all the eventual possible Vyrnwy sources.

The costs of these options have been copied from the WRMP24 format cost tables in various Gate 2 documents[63] [64] [65] [66]. The summary of the cost comparison is shown below:

	Abingdon reservoir 125 Mm3	**STT Phase 1 with Minworth and**
Initial Capex	£2,057 m	£1,656 m
Opex in Gate 2 report	£4.5 m/year	£58.5 m/year
GARD modelled opex	£4.5 m/year	£18.3 m/year
NPV with Gate 2 opex	**£1,389 m**	**£1,947 m**
NPV with GARD opex	**£1,389 m**	**£1,345 m**

Note: the Capex and Opex are at 2020/21 prices with no discounting

Table 14 - Comparison of costs of 125 Mm^3 Abingdon reservoir with Phase 1 STT

This shows that the STT Phase 1 option NPV is £550 million more than Abingdon Reservoir, if OPEX is costed at continuous maximum flow, but slightly less than Abingdon reservoir if OPEX is at costed GARD's (and we suspect Gate 2's) modelled actual use. If the OPEX assuming continuous maximum use has been used in the WRSE and TW investment modelling, it would explain WRSE's statement that the "*a plan without SESRO would cost £500 million more than the best value plan".*

[62] https://Minworth_gate_two_submission_111122_-_Redacted.pdf
[63] SESRO Gate 2 cost report, page 28
[64] STT Gate 2 cost report Appendix A
[65] Minworth Gate 2 report, Annex K1
[66] STT Gate 2Annex K1, page 2

Therefore, it appears that the 500 Ml/d STT Phase 1 option, supported by Minworth and Netheridge would be slightly less costly than Abingdon Reservoir 125Mm^3 if OPEX were to be costed realistically. However, even this is not a fair comparison, because the 500 Ml/d capacity connector is over-sized if the support is limited to Minworth and Netheridge. As indicated above, GARD modelling suggests that the 230 Ml/d deployable output could still be achieved if the connector capacity is reduced to 400 Ml/d. This would reduce the STT CAPEX cost by about £100 million and the STT option would be substantially less costly than Abingdon reservoir.

The CAPEX costs in the GARD comparison for the 3 components of STT Phase 1 are all as per the Gate 2 cost reports (no advantage taken for simultaneous upgrade of Minworth for STT and GUC[67]). The timing of construction of the STT has been adjusted so that its operation starts in 2039-40, matching the start of operation of Abingdon Reservoir, assuming a 2 years fill-time after the end of construction.

The OPEX costs shown in the versions of the WRMP tables included in the Gate 2 cost reports all assume that the three components of the STT operate at full capacity for 365 days per year. This is obviously an unrealistic assumption which greatly overestimates the operating costs. This is also in spite of the fact that the STT Gate 2 report actually includes figures for utilisation of the supported options at 22.3-22.6% for both '*historical*' (1920-2010) and '*Stochastic*' (series generated based on 1950-1997 dataset) modelling' of the WRSE system[68]. In the GARD model, the STT operating costs are modelled as for the average utilisations for the STT operating in conjunction with the London reservoirs to deliver a deployable output increase of 230 Ml/d. The operating costs are thus far less than for the maximum utilisations assumed in the Gate 2 and WRMP (£18.33million per annum vs £58.54million), with consequent reduction in the total NPV for the STT in its Phase 1 configuration.

GARD were informed[69] that the diameter of the pipe[s] chosen for the interconnector will require water to be pumped downhill from the summit as well as uphill to the summit. We are informed that this pumping prevents the recovery of the gravitational potential energy provided to raise the water, for example, using turbines or Archimedes screws, at times of peak flow. We further understand that when the flow is only the sweetening flow recovery of this gravitational potential energy is possible, and that the electricity generated can be used to reduce the OPEX. The inability to recover energy at higher flows materially inflates the operating costs of STT. We believe this is unnecessary. We believe that this needs to be evaluated more thoroughly.

We also believe the variable unit operating costs for STT to be excessive. We cannot find a quoted cost of electricity in the documents, but our calculation of the operating costs of pumping the water up to the summit at GARD's deployable output flow of 228 Ml/d is £3.8m at an electricity cost of 10p per kWh. The STT cost report summary, page iv, has this statement:

We note that the current high costs for power have not been incorporated in the variable calculations and rates will be reviewed at Gate 3 across all options

.

[67] This saving is expected to be about £47million.
[68] Ibid [62] table 8.1
[69] Thames Water drop-in meeting (Gareth Thomas) statement, Abingdon, 20th January.

Therefore, it is possible that there might be some increase in the OPEX costs at Gate 3 which would affect the STT option more than Abingdon reservoir. However, we note that the recent higher price of electricity has been driven entirely by increase in the price of gas caused by the war in Ukraine and that as the price of gas has already returned to more normal levels we consequently expect any long-term impact on the price of electricity to be small. Furthermore, the planned de-carbonisation of electricity which the water companies are required to assume in their plans, will eliminate gas-derived electricity entirely and we therefore expect that the power costs for Gate 3 will not be significantly higher than currently assumed. We therefore believe that the STT option could still be less costly than Abingdon.

4.1.6 Net Present Costs

As a check on this conclusion, GARD looked at the effect of calculating a Net Present Value for each option by discounting the actual CAPEX costs in the years they are incurred, rather than using WRSE's, and dWRMP's Net Present Cost figures which are calculated by discounting "financing cost"... The revised discounted costs on this basis are summarised below. The table shows that the method of discounting the CAPEX when calculating the NPVs does not have much effect on the comparative costs of the Abingdon reservoir and STT options.

Method of NPV calculation	Abingdon reservoir 125 Mm3	STT with Minworth and Netheridge
Discounted finance costs as per WRMP tables	£1,389 m	£1,345 m
Discounted capex in year incurred	£1,128 m	£1,142 m

Note: the Capex and Opex are at 2020/21 prices with no discounting

Table 15 - Sensitivity to use of discounted capex instead of discounted financing cost

4.1.7 Hiding the effect of 'Regulatory Capital Value' charges to customers on programme selection criteria

The 'costs' of Water Resource Management Plans, and hence of Regional Plans never include a discussion of the effect of including ***Regulatory Capital Value (RCV)*** of Companies in the charges to water customers, according to the formulae set up by the Regulator (Ofwat). We cover this in some detail in Appendix C. In short, the inclusion of RCV-related items in Ofwat's Pricing has the following effects:

1. There is a fundamental and extremely perverse incentive in the Water Industry regulatory regime that encourages investment in "big concrete" projects as the solution to any and all problems.

2. All expenditure by a Water Company that can be classified as being of a capital nature, including for example, building a reservoir and including the cost of developing proposals for a such capital asset, is added to the water company's ***Regulatory Capital Value (RCV)*** *and the company has a statutory right to make a real return on that RCV in all future years.*

3. These perverse incentives in the regulatory environment specifically *favour very long-life assets such as a reservoir in contrast to alternative methods of securing water for the*

southeast. The alternatives to the reservoir include the Severn Trent Transfer, desalination and fixing leaks. All these alternatives involve lower capital expenditure and shorter life assets. Consequently, these alternatives look less attractive from the perspective of Water Company shareholders.

4. If the reservoir were to go ahead, Water Company shareholders would still be earning their guaranteed return on the reservoir in 250 years' time. The asset lifetimes used for regulatory return calculations (and for accounting depreciation) significantly favour reservoirs (250-year life) over tunnels, pipelines and other water network assets (80 – 100 year lives).

5. Almost all Water Companies have highly geared balance sheets with very high levels of borrowings. These borrowings which have all been incurred since privatisation have largely been used to fund payments to previous shareholders. As a consequence of their corporate structures and high borrowings, most Water Companies have paid very low levels of corporation tax, if any at all, for many years. As an example, the accounts of Thames Water will be analysed in GARD's dWRMP response.

4.1.8 GARD's Financial Model

GARD created a financial model using cost and other data contained in the RAPID Gate 2 document for the Abingdon Reservoir and the Thames Water dWRMP. The model also used data from the Competition and Markets Authority's (CMA) determination on the elements of WACC. GARD have used this model to calculate the cashflows arising from over the 250-year life of the reservoir, 2022 to 2285. We will be giving more detail in our response to the Thames Water dWRMP24, but we note briefly:

- *The increase in Shareholder Value that would immediately arise and benefit the Shareholders* in the three Water Companies who would jointly own the reservoir if the Abingdon 100 Mm^3 were to be given the go ahead (Thames Water, Affinity Water and Southern Water), would be £846 million. This arises from the return on the increase in Regulated Capital Value (RCV) resulting from the £1,788 million Capital Expenditure on the reservoir, and discounted back to the present. All these numbers are fixed in 2022 currency

- GARD separately calculated the increase in Shareholder Value that would arise if the same amount of money identified as the initial construction cost of the reservoir, £1,878 million, were instead to be spent on increased operating expenses over the same period, to reduce leakage and to reduce demand. We believe that the answer is zero.

- There is therefore a ***staggering £846 million incentive*** within the Regulatory Regime to build the reservoir rather than to accelerate the reduction of leakage and the reduction of consumption.

- Additionally, Water Company customers would pay a huge cost for the reservoir: we calculate £4,829 million over 80-year WRSE planning horizon and £13,673 million over the 250-year life of the reservoir. Again, all these numbers are fixed in 2022 currency.

- In contrast, the additional cost that Water Company customers would pay for an additional £1,878 million of operating expenditure to reduce leakage and to reduce demand is only

£1,878 million. ***The reservoir would therefore cost customers an additional £3,041 million over the 80-year planning horizon of the WRSE process.***

GARD have used £1,878 million here to illustrate the differing financial consequences to customers of the same value of expenditure on different things. These aspects of costs to consumers need to be:

- made explicit in any evaluation of dWRMP and Regional Plans (and the only way this can be done is if they are transparently laid out by WRSE and the companies in these plans;
- *used in a metric* as input to the establishment of a Best Value Plan. In some senses the '*Inter-generational Equity*' (IGEQ) metric could be a place to start. However, at present, the use of IGEQ in WRSE's Plan only includes costs based on NPV discounting[70]. GARD has previously called for inclusion of the financial effects of RCV in the IGEQ metric[71] . *We re-iterate this call here.*

Our findings re-iterate our view that the building of the reservoir is on all measures worse than the alternative examined here of reducing leakage and consumption: it is more expensive and specifically more expensive for customers, has a materially worse carbon footprint, is more environmentally damaging, is less resilient and, specifically, less drought resilient.

4.2 Assessment of Deployable Output

GARD will be reviewing deployable outputs of some strategic resources options in our response to the consultation on Thames Water's plan. It has not been possible to include details in this response to WRSE's plan because of the late receipt of modelling output data requested from Thames Water – data requested on 12th December 2022 and received on 30th January 2023. The issues we are likely to consider include:

- the emergency storage provision for Abingdon reservoir
- the drought resilience of Abingdon reservoir
- the environmental restraints on output of the Teddington DRA scheme
- the Deerhurst hands-off flow
- the allowances for STT and Abingdon reservoir transmission losses
- the assessment of deployable output from Vyrnwy reservoir support

We anticipate covering these matters in our response to Thames Water's plan.

[70] https://www.wrse.org.uk/media/1g3jh5vs/wrse-best-value-plan-doc-final.pdf
[71] See response to Thames Water dWRMP19: https://www.gard-oxon.org.uk/downloads/GARD%20%20response%20to%202nd%20Consultation%20on%20TW%20draft%20WRMP%20Rev%2029.11.18.pdf

4.3 Skewing of Environmental, Natural Capital and Bio-diversity Net Gain Assessments

4.3.1 General Comment

The first thing to state about the 'Environmental' documentation for the purported consultation of the WRSE draft Regional Plan, is that the '*Draft Regional Plan Strategic Environmental Assessment Environmental Report*'[72] (below referred to as the '*SEA Report*') is pretty much devoid of content, outside of the Appendices H, I and J. Throughout the document, one is treated to over 200 pages of Process Diagrams and formulaic 'scoring' tables. It could indeed, have been written by a robot. In this sense, it shares much with other parts of the WRSE documentation. It is rather as if a visit to the doctor resulted in an extensive presentation of anatomical diagrams but no actual evidence-based diagnosis of what was actually wrong

In this section we make our comments below on instances where we have been able to see fallacious or counter-intuitive 'results' purporting to come from detailed dispassionate analysis. GARD's focus for this consultation, in the areas of Habitat Regulations Assessment (HRA), Water Framework Directive (WFD) and Biodiversity Net Gain (BNG) and Natural Capital Assessment (NCA) is on the difference in treatment of the Abingdon Reservoir, and its major competition in the pre-2040 priority, the Strategic Water Transfers (STT, GUC) , Leakage Reduction, and, to a lesser extent the Thames Basin recycling schemes.

4.3.2 Habitat Regulations Assessment (HRA)

This is addressed in Appendix H of the SEA Report.[73] There is little of concern here for any of the water transfer schemes which GARD would propose as priorities. The Grand Union Canal is not mentioned at all as impinging on either Special Areas of Conservation (SAC) or Special Protection Areas (SPA). The STT, in its Phase 1 configuration which GARD would propose (see section 4.1), essentially the Deerhurst Pipeline with Netheridge support and the supporting Minworth STW, impinges on a half-dozen SAC/SPA. The Abingdon Reservoir, on the other hand is claimed to only impinge on one SAC. We have some observations on this:

- The degree of impingement is not evaluated, but we note that the Minworth STW has no impacts and the Pipeline itself, involving a 'land-take'; of around 50m width or in construction, should be easy to mitigate section by section during construction. Once the pipeline is buried, the flora can be replaced[74], and the distance of displacement of the fauna is the sort of range (few 10s of metres) of mammals and birds. Minworth itself has no impact. The later implementation of the *whole of STT*, being envisaged by WRSE in its Best Value Program post-2075, contains a significant number of issues with the extension to Vyrnwy.
- To ignore a possible 'Phase 1' implementation of STT, as characterised by GARD in 4.1, ignores major strengths of such water transfers: *flexibility, scalability, upgradeability and early delivery.*

[72] https://www.wrse.org.uk/media/rddhyaum/wrse-draft-regional-plan-strategic-environemntal-assesssment-environmental-report.pdf
[73] https://www.wrse.org.uk/media/1atjvely/wrse-draft-regional-plan-sea-er-appendix-h-habitats-regulation-assessment.pdf
[74] Once construction is complete, the lasting effect would be similar to other pipelines/power lines which have been buried through the Cotswolds, eg the Gas Grid pipeline and 400kV National Grid lines – virtual invisibility.

GARD advocates specific evaluation of this option, before a Best Value Plan is conceived. The present 'tick box' assessment is not sufficient.

Of course, it is true that Leakage Reduction programs have virtually no HRA implications.

4.3.3 Water Framework Directive (WFD)

According to Appendix I of the SEA[75] there are no WFD issues involved with any of the Strategic schemes discussed here, a text search for 'GUC', 'STT' and 'SESRO' or 'Abingdon' revealing no occurrences. Although the state-of-the-art on these issues (as can be found in the RAPID Gate 2 documents) is not such as to cause great concern, this is an indication of the possible not-fit-for-purpose nature of WSRE's documentation.

To summarise from the RAPID Gate 2 documentation:

- For the GUC Scheme, there are no major WFD Issues flagged;[76]
- For the STT scheme, redesign has produced a favourable outcome with the issues regarding the Vyrnwy source and its direct discharge into the River Vyrnwy.[77] (Note these are not part of the 'Phase 1' as defined by GARD). GARD would dispute some of the initial worries on these parts of the scheme, but it is not our focus here. There are remaining issues for the design of the Minworth STW in the scheme, when operating at its full capacity of 115 Ml/day, due to potential WFD issues in the River Avon, but these are regarded as resolvable in the design and operating rules.[78] For the Abingdon Reservoir, the WFD status of some local waterbodies is compromised, but the effects are smaller in the 100Mm^3 design of the WRSE Best Value Plan. As with the STT, the concerns over these waterbodies are regarded as susceptible to mitigation measures.[79]

The main conclusion here is that concerns of WFD status are not a discriminator between these major strategic schemes.

Once again, Leakage Reduction programs have no WFD implications.

4.3.4 Strategic Environmental Assessment

The SEA results, described in detail in the WRSE draft Plan documents, are given at the level of Regional Plan only, and hence it is not possible, without asking further information of WRSE, to establish the particular characteristics of the individual schemes themselves. As the principal interest of GARD is in the comparative details of major schemes (and medium-level schemes where these

[75] https://www.wrse.org.uk/media/0eglc2vx/wrse-draft-regional-plan-sea-er-appendix-i-water-framework-directive-assessment.pdf

[76] https://ehq-production-europe.s3.eu-west-1.amazonaws.com//original/GUC_gate_two_submission_221222_-_Redacted.pdf

[77] https://www.thameswater.co.uk/media-library/home/about-us/regulation/regional-water-resources/water-transfer-from-the-river-severn-to-the-river-thames/gate-2-reports/STT-G2-S1-001-STT-Detailed-Feasibility-and-Concept-Design.pdf - para 6.10 and 6.11.

[78] Section 6.13 of ref[76]

[79] https://www.thameswater.co.uk/media-library/home/about-us/regulation/regional-water-resources/south-east-strategic-reservoir/gate-2-reports/SESRO-Gate-2-Main-Report-FINAL.pdf -see table 6.4.

can be combined to replace major scheme proposals) we have not pursued this further, but will instead be making our comments on the dWRMP and RAPID Gate 2 documentation on SEAs.

Worse, by the admission of the ref [80] document:

"*The cumulative assessment results identified across the Best Value Plan, Least Cost Plan and Best Environmental and Societal Plan are similar. This is likely due to the nature of the assessment in only considering options within water company boundary buffers which are similar across all three plans."*

This largely excludes the major schemes, such as Abingdon 100, and the GUC Phase 1 is the only scheme making it into the Assessment.

GARD concludes that the SEA Assessment in the draft Regional Plan is completely unfit for purpose.

4.3.5 Natural Capital and Bio-diversity Net Gain Assessment

The Natural Capital (NCA) and Bio-diversity Net Gain (BNG) assessments, as described in this plan[80] feature desk-based assessments of the worst 'handle-turning' type, and it is doubtful as to whether any actual imagination of, for example the reality of habitats being disturbed/replaced, took place. There are also serious concerns about how the various assessments were used on various plans. As admitted in ref [80] (section 2.2):

> "*This technical appendix only reports on the NCA and BNG in-combination effects assessment of the chosen programmes of options selected in the Draft Regional Plan (referred to as the Best Value Plan (BVP))…*"

and later

> " *The approach has involved two separate assessments which has comprised of options selected by 2050 and separately those selected post 2050 (and up until 2075)….). The pre and post 2050 options have been assessed separately because up to 2050 is the 25-year statutory WRMP period and after this the plan becomes the regional strategy with uncertainty related to planning scenarios and technical improvements for options.*
>
> *The two alternative programmes, the Least Cost Plan and the Best Environmental and Societal Plan, have not been subject to the NCA and BNG in-combination assessmen*t."

There is thus a faulty comparison between different plans, and, as the basic assumption is that of no exchange of schemes between pre- and post-2050 plans resulting from these assessments, the whole exercise is not a true component of a 'Best Value' Assessment

GARD notes further concerns about the assessments, from assumptions stated in the text in section 2.3. For NCAs:

[80] https://www.wrse.org.uk/media/gfbbnqjn/wrse-draft-regional-plan-sea-er-natural-capital-assessment-and-biodiversity-net-gain.pdf

*"The costs for constructing, operating, and maintaining the options were not considered within the assessments. …*and
Natural capital stocks presumed temporarily lost were expected to be reinstated/compensated."

These statements are part of a section headed '*Assumptions and Limitations*'. The latter statement is particularly concerning, and we view it as a *serious limitation,* as it seems to ignore the *scale* of any re-instatement/compensation program.

Further in section 2.3, for BNG Assessments:

"No enhancement of biodiversity post construction was considered, apart from where this has been explicitly included in the option description/design. BNG habitat units were assigned to the pre-construction land use according to the habitats present within each option boundary. The post construction land use, including agreed mitigation (if any), was used to calculate the post construction biodiversity score. "

which is a clear comparison (although it begs the question of how much thought has gone into the '*agreed mitigation'* for it to be part of a scheme). However, far less satisfactory is the statement:

"The duration of disturbance and timeline for habitat creation has not been included in the assessment. Durations of disturbance, including proposals for creating habitats in advance of disturbance, will need to be refined with greater design detail at later stages to refine the accuracy of the BNG calculations for each option".

GARD believes that ignoring *duration* of a disturbance, will naturally lead to an under-estimation of the negative effects of long-term biodiversity damage over a wide area. As we noted in the section on Habitats Regulation Assessment above, the disturbance to wildlife over a several square mile area is radically affected by the length of time, and the spatial dimension, of the disturbance. Wildlife driven from a 10 square mile area of, effectively quarrying activity for a 8-10 year period, is far less likely to return than that disturbed over a narrow swathe, even with the same area, capable, as it would be, of progressive remediation over a 5-year period. This omission of duration of disturbance, accompanied by lack of spatial configuration assessment, downplays the damage from construction of a project like Abingdon Reservoir, when compared to a pipeline or Recycling project (or even more perniciously, when compared to a Leakage Reduction programme).

For these reasons, GARD advocates that the NCA and BNG assessments should be revisited with explicit comparison of assumptions about possible (not just 'agreed') mitigation between large projects and assessment of the effects of duration and spatial extent of damage.

Without this, there can be no opportunity for Stakeholders to assess the contradictions which occur in the WRSE Assessments compared to the RAPID Gate 2 work (done explicitly by the water companies), For example the NCA of the 'STT Deerhurst Pipeline' solution is quoted as:

+£1,237.091 in the STT RAPID Gate 2 detailed design Appendix[81] … but …
- £5,116,76 in the WSRE Natural Capital assessment[82]

Notwithstanding the ludicrously precise numbers (9-10 figure accuracy for such a nebulous concept), there is an obvious mismatch of the STT receiving a positive metric in one assessment, and a negative one in the other. The methodology of the RAPID process should be employed by the WRSE team and the assumptions made transparent in both[83].

4.3.6 Special Pleading for Reservoirs in NCA

There is an aspect of 'special pleading' in Natural Capital Assessment in the case of reservoirs, as it seems that the *very act of creation of a reservoir itself* has positive value. This comes from the positive value assigned to what is called the '*Recreation and amenity value*' metric for and NCA on a particular proposal. To quote from ref [9], page 19:

> *"● Recreation & amenity value*
> *Some options such as reservoir options are resulting in a net-increase in habitats, natural capital assets, and corresponding ecosystem services. Broad habitats gained include:*
> ● *Abiotic*
> *This broad habitat corresponds with the following habitat type:*
> ● *Modified waters (reservoirs*)"

This is presumably within the rules of NCA, but it allows enormous scope to 'game' the system by being over-optimistic about the supposed Recreation and Amenity value of a Reservoir, and, perhaps worse, seeking to influence the design of the reservoir to maximise the value of this water area, downplaying other concerns (see section 4.5 on Reservoir Safety for some of GARD's concerns that this is being done in the Conceptual Design Report for Abingdon Reservoir).

The reality is that reservoirs do have very different possibilities of exploitation for 'Natural Capital'. It does not take much imagination to realise that large bunded reservoirs with all-round concrete walls and extensive rip-rap-enclosed shorelines and possible security and invasive species issues, have less Natural Capital possibility than 'classic' flooded valley reservoirs with more natural shorelines. Indeed, there seems to have been an acknowledgement of this to a certain extent in the WRSE figures. Table 4.1 of ref [9] gives the (totally unsubstantiated) comparison figure for the Havant Thicket Reservoir (described as a 'classic' reservoir) and the Abingdon 100 Reservoir. The values for Recreation and Amenity are quoted as:

Havant Thicket	£335,412
Abingdon 100	£249,021

[81] https://www.thameswater.co.uk/media-library/home/about-us/regulation/regional-water-resources/water-transfer-from-the-river-severn-to-the-river-thames/gate-2-reports/STT-G2-S1-001-STT-Detailed-Feasibility-and-Concept-Design.pdf -para 6.31.
[82] Ref [80] – Appendix C table page 38.
[83] In this respect we note that the BNG assessments were undertaken using the '*most up-to date Defra BNG Metric at the time (2.0 Metric*)'. We believe the assessments should use the more up to date 3.1 Metric which was published on the 21st April 2022. This demonstrates no development of the plan from the 'Emerging Plan' of WRSE which was so roundly criticised in the previous consultation. We note that the RAPID SRO reports use the more up-to-date 3.0 version of the Metric.

Havant Thicket holds 8.7 Mm^3 of water, and is in no way comparable to Abingdon on all other criteria, but the simple result that the NCA Recreation and Amenity for a small classic reservoir (with an area of 1.6 km^2 a construction phase of about 3 years,[84]) will result in 50% more Recreation and Amenity value than the Abingdon project with a capital cost more than 10 times higher, a construction phase 3 times longer and an area nearly 4 times larger.

The implication of a result like this is that the NCA Recreation and Amenity value of Abingdon 100 is nowhere near as good as a much smaller classic reservoir, and would, on its own, be regarded as a rather poor value for money. The more relevant implication is that WRSE, Thames and Affinity Water are painfully aware of this, but continue to push out the NCA value of Abingdon 100 as a real plus. We will return to this in the Thames Water consultation.

4.3.7 Special Pleading for Reservoirs in BNG

Similar special pleading is employed for reservoirs in the case of BNG. It is important to realise that this does *not* refer to the possible creation of habitats *around* the reservoir, which are simply analysed by a simple sum of (habitat type created by area) minus (habitat type lost by area). This refers to the actual BNG of the water area itself. Thus in table 4.2 of ref [80], the BNG of Abingdon 100 and its flood compensation lake (6.48 km^2) outweighs by a simple area ratio the BNG of Havant Thicket (1.34 km^2 an error value?). This does not take into account the fact that Havant Thicket (with a clear accepted detailed design) has wetland *within the reservoir boundary*, and the real possibility of fishing from shallow embankments – fish stocks attract birds as well as just people, and there are clear nesting possibilities which exist on Havant Thicket which do not exist on the Abingdon high-embankment, rip-rap desert. A great deal of this Abingdon possibility is clearly at the 'yet to be thought out' stage.[85]

GARD's conclusion is that the BNG and NCA Recreation and Amenity scores need to be based on more detailed designs for the Strategic Resource Options (but especially Abingdon Reservoir) before they are used as Metrics in program selection.

4.4 Carbon footprint assessments

In the WRSE Emerging Regional Plan documents, it was clear for several reasons that very little thought had been put into the issue of carbon footprint, and GARD made several criticisms at that time.[86] Whilst it is welcome that there is more analysis in this report, there are key issues which remain with what is declared as the general rationale behind the selection of options using carbon costs as a metric.

We address these below under the headings of 'CAPEX, or Embodied Carbon', 'OPEX or Operational Expenditure carbon' and 'Issues with Demand Management Options'. We will address issues as

[84] https://havant-thicket-reservoir.uk.engagementhq.com/planning-and-construction/widgets/44605/faqs#question13305
[85] Thames Water staff, in answer to questions at the *Thames Water Drop-in* event on dWRMP24. Steventon Village Hall, 18th February 2023.
[86] https://www.gard-oxon.org.uk/downloads/GARD%20WRSE%20final%20response%2014.3.22.pdf – pp 10-14.

identified in section 11 of the WRSE Technical Annex 2[87], and not go into details for individual schemes, as GARD will comment on these in detail in the forthcoming Thames Water and RAPID Gate 2 consultations.

4.4.1 CAPEX or capital carbon

Our focus is on the 'Strategic Resource Options' as defined in the RAPID Gate 2 process, and also on Leakage Reduction on the Demand side. The former are important as they are the schemes which form a huge part of the WRSE investment programme, and the latter because they constitute the most resilient guard against future climate change and extreme drought.

WRSE state in section 11 of Annex 2

> *"As most of these schemes will not be built until several years from now, time is available to work with the supply chain (e.g. steel and concrete manufacturers) to find new lower carbon solutions to construction. The All Company Working Group (ACWG), made up of the water companies with Strategic Resource Options (SROs), have engaged with the supply chain to estimate just how much progress with reducing emissions might occur over the next 60 years. This engagement has produced emission reduction estimates for most facets of construction, ranging from the types of construction equipment moving around on site, to the type of steel that might be used in future pipelines. Three different scenarios have been produced, a worst case, middle case and best case scenario; to allow for the industry moving slower or faster than expected."*

The All-company working group report can be accessed at,[88] and whilst such an exercise is genuinely to be welcomed, the conclusions drawn by WRSE (note, not necessarily by the ACWG itself) are very over-optimistic.

An example from section 11.13:

> *" … [an example of] this approach is for pipelines. For many large pipelines conveying vast quantities of drinking water around the region, 70% of the capital carbon emissions are attributed to producing the pipeline material itself. In the middle case (a moderate level of ambition), estimates by the ACWG indicate that 7% of carbon could be reduced in the manufacture of ductile iron pipes in the next 15 years, increasing to 39% in 15 to 35 years. Physically this would mean manufacturers of iron deploying stove flue or top gas recycling in most blast furnace-basic oxygen furnace sites, which is a transition the water companies can help promote by requiring contractors to use lower carbon materials thereby generating demand for these new materials"*

The report excludes alternative pipeline materials to iron and steel, whilst although they offer significant embodied carbon reductions and are, in some cases, widely available, they are '*not suitable for large diameter pipeworks*' involved in SROs. This seems reasonable, though we will return to this in the discussion on Leakage reduction.

[87] https://www.wrse.org.uk/media/lanejwxx/wrse-draft-regional-plan-technical-annex-2-nov-2022.pdf
[88] https://www.wrse.org.uk/media/muvl5thv/acwg-low-capital-carbon-alternatives.pdf

These figures for iron/steel are optimistic in the medium to long term, as it not only requires some research to be completed (not all iron grades are developed yet), but also testing and qualification programs (including long-term testing) and roll-out of factory refurbishment over a massive industrial plant complex (much of which is overseas[89] and on which UK Water companies have little leverage). Studies in other fields such as Nuclear power[90] have cited that it takes around 15 years to take an iron/steel variant from existence to the presence of *some* manufacturing capability. If the authors of the ACWG report cannot identify an actual *qualified* alloy available *now*, then it is highly unlikely to be available to contribute before a project start date of 2038-40. This emphasises not only the urgency to develop the materials, but also to revisit parts of SRO projects requiring long pipelines, and re-examine (eg. in the case of the Cotswold Canal version of the Severn-Thames transfer) solutions which limit the need for long-distance pipes (see also section 3.4.1).

> *"Likewise, concrete is another building material with a large carbon footprint, and many of the assets needed in the SROs include concrete. Again, WRSE cite:"Building on the work of the Low Carbon Concrete Routemap 91, the ACWG estimates that by optimising current practice in manufacturing and using supplementary cementitious materials, 20% of carbon emissions generated when building tanks could be eliminated if built within the next 15 years."*

The low-carbon routemap for concrete has few dates in it and, whilst it can point to the existence of some materials, the roll-out to industrial capability is largely aspirational. The routemap at least has the major benefit that it assesses development according to *Technology Readiness Level* (TRL) and *Commercial Readiness Level* (CRL), but even the highest TRL9 grading ('*System Approved*') only corresponds to the stage CRL2 ('*small scale commercial trials*'). There are still stages after that for progress to CRL4 and 5, where commercial competition ensures good value for project contracts. The figure 4.2 of the Routemap shows only one 'low-carbon' cement of the 27 cement types 'existing' is qualified to BS standards (effectively TRL8 stage). The carbon content is very variable (typically 30% difference between maximum and minimum values), but the variant offers guaranteed (min of cohort – max of the low-carbon type) of some 20%. This is still a thin base on which to derive a construction program benefit.

The third major area concerns large-scale earthworks and the emissions from heavy petrol and diesel-fuelled quarrying/construction/transport vehicles involved (though this latter has the added complication of negative impacts in the health and air pollution areas). Whilst present in all SROs, this dominates the embodied carbon for a reservoir. The figure 3.1 from ref [88] shows the breakdown for SRO-scale reservoir.

[89] Including in countries whose governments are not fully-committed to the COP26 agreement.
[90] See for example, D Stork et al., *Materials R&D for a timely DEMO: Key findings and recommendations of the EU Roadmap Materials Assessment Group*, Fusion Engineering and Design 89(7-8) (2013) 1586-1594. http://dx.doi.org/10.1016/j.fusengdes.2013.11.007 and references cited therein.
[91] https://www.ice.org.uk/media/q12jkljj/low-carbon-concrete-routemap.pdf

Figure 3-1: Reservoir SRO Capital Carbon Hotspots

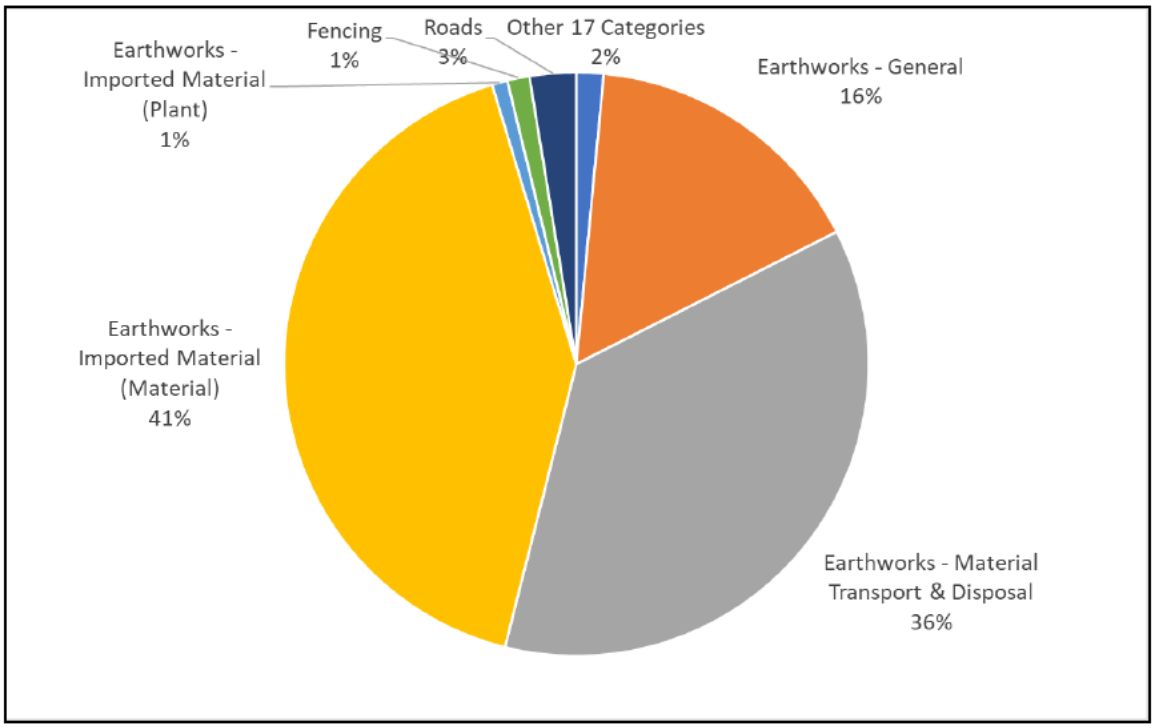


Figure 12 - Abingdon reservoir capital carbon hotspots

The dominant sources are 41% from quarrying and 36% from to-site transport of materials and 16% from the movement of earthworks on-site. The report purports to analyse how the embodied carbon might be reduced in the project, but the 'analysis' is woefully lacking in substance and hopelessly optimistic. It is also uneven in quality and philosophy when compared to that carried out for the pipe material and cement cases above. There are thus no details of technology existing, or industry-accepted roadmaps, or TRL discussion, or indeed of anything that could not be found from a Google search. Instead, anecdotal discussions are cited with two manufacturers *"…indicate that prototype* [hydrogen powered] *large excavators (21T and 35T) and dozers are being developed and potentially available in the next 2 years*" (ie. the *prototype* might be available). Such 'analyses' are used to derive an astounding (for its *chutzpah*) conclusion that a '*mid-case*' scenario (the one taken by WRSE) could result in a 60% reduction in embodied carbon in the 2025-2040 timeframe. This analysis excludes an analysis of transport by rail (currently diesel along the Great Western Line identified for bringing the 5+ megatonnes of Rip-rap to the site), as it only mentions HGVs in the text. It depends on the availability of Hydrogenated Vegetable Oil (HVO) fuelled vehicles, to provide 50% of the fleet, in spite of the fact of admitting that:

> *"Currently the UK's supply of HVO is underdeveloped. Although construction plant technologies operating with HVO are available, the risk of a secure supply of HVO may limit its applicability nationwide".*

All this to 50% market penetration by 2027! There are currently no diesel train fleets with HVO-powered vehicles. The changeover to HVO, not even considering the expensive need to write off plant which is far from life-expired, will not even start on any scale until the HVO fuel supply-chain is settled.

There are even more risible items in the '*analysis*'. This whole section has the air of being written by a Reservoir fanatic (something shared quite commonly across the Abingdon 100 Mm^3 analyses). We conclude that this is not worth consideration, as although it shows the steps required, the only conclusion could be that Reservoir construction is best delayed until at least 2035 -2040.

Over the program and the materials cited, WRSE claim 26% mitigation in embodied carbon from such measures implemented over the program from 2021 to 2075. This is really highly optimistic and to achieve it one would have to severely *back-load* the program, which might destroy the Risk Mitigation characteristics of the infrastructure (See section 3.3)

4.4.2 Leakage Reduction programs

In contrast to the attention to new infrastructure projects, the assessment of Demand Management options' embodied carbon reductions has not even been performed by WRSE! As admitted in para 11.23 of Technical Appendix 2:

> *"A particular area of weakness that is acknowledged is around estimation of carbon emissions associated with demand management interventions (particularly metering and leakage - reduction activities, including mains renewals). Due to gaps in some carbon data for demand management options the demand management emissions estimate is based upon high level analysis of carbon intensities for demand management interventions, but further work is planned to refine this for the Final Plan."*

One has to conclude that, this just shows a lack of seriousness in addressing this issue across the board. The issue is not tackled at all in the ACWG report, in spite of the fact that quite a lot of the likely sources of carbon in Leakage and PPC-reduction programs are tangentially-analysed in the sections on pipes and reservoirs. Thus the pipe section notes that low-carbon pipe materials (HPPE and MO-PVC) are identified with significant reductions over steel/iron, but being unsuitable for large diameter pipework (over DN800) so not adopted for SROs. They are presumably available for replacing leaking city mains supplies. Also, the smaller construction plant involved in digging small trenches (or the vans delivering meters!!) are already available in electric-powered form and will be subject to the same development possibilities as the heavy plant associated with reservoirs.

We conclude that the WRSE analysis is certainly not fit for purpose in establishing a Best Value plan using embodied carbon as in input metric. Moreover, it is biased against Demand Management solutions, and on the new infrastructure supply side is substantially tilted to give a favourable result for reservoir projects.

4.4.3 OPEX or operational carbon

The Operational (OPEX) Carbon burden is of course a concern for projects which require substantial pumping or pressurising action. These are often used to discriminate against projects which are outside the reservoir category, although the Demand Management side also has an even lower OPEX burden and it doesn't seem to be counted in its favour anywhere in the assessments.

There are many issues regarding evaluation of OPEX carbon, but we cite some below. We will return to these in more detail in GARD's submissions on the Thames Water and RAPID Gate 2 consultation responses.

1. As noted in section 4.1.5, the OPEX costs quoted in the WRMP and RAPID Gate 2 documents seem to assume that the pumped transfer schemes are operating at full flow for the whole year. This increases the OPEX carbon cost of transfers, and Recycling schemes, relative to reservoirs. In reality, all SROs, as can be seen in the RAPID Gate 2 documents, are expected to be operated for some 20-30% of the time at full flow.[92]

2. Uneven detail exists in the evaluation of potential of energy recovery from the 'downhill' part of the inflow/ outflow of the various schemes. Although energy recovery is assumed in all schemes, the constraints (for instance the statement that energy recovery for the STT pipeline is 'less efficient' at high flow) have not been optimised.

3. Operational use of chemicals is assumed to remain a substantial part of the OPEX carbon budget, due mainly to the assumption that the decarbonising of this sector will take a long time (and the Power grid, the other main source of carbon, has a decarbonising trajectory). However, the same analysis needs to be applied to this source of OPEX as has been applied to cement and pipeline iron/steel (See 4.4.1 above). Whatever the limitations of the above analysis, at least it is an attempt. However, there is no attempt to assess carbon mitigation in the chemicals carbon operational budget in the WRSE draft Plan (section 11.20 of Technical Annex 2). This is a major failing, and it is hence impossible to compare OPEX and CAPEX carbon strategies in the Plan (which starts with an un-mitigated chemical-OPEX carbon equal to 25% of the whole unmitigated plan value.

4. The exact decarbonisation trajectory for the Grid electricity is not explicitly described in the Plan. In some senses, it should not make a difference, as both the Ofwat '*High Technology*' and '*Low Technology*' common-reference scenarios against which the companies are supposed to assess their plans are both to assume 100% decarbonised electricity production by 2035[93] (which also affects all production of materials, and the carbon footprint of electric vehicles). Thus OPEX electricity generation should be a vanishingly small issue for all SRO schemes which come into operation post-2035 (this is STT and GUC Phase 2 in GARD's basic plan). However optimistic this proves to be, there seems to be no sensitivity testing to these scenarios in the WRSE plan.

4.5 Absence of assessment of Reservoir Safety Issues

4.5.1 Introduction

The statements that the WRSE draft regional plan

" … is not a consultation on an individual water company's draft WRMP"

and that

… " It does not include the technical details of how individual schemes will be implemented as this is a matter for the relevant development consent process"

[92] https://www.thameswater.co.uk/media-library/home/about-us/regulation/regional-water-resources/water-transfer-from-the-river-severn-to-the-river-thames/gate-2-reports/STT-G2-S1-001-STT-Detailed-Feasibility-and-Concept-Design.pdf table 8.1.

[93] https://www.ofwat.gov.uk/wp-content/uploads/2021/11/PR24-and-beyond-Long-term-delivery-strategies-and-common-reference-scenarios.pdf pp33-34.

are used by WRSE in an attempt to duck responsibility for many issues. Amongst the most important of these is the issue of *Reservoir Safety.*

In GARD's view WRSE, as the overall coordinating body for SE water supply, and including as it does all the individual water companies, has wider responsibility for ensuring that certain important issues that may have direct and serious public impact are addressed. These obviously include things such as the health and safety of, and risks to the welfare of SE communities, and response must be coordinated at the highest level. Thus, whilst the more detailed issues on Reservoir Safety will be addressed by GARD to Thames Water and Affinity Water, ***we believe that WRSE has failed in its duty of due diligence in safety matters***, and we give a summary within this response of our concerns and our own developing view of this.

The issues we raise should clearly have been investigated by Thames Water in its case for the Abingdon Reservoir proposal, especially as it has been on the table, essentially in the current format, for at least 15 years. It is simply not good enough to argue that these are for detailed examination at a later stage of the processes (the current destination of the procrastination being the RAPID Gate 3 process). As water infrastructure, reservoirs, and especially those of the size of the Abingdon proposal, have unique dangers and design issues which should be established at the stage of draft Plans. That scoping studies, costing only a few thousand pounds have not been done (or at least remain secret) is a real scandal and cannot be allowed to go unchallenged.

GARD's examination of the Reservoir Safety Issues are given in some outlines below, in the hope of jolting WRSE into action on this.

4.5.2 Overview of Safety Issues involving Abingdon Reservoir

A list of issues related to Reservoir Safety are given in the Appendix 1 'Concept Design Report' (CDR) of the RAPID Gate 2 submission on the Abingdon Reservoir[94]. Some of the key design features relating to safety which, by implication, are not yet sufficiently investigated, are:

- *Internal filtering and drainage – to safely manage dam seepage flows whilst preventing these eroding the dam internally.*
- *No buried engineered fill / structure interfaces. Instead, all water conveyance would be via a tunnel excavated through the foundation clay, or via siphon pipes over the dam crest.*
- *Provision of pipework to enable an emergency drawdown at an initial rate of 1m/day – this is the maximum recommended installed rate within current UK guidance for reservoirs and matches that adopted at all other major Thames Water reservoirs.*
- *A wide embankment crest and measures to prevent uncontrolled vehicular access to limit the risks of damage induced by persons.*
- *Provision of a comprehensive control system to prevent overfilling.*

[94] https://A-1_-_SESRO_Concept_Design_Report.pdf, section 2.2.2.1

- *Wave erosion protection – the inner face of the embankment would be protected from wave erosion capable of protecting against extreme storm winds.*

- *Sufficient freeboard (difference in level between maximum operating level and top of wave wall / dam crest) to take account of long-term settlement of the dam, and the risk of large waves breaking over the dam*.

- *Monitoring and surveillance – A comprehensive, automated system of instruments would be installed within the dam. Such readings would supplement on-site monitoring by operatives trained in reservoir safety surveillance.*

When questioned by GARD members and local residents at 'pop-up' or 'drop-in' sessions on the Abingdon Reservoir, Thames Water staff usually fall back on assertions about safety, rather than point out actual work which has been performed to quantify safety issues. The assertions repeat the text in the CDR that "*The reservoir would be designed and constructed in compliance with the applicable reservoir safety legislation (The Reservoirs Act 1975, as amended). In accordance with this Act, the design and construction of the reservoir would be supervised by a Construction Engineer, namely a competent and highly experienced dam engineer already appointed to the 'All Reservoirs Panel' by the Secretary of State. It would also be overseen by an independent expert engineering panel for additional scrutiny appropriate for a large reservoir such as SESRO*". This just states the obvious legal position, and is not necessarily a guarantee that the Reservoir is the Best Value Option, as, if some of the aspects above are left to a late stage, and revisions arise due to *evaluated* safety considerations, there will be inevitable cost and schedule escalation, and perhaps even loss of deployable output, in the final plan if approved.

Of course some issues covered in the bullet list above, are properly covered in later stages of the design process. Others however need explicit early coverage. In GARD's view these are:

1. Issues around Safety in the case of detected major fault in the dam wall, and the extent of the Emergency evacuation of the surrounding population and the Emergency Drawdown of the Reservoir. This includes, but is not limited to, the design of the Emergency Drawdown system of the Reservoir alluded to above.

2. Issues around the threat from Terrorism to the Reservoir security – this is alluded to obliquely in the bullet list as "….*measures to prevent uncontrolled vehicular access to limit the risks of damage induced by persons.* "

3. Issues of the basic height of the Freeboard and the related issue of the protection of the inner face of the Embankment against wave-erosion.

In all these cases a scoping exercise would establish the scale of the concept design measures, and help to crystallise issues around realising some of the 'Natural Capital benefits'.

4.5.3 Major Dam wall fault and Emergency evacuation/drawdown

The *Likelihood* of a major fault developing in a dam wall constructed under modern practice is regarded as '*unlikely' or 'rare',* but nevertheless given the *high impact* of such a fault, the *Risk* (as usually evaluated as a 'product' of *Likelihood x Risk*) has to be evaluated, and there is an obligation

for owners proposing to build dams to establish the effects of a major catastrophic breach on the local population and infrastructure. Dams are classified as '*High Risk*' in the relevant legislation[95] if they have an above-ground volume of greater than 10,000m^3. In this case the process has to involve the provisions of the Reservoirs Act of 1975, as cited in the WRSE text above. The 100 Mm^3 Abingdon Design has an above-ground water volume of at least 67 Mm^3 (taking the Thames Water quoted 'borrow pit' in the Conceptual Design), so it clearly is a '*High Risk*' facility within the terms of the Act. However, the DEFRA advice on assessing safety on 'small dams' (<25,000m^3 as defined in ref [95]) contains formulae and procedures which can be used to scope out the situation for larger dams. GARD has employed these formulae and procedures These formulae and procedures give an idea of the area and severity of damage for a catastrophic dam wall breach (as defined in ref [95]), The special issues which make the Abingdon Reservoir a higher-than-normal safety hazard regarding reservoir-wall breach are:

- the much longer perimeter impounding wall of this Reservoir (around 8.7 Km for the Abingdon 100 design) compared to most impounding wall dams;
- the size of the above-ground water volume compared to the majority of reservoirs, exacerbating the length of the Emergency Drawdown, and period of Emergency evacuation;
- the issue of accelerating climate-change and its rising temperatures on the micro-fissure creation in the embankment;
- the relative proximity of some surrounding communities, especially when one considers the '*all-round*' nature of the possibility of a breach

The procedure uses equations from Frohlich,[96] and assumes for each breach position, that water flows out with a quantity (Q_p) over a width (W) as defined in the flow equations (ref [96]), with 'typical' friction applied to the flow. The procedure takes an extreme breach, but this is necessary to define what is the worst *deterministic* accident. In this sense, the DEFRA procedure has a similar philosophy to a Nuclear installation '*Design Basis Accident*'[97], an assessment necessary to define the off-site consequences, and hence precautions, for a catastrophic incident.

The procedure has been used to establish the quantity DV (Depth x Velocity) of the flow from a catastrophic breach opposite various communities around the Reservoir. The value of this parameter would then be used in the DEFRA procedure to establish level of casualties in each location (assuming no warning).
As GARD's calculations are still in a relatively simple form, we do not intend to publish detailed maps of the calculated flooding/damage/fatalities. However, we intend to send GARD's refined calculations to a limited distribution once we are satisfied with checks. We will certainly include something more refined in the response to Thames Water's dWRMP24. For now, we note that there are several communities at risk of flooding or damage in the Reservoir vicinity. Several locations are at '*High Risk*' (defined as DV > 3m^2/sec) from a breach, whereas more have '*Medium Risk*' (3 > DV > 2

[95]https://assets.publishing.service.gov.uk/media/603390fc8fa8f54334a5a673/small_reservoirs_simplified_risk_assessment_methodology_guidance.pdf
[96] Froehlich, D.C. (1995) Peak outflow from breached embankment dam. *ASCE Journal of Water Resources Planning and Management* 121(1), 90-97.
[97] Essentially, if something *can happen* this DEFRA analysis assumes it *will happen*, irrespective of probability.

m^2/sec), with yet more defined as having '*Flood risk*' (without fatality) where DV is less than $2m^2$/sec but greater than zero.

All these communities would lie in the Reservoir Flood Risk Area, as defined in the EA's maps.[98] It is these areas which would have to be evacuated in the event of a major fault being detected. Such an event happened in the case of a much older earth dam at Whaley Bridge, Derbyshire[99] in 2019. The 1500 population of the town of Whaley Bridge spent 6 days out of their homes whilst the threatened breach was made safe.

From the initial studies, the communities in danger of some level of flooding or damage from a major breach somewhere around the 'Abingdon 100' perimeter, would include Steventon, East Hanney, Drayton, Marcham, Milton, parts of South Abingdon, Culham, Sutton Courtenay and Appleford. All these communities are expected to be in a potential Flood Risk Area.[100] The evacuation duration for a community threatened by the major breach would be potentially long (the Whaley Bridge episode lasted much longer than anticipated). At an Emergency Drawdown rate of 1 m per day, as quoted above, it would take 10-15 days to bring the Reservoir water level to something which could be regarded as safe. Thus, in the worst case, 10-20,000 people would have to be provided with emergency accommodation for up to a fortnight.

As a corollary, we note that the amount of water passing through the pipes in an emergency drain-down is around 63 m^3/sec, assuming a 1 m per day drawdown of the 100 Mm^3 reservoir. This is more than the natural flow-rate of the Thames at Sutton Courtenay for about 85% of the year.[101] Indeed, if the flow were released between December and March, about 20% of the time the resulting flow in the Thames would be close to historical maxima, and flooding would almost certainly result. Thus, the flooding effect of the Emergency Drain-down itself needs evaluation at this stage.

4.5.4 Terrorism as a threat to the Reservoir security

The issue of a terrorist threat to the Reservoir, as to all water infrastructure, is not something that should be taken lightly. One would expect Thames Water to have sought advice on this from the relevant authorities, even at this stage. Whilst one might not expect the advice to be made public, there are nevertheless aspects which one would expect to see informing the Conceptual Design, even at this stage. The most important of these aspects, from the point of view of WRSE trying to paint the Reservoir as part of a 'Best Value Plan' relate to the effect on visitor access to the Reservoir site, something which figures heavily in Thames Water's attempts to attribute positive '*Natural Capital*' outcome to constructing the Reservoir. As was admitted in the RAPID Gate 1 documents for

[98] https://check-long-term-flood-risk.service.gov.uk/map
[99] https://www.bbc.co.uk/news/uk-england-derbyshire-53580768
[100] Clearly, a breach would affect communities in an arc opposite the breach, thus a breach opposite South Abingdon would leave Steventon, East Hanney, and Milton largely unscathed, but the Flood Map must take into account all possible locations.
[101] https://nrfa.ceh.ac.uk/data/station/meanflow/39046

the Abingdon Reservoir[102]

> The reported positive change in natural capital value is primarily due to the significant increase in Recreation value expected for the site, which outweighs the decrease in ecosystem value of food production – although improvements in all the other services are also reported in comparison to the baseline, without recreation they are insufficient both alone and in combination to outweigh the loss in Food production value;

The positive Natural Capital assessment is essential to the Best Value argument, and even more to Thames Water's attempts to spin a positive view of the Reservoir (always seen in juxtaposition with pictures of sailing boats).

There are occurrences of the access to the London Thames Water reservoirs for sailing being restricted at the height of the IRA campaigns in the 1980s. GARD is in the process of taking advice from an expert in counter-terrorism issues relating to Infrastructure. If we get a briefing, it will be included as part of GARD's Thames Water response. From now we would like to note:

- The ***National Risk Register*** *rates* potential hazards such as diseases, major accidents and societal risks in terms of their *Impact (I)(Severity) and likelihood (L)(probability*) in terms of a 5 x 5 matrix with 1 being the lowest score and 5 the highest. The current National Risk Register[103] rates an attack on infrastructure as I = 3 and Likelihood of L = 2. UK Govt definitions are not stated in the document but typically:

- An impact score of 3 would indicate limited loss of life, structural damage and long-term delays to delivery. A Likelihood score of 2 would suggest that such an event would be unlikely to occur but there are examples of this sort of event. This would suggest a risk score of 2 x 3 = 6, a typical definition would suggest that the risk is ***tolerable*** where resources are not available to treat or mitigate (but ***the risk should be entered into an appropriate risk register for future treatment/mitigation****)*[our emphasis][104].It is intended to allow recreational sailing (and fishing) in the reservoir. Of concern is the vulnerability of the bund. Particularly of concern would be a Vehicle Borne Improvised Explosive Device (VBIED) this could be a say 500kg of Home-Made Explosive

- [Referring to the Conceptual Design Report – fig 2.1]**,** a freeboard of 1.0m looks inadequate, more appropriate for a dam on a rural farm (we shall further discuss this below. Although a legitimate terrorist target, the risk would be assessed as low (currently) and *terrorist considerations alone would not preclude construction*. Having said that a medium sized VBIED could easily cause a breach at the dam crest, with subsequent rapid erosion of a section of the downstream earthfill and total embankment breach, with resulting major loss of life and publicity and so sensible mitigating features should be included.

Recreation is seen as a key benefit. However, even if the project assessment requires that boats should be able to be launched and recovered from the bund, the Terrorist threat considerations

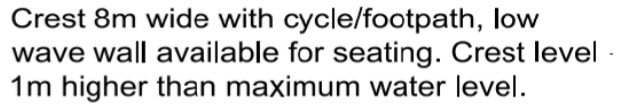
[102] https://www.thameswater.co.uk/media-library/home/about-us/regulation/water-resources/strategic-resource-solutions/new-reservoir-in-oxfordshire/environmental-assessment-report.pdf – sect 11.1.5, p 163
[103] UK_National_Risk_Register_2017.pdf
[104] Note that this risk is to infrastructure in general and not specifically for water related assets.

could well specify this should be done only from specific locations and that, ***apart for maintenance, vehicles should not be permitted on the bund*** Access to vehicles and plant onto the bund could well be physically restricted, and any slipways provided should be designed to prevent breach from a VBIED and access controlled: this would be a challenge.

GARD's view is that the Freeboard of the bund is indeed too low in the current design (for the issue of wave-overtopping in high winds, as discussed in section 4.5.5). It is also our view that the issue should be investigated and that the project's Natural Capital assessment, and social use definition ***must*** be settled, including the knock-on effects on design and cost, before the project is allowed to pass through this stage of either the draft Regional Plan, the dWRMP24 or the RAPID Gate 2 process..

4.5.5 Design of the height of the Freeboard and the related issue of the protection of the inner face of the Embankment against wave-erosion.

Figure 2.1 of the Conceptual Design Report shows Reservoir cross sections and indicates that the crest of the reservoir will have the following characteristics:



As usual in the Thames Water documents on Abingdon Reservoir design, more attention is paid to the issue of where visitors will sit or ride their bikes than how safe the design is. As indicated in the section on terrorism above, the height of the crest above maximum water level is thought to be too low. This opinion has also been expressed by ex-Reservoir Panel engineers to whom we have shown the design.

Minimising the crest height is important to the aspirations of Thames Water because of the criticism of the imposing height of the Reservoir overlooking the surrounding housing, and the need to have launch sites for sailing and areas for fishing. It is GARD's view that these have been more important than the design to avoid wave overtopping in high winds.

GARD has consulted the design advice document from HR Wallingford relating to reservoir crest design,[105] In common with other sources, the design recommendations cover design against overtopping in a period of subjection to the "*50-year wind*", ie the wind conditions expected (from historical measurements) to occur once in every 50 years. At present, there are no clear predictions from climate change models about the frequency of high winds, so we adopt this standard. There are (SR459, equation 2.3) factors to apply to the wind values according to:

- the '*fetch*' or distance over open water of the wind before it reaches the retaining wall (as wind speeds up over open water) – this figure is significant for Abingdon reservoir, as there are distances of around 2.5 km or more over open water;

[105] *Reservoir Dams: wave conditions, wave over-topping and slab protection,* A J Yarde, L S Banyard and N W H Allsop, HR Wallingford report SR459 (1996)

- the '*duration*' of the wind speed (20-30 mins is considered appropriate for reservoirs – the wind speed map being quoted as averaged over one-hour) – shorter durations give higher waves;
- the '*altitude'* of the reservoir (wind speed maps are at ground level);
- the '*repeat time*' of the significant wind (we take 100 years as reasonable considering the reservoir lifetime, but this only results in a 5% increase);
- the *'direction'* of the prevailing wind, relative to the measurement direction (relative to 240°, or WSW) – this is irrelevant for an 'all-round embankment like Abingdon.

The combined effects of these factors is to change the wind speed for consideration of the *significant wave height* from 20 m/s to 27 m/s (=U)[106]. From this, the significant wave height becomes (equation 2.6 of SR459)

$H = 0.00178\sqrt{F}/\sqrt{g}$ metres where F is the fetch length (metres) and g is the acceleration due to gravity (m/s^2).

Giving $H = 0.67m$.

SR459 considers that a factor for '*no wave surcharge carry over'* of 1.67 should be applied to the significant height giving a wave design height of 1.15 m.

This value can be lowered by facing the run up with rip-rap (as in the Conceptual Design) and, for a 1 in 6 slope (as CDR) with rip-rap a factor of 0.6 is used (figure 3.1 of SR459) leading to a final wave design height of H_D = 0.69 m.

If we take from SR459 fig 3.4, the value for 'safe' overtopping of the wall as 2 l/s/metre wall length, and apply formulae as in Box 5.3 of the document, we derive a freeboard height of around 1.5 m. This still seems low (and we should bear in mind the comments regarding Terrorist threats above), but is higher than the CDR value.

We make the following observations:

- even at this value 'safe overtopping' value, there would be an overtopping of around 7.2 tonnes (7.2 m^3) of water per hour over a 100m stretch of wall where the wind speed might exist – the downstream slope of the bund needs to take this into account;
- the freeboard height minimisation is heavily dependent on the use of rip-rap protection. This is foreseen in the conceptual design, but we note that the 'brochure' and 'Facebook picture' depiction of a smooth concrete slope for launching boats is at variance with what a rip-rap protected slope actually looks like. Sailing boat launching over a 'rip-rap field' of considerable extent with such a shallow slope would not be a simple task.

  Whilst these figures have been established in a relatively rudimentary fashion, we believe that WRSE and Thames Water need to justify explicitly their selection of a 1.0m high crest. We

[106] This corresponds to the upper end of Storm Force 10 on the Beaufort Scale. It is somewhat higher (10-20%) than the *mean* inland wind speeds recorded in the south-east in the October 1987 Storms.

believe that this has been selected with leisure activities, rather than safety against high waves, in mind.

Appendix A - Answers to Consultation Questions

Question 5: Our draft regional plan looks 50 years ahead. It plans to increase resilience to drought and address the potential shortfall in water as a result of climate change, population growth and increased protection of the environment, by taking an adaptive planning approach.

Do you think the draft regional plan addresses the scale of the challenge we face in the future through our adaptive planning approach?

Strongly disagree.

The plan grossly over-forecasts the future deficit in the South East. See Section 2 of our separate response, especially Table 16 – Summary of over-forecasting of 2050 deficits in Abingdon reservoir supply areas. Consequently the need for new supplies is grossly exaggerated.

Question 7: Our draft regional plan has considered the needs of other sectors and how their demand for water could be met in the future.

Do you support us continuing to work with other sectors so our regional plan fully embeds their future needs and includes appropriately-funded solutions to meet them?

Neither agree nor disagree.

There is no evidence in your plan to show you have worked with other sectors. The plan appears to have written by the six water companies to address the needs of the water companies and for the benefit of their shareholders. This would explain the exaggeration of the need for new sources, especially the lack of challenge of the Environment Agency's proposals for abstraction reductions.

Question 9: The draft best value regional plan includes investment in new water supplies and activity to reduce the demand for water.

The draft plan identifies that nearly 60% of the water needed by 2075 could come from demand management activities. This includes reducing leakage by at least 50%; extensive water efficiency through smart metering, customer behaviour change and new government policy; and the continued use of temporary restrictions on water use during periods of drought. The rest needs to come from a mix of new supplies.

Do you think the draft regional plan strikes the right balance between reducing the demand for water and developing schemes to provide new water supplies?

Strongly disagree.

Our analysis shows that the potential needs from realistic population growth, sensible environmental improvements and reasonably cautious allowance for climate change could all be met if the South East water companies all meet the Government's PCC and leakage targets, especially Thames Water and Affinity Water.

On this basis there is no need for <u>any</u> new sources in the areas potentially supplied by Abingdon reservoir. The potential needs from realistic population growth, sensible environmental improvements and reasonably cautious allowance for climate change could all be met if the South East water companies all meet the Government's PCC and leakage targets, especially Thames Water and Affinity Water. See Section 3.3 of our separate response.

Question 11: The draft best value regional plan promotes increased collaboration between water companies in the development of new water sources and the construction of more transfers to move water around the region and share it between companies.

Do you support the increased collaboration between the water companies in the South East and other regions, through the development of shared resources and an enhanced network to transfer water around the region and between regions?

Strongly agree.

In the areas potentially supplied by Abingdon reservoir (excluding the areas connected by the Thames to Southern transfer), the only essential new water supply infrastructure is the Thames to Affinity transfer and associated 'Connect 2050' pipe network (brought forward to 2030). This is needed to connect Affinity Water's Central Region supplies to Thames Water's London's supplies, including the London reservoirs. This would enable the high priority abstraction reductions in the upper Colne and Lea chalk streams, with the required replacement water becoming available through demand management and leakage reduction. See Section 3.3 of our separate response.

Question 13: If you have any other comments or feedback you would like to give us, please provide further details here.

The overwhelming driver of the need for new sources in WRSE's plan is the proposed abstraction reductions to achieve environmental improvements.

Overall, GARD concludes that, in view of the scale and costs of proposed environmental improvements in all regions across the country, no decisions should be taken on the need and choice of new resource schemes until the proper and transparent prioritisation of abstraction reductions has been completed, taking account of the costs of replacement sources and their environmental impacts – see Section 2.2.7 of our separate response.

Appendix B - Criticism of Net Present Cost as a comparator for project costs

The methodology used in the RAPID/WRSE/WRMP processes to establish and compare the costs of different projects is called Net Present Cost. Its use is mandated by the Environment Agency in its "Water resources planning guideline" and by the EA and OFWAT in the WRMP24Template-tables_Final spreadsheet. The use of the method is illustrated in a simple example in tab 5c of that spreadsheet. We will refer to this methodology as Net Present Cost to be consistent with WRSE terminology, even though its implementation here differs greatly from other methodologies which are also referred to by the name Net Present Cost. As implemented here, it is a very unusual method to use to compare the costs of different projects. The differences between using this methodology and more conventional approaches are particularly marked for projects with long life assets, including specifically SESRO which has a 250-year asset.

Net Present Cost as implemented in WRSE has many deficiencies as a cost evaluation methodology for projects of a capital nature. These include:

a. It ignores the timing of cash flows related to capital expenditure. Instead, it includes a depreciation charge and a return on capital – neither of which are cash flows.
b. In contrast, normal method of evaluating projects of a capital nature including DCF/NPV (Discounted Cash Flow/Net Present Value) – both take account of the timing of cash flows.
c. It includes depreciation – which is an accounting/non-cash figure and subject to manipulation.
d. The term labelled "Financing costs" is an unusual concept and does not correspond to the normal understanding of or use of the term. Instead, it combines two independent factors – depreciation, and a return on the increased value attributed to the regulated capital base of the water companies because of the project at the water companies weighted average cost of capital (WACC).
e. Possibly the clearest deficiency, is that as implemented here, it just cuts off after 80 years – ignoring any cash flows beyond that time and any value remaining in the assets after 80 years. This is a remarkable deficiency.

As implemented here, it would appear to be a strange combination of public sector accounting and private sector accounting.

This methodology will affect different projects in different ways and to different extents, leading to different ranking of projects when evaluated according to their Net Present Cost. This will in turn lead to flawed decision-making, resulting in different decisions from those that would be taken using a better methodology in either the public sector or the private sector.

The methodology uses an 80-year planning horizon consistent with the WRMP and RAPID processes. However, it does so in a manner which arbitrarily ignores costs and benefits remaining at the end of the period. It appears to us that the methodology makes no allowance for either the residual Net Book Value after 80 years or for costs incurred in subsequent time periods.

GARD attempted to recreate the calculation of the financing costs and of the Net Present Cost for SESRO 100 Ml/d using the data supplied in the WRSE and RAPID cost model and data in Thames Water's, Affinity Water's and Southern Water's Water Resources Planning Tables 2024 tab "5a – 5b Cost Profiles". We followed the instructions in "WRMP24-Table-instructions_2022_Final.pdf" and the method exemplified in table 5c of "WRMP24_Template-tables_Final". This ought to be straightforward; however, we were unable to do replicate the answers in the dWRMPs. We requested further details of the calculation to allow us to do so from Anthony Owen of Thames Water on 15th but we have not yet received them as at the date of drafting this Appendix. Any reply received after this date will not allow sufficient time to rework our calculations before the deadline for completing this section of GARD's response to the WRSE consultation. We therefore remain concerned that the calculations have not been performed as mandated in the example.

Another problem is the way that the EA/OFWAT methodology for Costed Risk and Optimism Bias appears to have been applied inconsistently across projects. For the SESRO 100 Ml/d option, they do not appear to be included in either Thames Water's Net Present Cost of £511.468m, or the detailed Capex breakdown for Thames Water's 41% share of SESRO in its dWRMP. However, they appear to be included in the Net Present Cost of £1,727.2m and detailed Capex breakdown for the STT project.

When discussing this methodology with representatives of Thames Water and other water companies we were informed that this is the methodology that they were instructed to use whether they thought it was sensible or not. They requested that we feedback our criticisms of the methodology as part of our response.

Appendix C - The Effects of the Regulatory Regime – The GARD Financial Model

1. Criticisms of the Process and the Financial Regulatory Regime

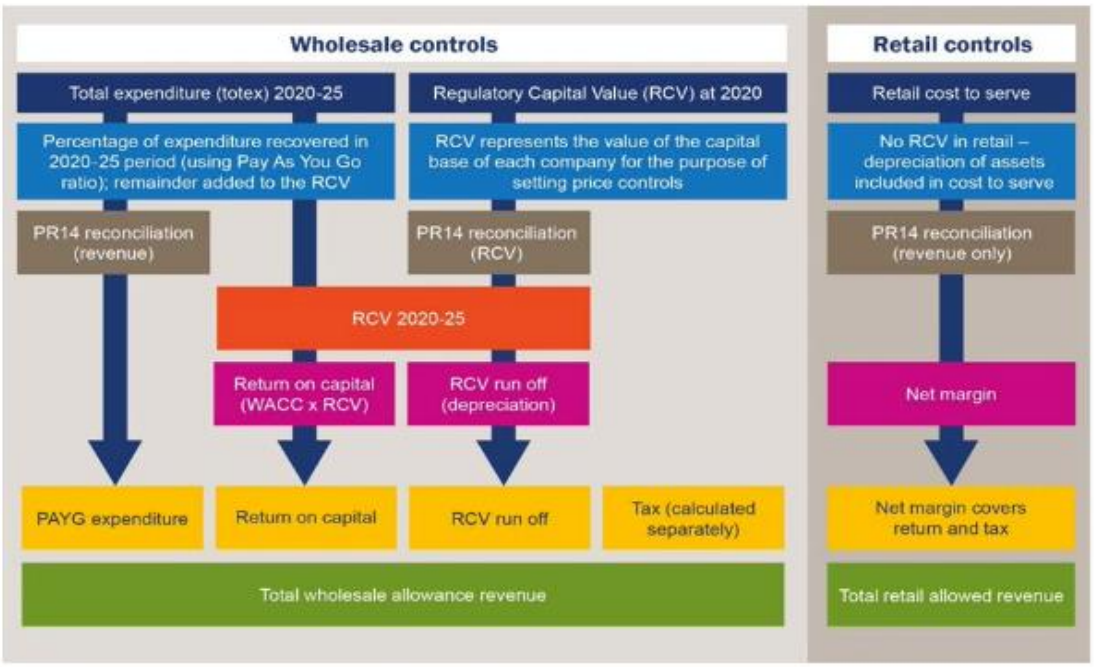
A. Introduction: Water Company finances and water industry regulation in relation to the proposed Abingdon reservoir.

Below is a coherent and damning description of Water Company finances, the regulatory regime and regulatory incentives since privatisation in 1989 that helps explain why Thames Water has been proposing to build a reservoir in Abingdon since 1995 and why, together now with its fellow water companies, Thames Water continues to keep proposing it.

There is a great deal of useful authoritative and publicly available information on Water Company financing and water industry regulation on which this is based. The issues are complex as this document illustrates but the underlying story is simple. The Competition and Markets Authority investigated and reported on the market and specifically the price control mechanism at the request of four water companies that appealed Ofwat's PR19 price control determinations. Its Reports and Determinations are of particular use in understanding the regulatory regime and the role of OFWAT is setting price controls. Figure 2-2 of the Competition and Markets Authority's '*Final Report*', reproduced below, sets out diagrammatically the major components that determine the total revenue that Water Companies are allowed to charge their customers.

2.105 This is illustrated in Figure 2-2.

Figure 2-2: Determination of overall revenues from the building blocks



Source: Ofwat

This information is relevant to all the current processes: WRSE Regional Plan, Water Company dWRMPs, and the RAPID Gated process.

GARD has created a spreadsheet, described below, which computes the very large financial returns that would accrue to Water Company shareholders if the reservoir were to be built. We compare this to the absence of any similar return from spending additional money improving operations - including specifically additional operating expense to reduce leakage and per capita consumption earlier and more rapidly. It is clear that the regulatory regime creates extremely large incentives for Water Companies to favour large capital projects like the reservoir, to the detriment of improving operations. Initial results which demonstrate this are discussed in section II below.

Summary

1. There is a fundamental and extremely perverse incentive in the Water Industry regulatory regime that encourages investment in "big concrete" projects as the solution to any and all problems. This is widely acknowledged and has been stated by many authoritative experts including Sir Ian Byatt, former Director General of Ofwat, and Professor Sir Dieter Helm of Oxford University and UK Government adviser on regulation.

2. In simple terms and as shown in Figure 2.2 above, all expenditure by a Water Company that can be classified as being of a capital nature, including for example, building a reservoir and including the cost of developing proposals for a such capital asset, gets added to the water company's Regulatory Capital Value (RCV) and the company has a statutory right to make a real return on that RCV in all future years.

3. These perverse incentives in the regulatory environment specifically favour very long-life assets such as a reservoir in contrast to alternative methods of securing water for the southeast. The alternatives to the reservoir include the Severn Thames Transfer, desalination and increased effort in reducing water wastage by leakage reduction in the distribution pipework system. All these alternatives involve lower capital expenditure and shorter life assets , but consequently, these alternatives look less attractive from the perspective of Water Company shareholders.

4. If the reservoir were to go ahead, Water Company shareholders would still be earning their guaranteed return on the reservoir in 250 years' time. The asset lifetimes used for regulatory return calculations (and for accounting depreciation) significantly favour reservoirs (250-year life) over tunnels, pipelines and other water network assets (80 – 100 year lives).

Almost all Water Companies have highly geared balance sheets with very high levels of borrowings, which constrains financial flexibility and in order to reduce gearing favours the expenditure on assets which increase their RCV, e.g. currently net debt to regulatory capital value (RCV) for Thames Water is at above 80%. These high levels of borrowings which have all been incurred since privatisation have largely been used to fund payments to previous shareholders. As a consequence of their corporate structures coupled with high levels of borrowings, most Water Companies have paid no or very low levels of corporation tax, for many years.

B. The perverse financial incentives in the Water Industry Regulatory Regime

Since the setting up of Ofwat in the 1989, the concept of the Regulated Capital Value (RCV) and Regulatory Asset Base (RAB) has been used as a key element in determining the charges that water companies can levy on their customers. As described above, in simple terms, expenditure that can be classified as being of a capital nature (eg a reservoir - and including the cost of developing proposals for a reservoir) is added to the water company's RCV and the company is allowed to charge customers a guaranteed inflation-proof return on that RCV in all future years.

This is succinctly expressed by Professor Sir Dieter Helm of Oxford University, writing in Sept 2021[107]: "*the companies had an incentive to find hard physical capital solutions (concrete) rather than seek out natural capital options and find common interest outcomes that took account of the wider catchment costs and benefits. The way the capital base was determined (and the RABs) formed part of the attraction of the concrete route to investors*".

"*It is not exaggerating to say that this is a scandal of financial engineering, aided by OFWAT*."

And in October 2022:

"Failure to overhaul the regulatory regime won't make the companies behave any better, because it will not change the incentives they face."[108]

Sir Ian Byatt who was the head of the UK water regulator Ofwat after the industry was privatised in 1989, was equally forceful when quoted in the Financial Times in 2017 [109]:

"Sir Ian says ***THE SYSTEM REWARDS COMPANIES FOR SPENDING MONEY ON CAPITAL INVESTMENTS WHETHER OR NOT IT IS IN THE INTEREST OF CUSTOMERS.*** *This often comes AT THE EXPENSE OF MORE MUNDANE OPERATIONAL TASKS, such as* ***PREVENTING SEWAGE FROM SEEPING INTO THE WATER, STOPPING LEAKS ON ITS 10,000 MILES OF PIPES AND INSTALLING WATER METERS – one of the most effective means of preventing water waste****."*

"If they had remained [public limited companies] they would have retained a corporate governance code. But ***WHAT PRODUCES DIVIDENDS NOW IS GETTING THE CAPITAL BASE UP****."*

This regulatory environment further creates additional incentives in favour of the reservoir in comparison to alternative methods of securing water for the southeast which involve higher

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[107] http://www.dieterhelm.co.uk/natural-capital/water/floods-water-company-regulation-and-catchments-time-for-a-fundamental-rethink-2/

[108] http://www.dieterhelm.co.uk/natural-capital/water/water-a- new-start/

[109] The Financial Times "The Big Read Thames Water PLC Thames Water: the murky structure of a utility company. As raw sewage poured into London's rivers, the water supplier awarded huge dividends to Thames Water's Investors" Gill Plimmer and Javier Espinoza May 4, 2017. https://www.ft.com/content/5413ebf8-24f1-11e7-8691-d5f7e0cd0a16

operating expenditure (specifically the Water Transfers but also Desalination and Demand Management measures like Leakage Reduction). The alternatives do not look anywhere near as attractive from the perspective of Water Company shareholders, having lower CAPEX, shorter depreciation periods, and a higher proportion of operating expenses

Advantages of an Abingdon-sized Reservoir to Water Companies

Water Company representatives have stated on several occasions that the Abingdon (SESRO) Reservoir was preferred because it was a simple straightforward scheme when compared with Severn Thames Transfer (STT) which would be more difficult to implement and more complex to operate.

From these statements, GARD believe that the reservoir is preferred by the Water Companies, over the STT for the reasons set out below, none of which relate to it being the lowest cost or best value solution, but just to it being easy to understand and implement:

- The reservoir requires less co-ordination with third parties – the majority of the construction works are on a single self-contained site, all within the Thames Water region.
- The reservoir results in a self-contained easily identifiable asset – the reservoir will be a completely new asset capable of clear delineation.
- **The raw water source** is entirely within Thames Water's sole control – there is no need for raw water from another company, nor for price negotiations on the cost of such water.
- The reservoir will have a long service life, with steady cash flow. In contrast, any charging mechanism for the STT would have a fixed and variable element, with in some years less water required than others. This would make any income from the asset less predictable and make the project harder to borrow against.
- The reservoir would create a larger and longer lasting addition to the Water Companies Regulated Asset Bases – thereby creating a larger return for their shareholders.
- The export of a majority of the deployable output of the reservoir to provide the needs of Affinity Water and Southern Water provides a guaranteed income stream.
- Because of all the above, SESRO would be a more 'Bankable' scheme against which finance could be raised relatively straightforwardly.

C. General Criticisms of Regulatory Regime.

WRSE and RAPID processes. We have serious concerns over the way these processes are run, including:

1. Complexity of the process. GARD believe that the processes of WRMPs, Regional plans and RAPID plans which are nominally under the control of OFWAT and the Environment Agency have in effect been captured not just by the Water Companies but in addition by the armies of consultants advising the water companies. The water companies and the consultants have

made the whole process including in particular project evaluations so complex that no one who has not spent a very long time immersed in the process stands much chance of understanding it. In common with other aspects of water company regulation, these processes get more complicated each time they are iterated. We have serious doubts whether the water companies or their consultants themselves can see the wood from the trees. The ability of computers to churn out endless output just serves to hide the wood from the trees – one example is the 1566 pages of WRSE's Investment Model report[110]. Who can have looked through all of this report, let alone all the many other examples? We seriously doubt that the Water Company Board members who must give their "assurance statement" do so.

2. Complexity as a cover. This complexity acts as a cover for the water companies to promote their favoured schemes (those who pay the piper call the tune). This response from GARD identifies many errors and other failings that we have identified in the process in the time and with the limited resource available. We believe that many more errors are contained in the proposals, but that shortage of time and resource prevent them being identified.

3. We believe that the Capex figures for the SESRO reservoir are likely materially underestimated. We note with alarm that the cost estimate for the Thames Tideway Tunnel at an equivalent stage (£2 billion) doubled once the Tideway Tunnel project was approved by the government and detailed work was undertaken. It increased from £2 billion to between £3.7 billion and £4.3 billion in September 2010. This doubling was attributed to: *"the original cost estimate for the tunnel [being] revised following extensive studies, said head of London Tideway Tunnels Phil Stride". The original £2bn figure was reached in 2006 by a desktop study worked on by "a handful of people", he said, but more detailed research, ground investigations and site surveys have led to the revised figure. "It's much more detailed. We've had hundreds of people working on it, which comes at a cost in itself," said a Thames Water spokesman. Stride said the original study was limited by the amount that could be spent on it given that the project had not been approved by the government at that time. "The accuracy of any estimate is dependent on the time and effort that goes into it,"*[111]

   In the light of this, we note the alarming parallels that:

   a) the SESRO project has not yet been approved by the government, and
   b) Thames Water are yet to conduct "ground investigations" on the SESRO site as notified by their Engagement Manager on February 7th 2023. *"As part of the development work on the proposed reservoir we need to carry out some survey work to gather technical data about the ground conditions and existing environment to inform engineering design and assessment of potential environmental impacts. We're writing to local landowners to request access to their land to carry out the surveys."*[112]

[110] https://www.wrse.org.uk/media/yiplrr4w/wrse-investment-model-draft-regional-plan-results.pdf
[111] New Civil Engineer "Thames Tunnel sewer costs rise up to £2bn" 16th September 2010
[112] Email from Rachel Groves "Notification of local survey work - for your information" to Garford Parish Meeting dated 7th February 2023

Any increase in the cost estimate for SESRO, let alone a doubling, would further damage the case for it being included in the best value plan.

4. Our specific concerns over Environmental Assessment and Population projections are well-covered in our main report.

2. Financial Model

GARD created a financial model using cost and other data contained in the RAPID Gate 2 document for SESRO and the Thames Water dWRMP. The model also used data from the CMA determination on the elements of WACC. GARD have used this model to calculate the cashflows arising from over the 250-year life of the reservoir, 2022 to 2285. Specifically, GARD used this model to calculate the following:

1. The increase in Shareholder Value that would immediately arise and benefit the Shareholders in the three Water Companies who would jointly own the reservoir if it were to be given the go ahead (Thames Water, Affinity Water and Southern Water).

   Our calculations show that the immediate increase in Shareholder Value created by any decision to approve the reservoir would be £846 million. This arises from the return on the increase in Regulated Capital Value (RCV) resulting from the £1,788 million Capital Expenditure on the reservoir. All these numbers are fixed in 2022 currency.

2. GARD separately calculated the increase in Shareholder Value that would arise if the same amount of money identified as the initial construction cost of the reservoir, £1,878 million, were instead to be spent on increased operating expenses over the same period, to reduce leakage and to reduce demand. We believe that the answer is zero.

   There is therefore a **staggering £846 million incentive** within the Regulatory Regime to build the reservoir rather than to accelerate the reduction of leakage rates and water consumption.

3. The additional cost that Water Company customers would pay for the reservoir. The numbers are absolutely staggering: £4,829 million over the 80-year WRSE planning horizon and £13,673 million over the 250-year life of the reservoir. Again, all these numbers are fixed in 2022 currency.

4. In contrast, the additional cost that Water Company customers would pay for an additional £1,878 million of operating expenditure to reduce leakage and to reduce demand, is only £1,878 million. The reservoir would therefore cost customers an additional £3,041 million over the 80-year planning horizon of the WRSE process.

5. GARD have used £1,878 million here to illustrate the differing financial consequences to customers of the same value of expenditure on different things. Furthermore, figures 11-3, 11-4, 11-5 and 11-6 in Thames Water's dWRMP together with tables 5-1 and 5-2 in WRSE's "Draft Regional Plan Technical Annex 2 (Nov2022)" show that accelerating Thames Water's plans to reduce leakage and reduce per capita consumption would provide a reduction in demand equal to or greater than the deployable output of the 100 Ml/d SESRO. This is quite apart from the improvement in resilience from reducing demand. The benefits of regulators setting more aggressive demand reduction targets are illustrated in this quote from the EU: *"Whilst water loss*

management is often pictured as the implementation of technological solutions to a hidden problem, this is really only part of THE REAL SOLUTION, which is all ABOUT MANAGING UTILITY PEOPLE TO PERFORM. It is about empowering them with the responsibility, training, practical tools and proven techniques, MOTIVATING THEM TO PERFORM, and inspiring them to believe that they can make a difference."[113]

6. It needs to be stated that the building of the reservoir is on all measures worse than the alternative examined here of reducing leakage and consumption: it is specifically more expensive for customers, has a materially worse carbon footprint, is in the wider context more environmentally damaging and by bringing in no new water supplies to the South East is not drought resilient.

[113] EU Reference document Good Practices on Leakage Management WFD CIS WG PoM 2015 https://op.europa.eu/en/publication-detail/-/publication/3ff6a13c-d08a-11e5-a4b5-01aa75ed71a1/language-en