

Development of large scale water resource options for London

Briefing paper on water resource options and the assessment of options

October 2014

Thames Water



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1 Overview

TW published its WRMP14 in August 2014 following approval from Defra. The plan sets out the need for development of new resource from the mid 2020s. TW is planning detailed work over the next 5 years to review and identify the best value resource options to ensure a secure supply of water in the future.

WRMP14 identified wastewater reuse as the preferred large scale resource option; however significant uncertainties remain over this and other options. A four phase programme has been developed to reduce uncertainties and update options for WRMP19. Mott MacDonald, working in partnership with Cascade Consulting, has been appointed to undertake Phase 1. The objective of Phase 1 is to reduce the number of options carried forward from the WRMP14 constrained list, including reviewing any rejected options, and to better target Phase 2 investigations by focusing on uncertainties and risks that are material to option selection.

The work was introduced at the stakeholder meeting in June 2014 and a technical meeting held on 30th September 2014 to consult stakeholders on:

1. the large (50MI/d+) options under consideration including the possibility of any new options; and
2. the new fine screening methodology and its application.

This paper is intended to provide background information for stakeholders and summarise the discussions held at the workshop on the 30th September 2014. It covers:

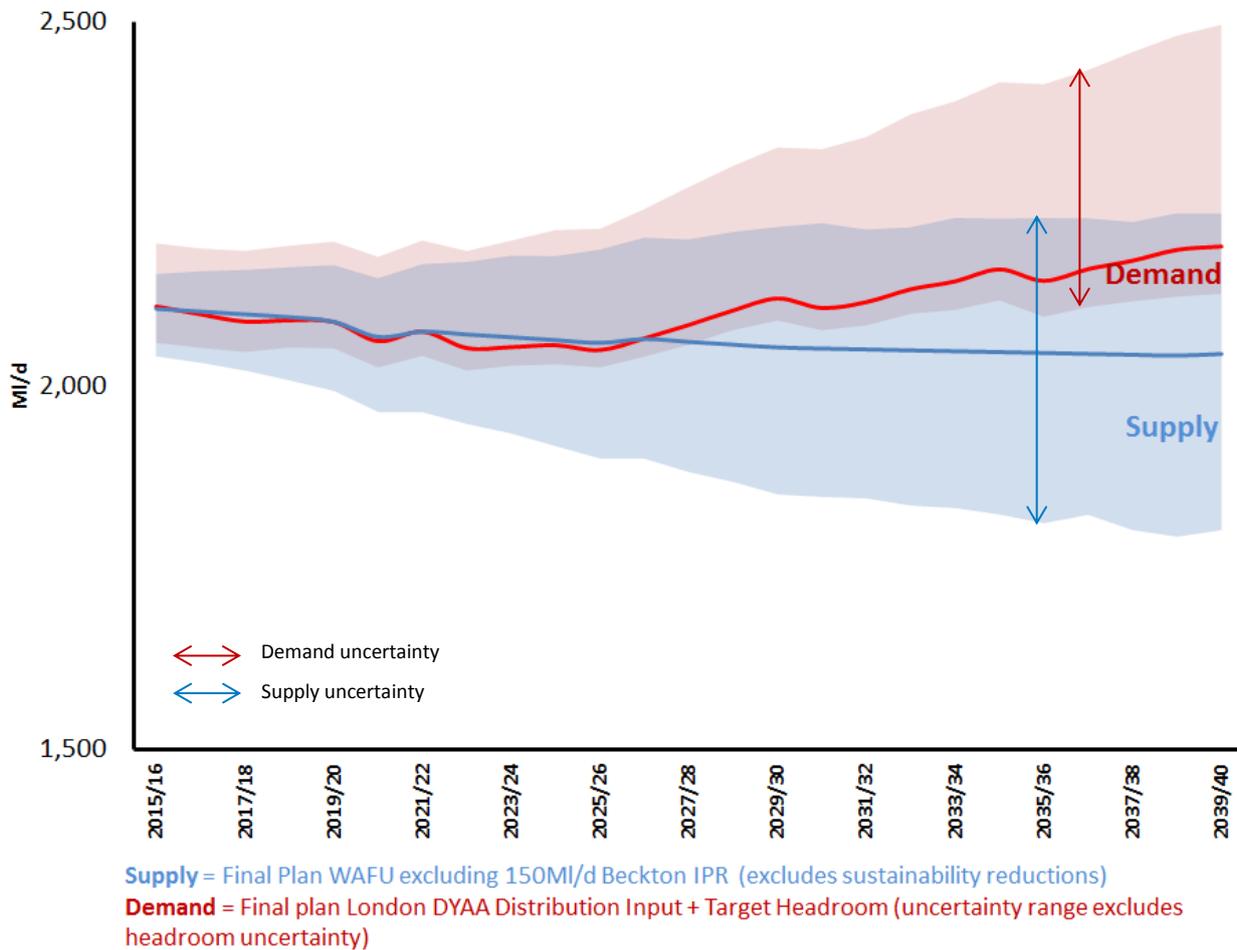
1. the resource options that TW has considered in WRMP14 and potential new options; and
2. the screening methodology undertaken to review options in WRMP14 and proposals to add a further screening process to enable completion of detailed studies in AMP6.

2 Introduction

Thames Water's Water Resource Management Plan (WRMP14) for the period 2015 to 2040 identifies a need for a new large water resource in the mid-to-late 2020s, primarily to supply London. Figure 1 summarises the current supply-demand forecasts and associated uncertainties. The figure shows the WRMP14 supply demand balance for the London Water Resource Zone with implementation of the WRMP14 programme except for the 150MI/d reuse scheme at Beckton (i.e. it shows the supply-demand balance forecasts for London without a large scale water resource).

While some large scale resource options to address the projected resource deficit have been ruled out there remain a significant number of option types under consideration, including impounding reservoirs, raw water transfers, wastewater reuse and desalination. Additionally, for each option type, several sub-options (e.g. location, size, route) have been identified.

Figure 1: The water resource planning problem in London



Thames Water is committed to undertaking further investigations to review and refine the options over AMP6 to determine the best value option for promotion in WRMP19. Phase 1 of these investigations includes a review of the options included in WRMP14 and development of a transparent and robust approach for reviewing and refining the options taken forward for subsequent more detailed investigation (Phase 2). The focus of the project is on large options with the potential to provide a resource larger than 50MI/d – resource options smaller than this will be subject to a consistent process being undertaken by Thames Water.

This briefing paper describes the work planned in Phase 1 to review the options and further develop the options appraisal process.

3 Large scale resource options

A summary of resource options for London that have been considered is provided in Figure 2. The figure splits options into those that were rejected at WRMP14 and those that are currently 'live' options. The live options will include the WRMP14 constrained list, plus a number of options from the WRMP14 OJEU process that were not excluded by Thames Water, options identified from the review of the WRMP14 rejection register, plus new options identified by Thames Water, the Water Resources for the South East group (WRSE) and other stakeholders.

Figure 2: Summary of resource options for London

Rejected options

WRMP14 Rejection Register

Generic Option Rejection

- National water grid
- Company mergers
- Rising groundwater in London
- London Docks as a reservoir
- Thames Barrage to impound fresh water
- Redevelopment of existing resources
- Icebergs
- Cloud seeding
- Commercial tariffs
- Commercial property water use audits
- Retrofit domestic toilet cisterns
- Retrofit domestic showerheads
- Other single-measure domestic retrofit
- Enforce use of water efficient fittings in new buildings
- Flow restrictor charging
- Ban high water use devices
- Preventing new development
- Legislate on water use

Primary Screening (unconstrained option rejection)

- Bulk Transfers: Raw Water Transfers
- Combined 30 Mm³ reservoir sites
- New Reservoir Storage: Gravel pits as reservoirs
- Aquifer Recharge options
- Aquifer Storage and Recovery options
- Groundwater Wells (boreholes)
- Direct River Abstraction: Development of surface water resources
- Bulk Transfer: Sewage Water Transfer
- Reclaimed Water: Indirect Potable Reuse of effluent discharged up-catchment and currently re-abstracted in London
- Tankering of Water: Imports by sea
- Bulk Transfers: Intra-zonal Transfers
- Improved/sophisticated conjunctive management: Licence Trading/Transfer
- Improved/sophisticated conjunctive management: Reduction of Supply-side Operational Use and Losses

Secondary Screening (constrained option rejection)

- Bulk Transfers: Raw Water Transfers
- New Reservoir Storage options
- Aquifer storage and recovery wells (ASR)
- Groundwater Wells (boreholes)
- Reclaimed Water: Indirect Potable (Waste Water) Reuse
- Bulk Intra and Inter Company Transfers
- Licence Trading Transfer
- Options presented in response to our Official Journal of the European Union (OJEU) advertisement (3No. > 50MLD, 6No. Unknown, 3No. <50MLD)
- Catchment Management Initiatives

Live options

WRMP14 Constrained List (>50MLD)

- **Supported Severn transfers** (Longdon Marsh Reservoir & transfer via Cotswolds Canal or Deerhurst Pipeline)
- **Unsupported Severn transfers** (Deerhurst pipeline or Cotswolds Canal)
- **Estuary South Desalination**
- **Direct river abstraction** (Lower Lee)
- **Indirect potable use** (RO/NRO) at Deephams, Beckton and Abbey Mills STW
- **Reservoir storage** (Direct Supply to SWOX: Abingdon, Longworth; River Regulation for London: Abingdon, Longworth, Chinnor)

OJEU options (>50MLD)

- 4No live options >50MLD (including tankering and water transfers via canal, river or pipe networks from UU and Severn Trent)

New options (>50MLD)

- 1) **River flow compensation options** (e.g. Beckton STW final effluent (FE) for discharge at Teddington weir for flow compensation in the River Thames, via new pipe inside Tideway Tunnel)
- 2) **Desalination:**
 - Estuary South Desalination (at Crossness) with new storage reservoir locally instead of pipeline to Honor Oak Reservoir
 - Increasing capacity of Beckton desalination plant (previously investigated and rejected but not documented in rejection register)
- 3) **Greywater re-use in new London developments:**
 - Final effluent supplied by TW to large buildings and new developments in London
 - Promoting greywater reuse in new buildings in London (through planning)
- 4) **Surbinton intake** (increased capacity)
- 5) **Others** – e.g. from WRSE and other stakeholders

Options from review of WRMP14 rejection register (>50MLD)

- Indirect potable use: Mogden
- Options to be identified following additional review of rejection register – stakeholder views welcome

3.1 WRMP14 rejection register

Further information on options in the WRMP14 rejection register can be found in WRMP14 Appendix Q. A review of the rejection register is planned and it is expected that some options may need to be revisited following this review.

Stakeholder views were invited on whether there are any large scale resource options in the WRMP14 rejection register that you think should be revisited? A summary of the discussions from the workshop on the 30th September 2014 is given below.

Options identified for review included:

- *National Grid option. This option was rejected in WRMP14 on cost/benefit grounds. Some concerns were expressed over whether the best option had been selected and therefore whether the cost estimates were not over-stated. Some stakeholders felt that a variation of a National Grid option may need to be re-considered.*
- *Cotswold Canals options. It was suggested that a higher DO may be achieved than what is currently assumed for the Cotswold Canals options. TW was encouraged to revisit this option.*
- *Tankering options. Albion Water proposed that its tankering option should be given further consideration. The view was also expressed that tankering is a resilient option as there are several water sources potentially available.*

Next steps: *Stakeholder comments will be considered as part of the review of the WRMP14 rejection register.*

3.2 WRMP14 constrained list

Further information on options in the WRMP14 constrained list can be found in WRMP14 Appendix R which is available on request from Thames Water. A diagram summarising the WRMP14 constrained list options by capacity band can be found in Appendix D to this report.

3.3 Third Party options

Thames Water received submissions in response to its call for water resources options from third parties. This process is described in more detail in Sections 7 and 10 of WRMP14. Unlike supply and demand options that were developed internally these options are subject to confidentiality agreements between Thames Water and those who responded to the OJEU notice. The responses received were assessed using similar screening criteria to those used for the primary and secondary screening. Four options have been identified as requiring further investigation.

3.4 New options

Several potential new large-scale options have been identified through a review workshop conducted with Thames Water in September. These options would require additional investigations to assess their viability, including:

1. **River flow compensation options:** This option involves the discharge of final effluent from a sewage treatment works, being subject to lower level of treatment than in the wastewater reuse options, into a river (downstream of a raw water intake) which would enable TW to increase raw abstractions upstream by providing compensation flows in the river. Different variations of these options can be considered in the Rivers Thames and Roding. One example includes the transfer of final effluent from

Beckton Sewage Treatment Works (STW) for discharge below Teddington weir in the River Thames possibly via a new pipeline installed inside the Thames Tideway Tunnel (TTT). In this way, the excavation and reinstatement costs for the pipeline route are minimised by combining the works with the construction of the TTT. Further investigations would be required to assess whether river flow compensation options are viable.

2. **Desalination:** This option involves a variation of the existing Estuary South Desalination option and includes a new service reservoir near the new desalination plant, which is currently in the Crossness STW area. This option would remove the need to construct a longer length of pipeline from Crossness to Honor Oak reservoir, which is included for the current desalination option.
3. **Greywater reuse and rainwater harvesting in new London developments:** This option involves the use of greywater and rainwater harvesting for non-potable purposes in new developments in London. This could be achieved by
 - a. TW supplying final effluent from existing STW to new developments for reuse as greywater or by
 - b. TW working with local planning authorities to promote local rainwater harvesting and greywater separation and reuse in new developments with a view to it ultimately being required as a planning condition. The capacity of this option is unclear and further investigation would be required.
4. **Increasing capacity of the Surbiton intake:** this does not provide new DO but will mitigate a potential loss of DO associated with construction of Molesey fish pass.

Other options previously considered and rejected by TW, but which have not been documented in the WRMP14 rejection register, include:

- Increasing the capacity of the existing Beckton desalination plant.

Stakeholder views were invited on whether there are other large scale resource options for London that have not been considered. A summary of the discussions from the workshop on the 30th September 2014 is given below.

New option suggestions included:

- Severn Trent Transfer (STT) options. *There was a question on whether the use of Farmoor Reservoir for the supply of SWOX is being maximised. The reservoir could have a greater role to play in a Severn Trent Transfer option (for example potential synergies between Cotswold Canals transfer with Farmoor Reservoir for flow regulation). An additional question was asked regarding whether existing unsupported STT options could be turned into supported options via other Third Party involvement (e.g. Minworth STW effluent into the River Severn).*
- Grand Union Canal options. *The use of the Grand Union Canal was screened out in WRMP14, but could be re-considered in conjunction with Severn Transfer and third party options.*
- River discharges. *Question on whether river discharges for treated effluent, (instead of discharge into a raw water reservoir), have been considered for any water reuse options. TW stated that this is part of the current water reuse investigations so is under consideration.*
- Reservoir operation options. *Question on whether options to address constraints associated with the rate at which reservoirs can be refilled could be addressed, resulting in additional DO.*
- Conjunctive use. *A possible ground water conjunctive use option was suggested where Anglian Water supplies Thames Water with groundwater at times of low flows in the River Thames, with the supply reversed when river flows recover.*

Next steps: *Stakeholder comments will be considered as part of the review of new options.*

SWOX supply options. *A general query was raised as to whether growth in SWOX has been incorporated in the SWOX supply options.*

Next steps: This is a factor that will impact the supply-demand balance and Thames Water will be reviewing this for WRMP19. This project aims to retain options across different size bands to address the uncertainty that exists in future resource deficits.

Synergies between options. The potential synergies between large-scale options have not been presented (e.g. reuse and transfers). These may have implications on the phasing of schemes.

Next steps: The dependencies and synergies between options will be considered as part of the review of new options.

4 Overall approach

An overview of the overall 4-phase approach to review and assess options is shown in Figure 3. The current focus is on Phase 1 which will be completed by April 2015. The following sections describe each of the stages in Phase 1 in detail and then provide a high level overview of the subsequent phases. A summary of the discussions held at the stakeholder workshop on the 30th September 2014 is also given, with a note of the subsequent outcomes and action points for Mott MacDonald.

4.1 Phase 1 – Option review and screening

The objectives of Phase 1 are to review the WRMP14 options, undertaking further screening and identifying investigation requirements for Phase 2. Each of the main stages shown in Figure 3 are described below.

Stakeholder views were invited on the proposed overall process for option screening going forward, set out in Figure 3, and on the proposed fine screening stage in particular. A summary of the discussions from the workshop on the 30th September 2014 is given below:

Assessment transparency and auditing. The stakeholders emphasised the importance of information transparency and that all outputs from key investigation reports (past and future) should be summarised in one place for the stakeholders to easily access; it was felt that currently the options information is quite fragmented. The group suggested that TW should consider how to address this issue in WRMP19, recommending the drafting of a feasibility report(s) to bring all the issues and rationale for option selection/rejection together (e.g. one could have a report that covered all the effluent reuse options).

Next steps: It is proposed that the assessment templates (see Appendix B for examples) will bring together the information for each option and the sources used. The accompanying option screening report will provide the overall rationale for the screening decisions.

Listing the further investigations required for Phase 2. The stakeholders suggested that an output of Phase 1 should be a clear list of the investigations and studies required in Phase 2 for the final selected constrained options.

Next steps: It is proposed that the assessment templates will set out further investigations required.

4.1.1 Review of WRMP14 rejection register

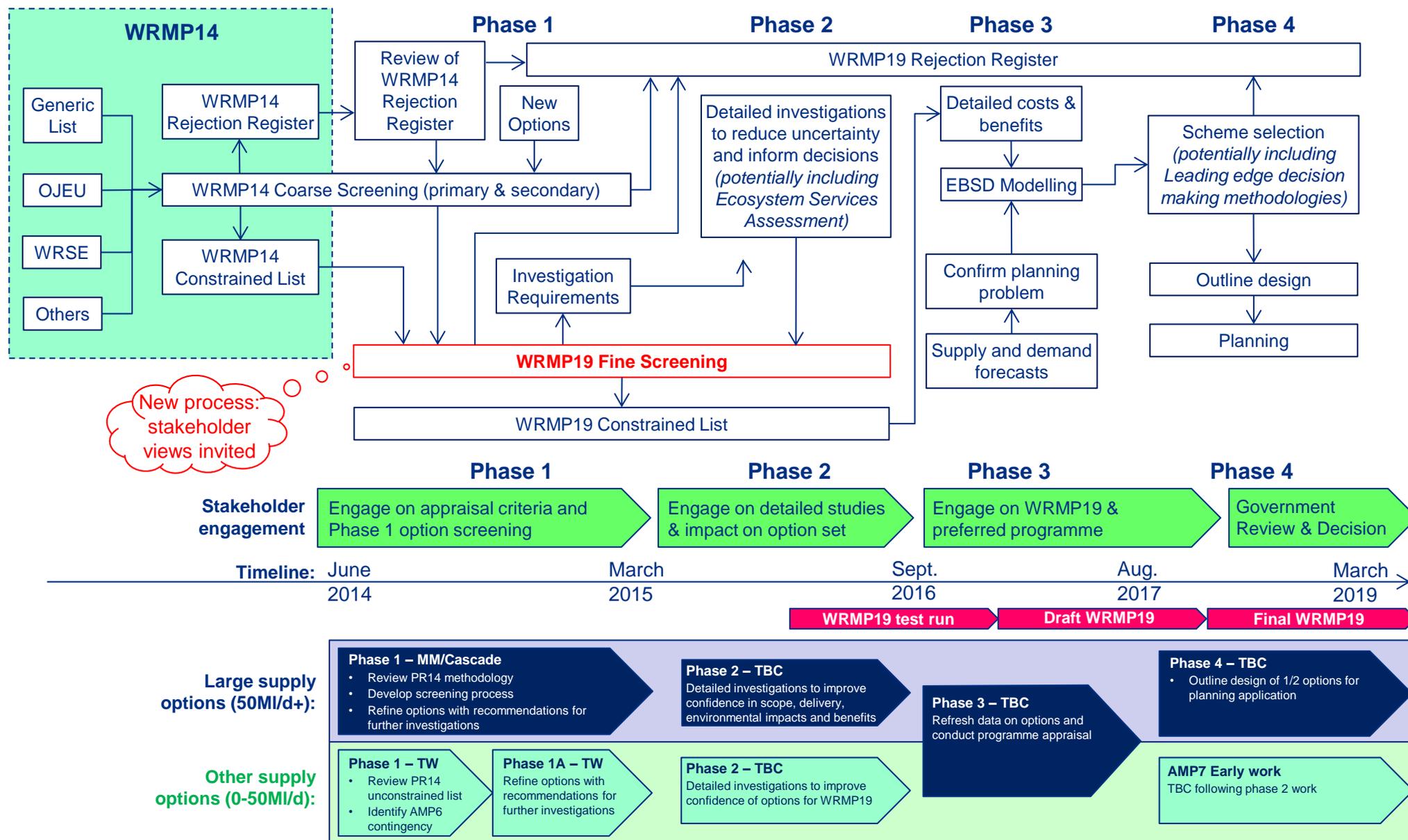
Resource options that were considered and rejected in WRMP14 were documented in a rejection register in Appendix Q of WRMP14 which summarises the reasons for rejection. A review will be conducted of the WRMP14 rejection register to identify those options that were rejected at WRMP14 that may require further investigation in the WRMP19 process. Depending upon the nature of the further investigation required this would either be conducted in Phase 1 or Phase 2. Where a sound rationale is presented in the rejection register, and this is considered to still be relevant and current, these options will be carried forward to the

WRMP19 rejection register. In cases where the robustness of the reasons for rejection are challengeable then these options will be re-inputted into the screening process.

4.1.2 New options

Mott MacDonald and TW have conducted a high level review of the options to identify possible new options. This process has identified several new options. Regulators and stakeholders will be consulted on these options and also their views on the completeness of the list of options to understand if there are any additional options which require consideration. New options identified will be inputted into the screening process.

Figure 3: Overview of proposed appraisal process



4.1.3 Coarse screening

It is proposed that where new options are identified or where there are options on the WRMP14 Rejection Register that need revisiting then these will be subject to the same primary and secondary screening that was conducted for WRMP14.

The WRMP14 screening comprised three stages, progressing from a wide range of generic option types, through an unconstrained set, to a feasible set and finally a constrained set of options to be taken forward into the programme development and appraisal process. A description of the screening criteria used for WRMP14 can be found in Appendix A to this working paper.

4.1.4 Fine screening

The proposal then is to subject the WRMP14 constrained list of options, and other new or revisited options that pass the coarse screening, to a further 'fine screening' stage. It is proposed that the fine screening will be based upon similar criteria to the coarse screening, but will use a refined form of analysis that extends beyond the simple pass/fail, and presents a balanced view of the results of quantitative and qualitative analysis that takes account of uncertainty in data and knowledge. The fine screening process will produce a revised constrained list of options. It will also be used to identify the further studies necessary in Phase 2 to reduce the current level of uncertainty in the options. The screening would then be updated in Phase 2 to take account of the findings from the investigation work conducted.

It is proposed that the fine screening process will compare large scale options in bands of similar capacity. The reason for considering options in capacity bands is that there is significant uncertainty around what the magnitude of the future resource requirement is. Key factors that will impact the future resource position are the scale of sustainability reductions that may impact Water Available for Use (WAFU), the rate of population growth, the effectiveness of demand management interventions, plus regional resource requirements identified by the Water Resources in the South East (WRSE) group. It is therefore essential that the screening retains the most favourable options covering the full range of potential capacity requirements. The WRMP14 constrained list and third party options divided by capacity band are shown in Table 1 below. It is expected that further options would be added to this matrix from the coarse screening before the fine screening is conducted.

It is proposed that the Fine Screening will consider options in each capacity band separately from both a quantitative and qualitative perspective. The key features, costs, risks and opportunities for each option will be documented in a template and then the options in each capacity band will be brought together on a summary dashboard for the purpose of comparison and screening. Two completed examples of the option template are shown in Appendix B of this report. A distinction is made between the quantitative analysis and the qualitative analysis. It should be noted that the assessments included in Appendix B are examples for illustration and will be subject to further development.

Table 1: WRMP14 Constrained list options plus third party options by capacity band

Option type	Scheme Yield				
	50-74Mld	75-124Mld	125-174Mld	175-224Mld	>225 MI/d
Transfer (supported)		Longdon Marsh/Third Party options ¹ + Cotswold Canals/Deerhurst pipeline	Third Party options + Deerhurst pipeline/ Cotswold Canals	Longdon Marsh + Deerhurst pipe	Longdon Marsh + Deerhurst pipe
Transfer (unsupported)		Deerhurst, Cotswold Canals ²			
Desalination	Estuary South	Estuary South	Estuary South		
New storage (river regulation)	Abingdon, Longworth	Abingdon, Longworth	Abingdon, Chinnor	Abingdon, Chinnor	Abingdon
Direct river abstraction		Lower Lee			
Indirect potable reuse (MBR/RO)	Beckton, Abbey Mills, Deephams	Beckton, Abbey Mills	Beckton, Abbey Mills		

4.1.4.1 Quantitative analysis

The WRMP14 least cost programme was derived through identification of the programme that minimised the discounted programme cost (including social and environmental costs) to address the planning problem using Thames Water's EBSD model. AISC³ was calculated as a comparator as part of options appraisal (and as required for reporting purposes), but not used for programme appraisal.

Thames Water is not planning to run its EBSD model for WRMP19 until 2017 to ensure baseline forecasts are as accurate as possible for WRMP19 and so for the purposes of further screening of large scale options an alternative approach is needed that is transparent and readily communicated with stakeholders. Several options for comparing costs in the screening process are set out in Table 2 which shows both a selection of cost indicators and the components that build them up.

While the use of a Benefit Cost Ratio is conceptually attractive, it requires benefit values to be estimated and there are often significant uncertainties particularly on water resource issues such as customer valuations for reduced risk of supply restrictions (e.g. sprinkler/hosepipe bans, restrictions on commercial water use and ultimately rota cuts and standpipes). Customers with little experience of supply restrictions have difficulty ascribing monetary values to reduced risk of different types of supply restriction. Furthermore, within the current water resource planning framework modelling of the future risk of supply restrictions (to which the values would be applied) is also not well developed and so incorporates significant uncertainty. For these reasons use of the BCR is not recommended for Phase 1.

¹ Third party transfer options based on proposals from Severn Trent Water and United Utilities (details of scheme bound by confidentiality agreements)

² Scheme yield of Cotswold Canals transfer route is yet to be confirmed and will be followed up by Thames Water and Cotswold Canals Trust during Phase 1.

³ The AISC is calculated by dividing discounted option costs (including environmental and social costs) by a scaling factor (linked to the capacity or expected output of the option, usually in MI/d).

Table 2: Cost components and cost indicator options

Ref	Component	Example ⁴	Description	Comment
Cost components				
A	Discounted CAPEX (£000)	312,230	Discounted capital expenditure comprising the up front investment and subsequent capital maintenance	Maintenance costs may be influenced by utilisation and so will be different under capacity and utilisation approaches
B	Discounted OPEX (£000)	100,347	Discounted operating costs (e.g. power, chemicals, human resources)	Power and chemical costs are influenced by utilisation and so will be different under capacity and utilisation approaches
C	Discounted opex savings (£000)	0	Discounted savings (e.g. if option reduces TW need to deploy high opex resources such as desalination plant)	Requires comparison of operating costs of preferred option against existing resources. Extent of savings depends upon likely utilisation so will be different under capacity and utilisation approaches
D	Discounted carbon cost (£000)	68,036	Embodied and operational carbon	Carbon will depend upon likely utilisation and so will be different under capacity and utilisation approaches
E	Discounted social & environmental cost (£000)	1,623	Social and environmental costs estimated using Benefits Assessment Guidance	Use of BAG gives low social and environmental valuations that are the subject of debate
F	Discounted WAFU (MI)	982,667	Discounted volume of Water Available for Use (WAFU)	Volume will be will be different under capacity and utilisation approaches
G	Benefits value (£000)		Estimate of the value of increased resource (e.g. in terms of reduced risk of supply restrictions and other environmental and social benefits)	Confidence in benefit values may be low and values for reducing risk of supply restrictions are dependent upon the do-nothing risk of supply restrictions

Cost Indicator Option	Calculation	Example ⁴	Comment
TOTAL Net Present Cost (£000)	A+B-C+D+E	482,236	May be calculated either assuming full capacity or expected utilisation. Is not normalised by volume to allow options that deliver different resource benefits to be compared. It is therefore of limited use for comparing options except in programme appraisal where combinations of options to satisfy a resource requirement are compared.
Average Incremental Cost (AIC) (£/m ³)	(A+B-C)/F	0.42	Normalises discounted capex and opex by a volume (the capacity of the option or the expected utilisation). Does not take account of carbon, other environmental or social costs.
Average Incremental and Social Cost (AISC) (£/m ³)	(A+B-C+D+E)/F	0.49	As for AIC, but includes carbon and environmental and social costs. However the valuations are low, subject to debate, and generally not large enough to impact decisions compared with capex/opex.
Benefit cost ratio (BCR)	(G+C)/(A+B+D+E)		Instead of normalising by volume, the volume is converted to a benefit value using customer valuations. A BCR > 1 indicates that benefits exceed costs. However, confidence in benefit valuations can be low.

AIC and AISC both weigh the costs of each option against volumetric resource benefits (i.e. MI of water available for use) rather than the monetised benefits that would be used for the BCR. The difference between AIC and AISC is the inclusion of carbon and other environmental and social costs in the AISC. While the carbon costs can be significant, the other environmental and social costs,

⁴ Example uses preferred Beckton wastewater reuse RO 150MI/d option from WRMP14

which are assessed using Benefits Assessment Guidance (BAG), often have a negligible impact on the AISC. This can be seen in the example provided in Table 2. The validity of the environmental valuations within BAG is subject to debate. On this basis two options are suggested for comparing costs in the quantitative screening:

1. **Use AISC** and recognise that there will be areas of overlap between the qualitative and quantitative analysis (most notably in relation to environmental and social costs and benefits)
2. **Use AIC + carbon** and compare environmental and social aspects in the qualitative analysis

Stakeholder views were invited on the choice of quantitative indicator. A summary of the discussions from the workshop on the 30th September 2014 is given below:

+ves, -ves of AISC and AIC + carbon approach. Stakeholders were more supportive of the AIC + carbon approach than AISC. They were informed that the monetary value of environmental and social costs in AISC usually accounted for less than 5% of the options capex/opex and hence did not affect the decision going forward, on cost grounds.

***Next steps:** It is proposed that the screening will proceed using AIC+carbon for costs, excluding other environmental and social costs*

Alignment with future guidance. The EA gave an update on their understanding of the WRPG - elements of the WRPG are being reviewed and the direction they are heading is towards more freedom to the approach undertaken, provided there is sound justification.

***Next steps:** Thames Water will continue to engage with the EA on the future development of the WRPG.*

Double counting. Stakeholders expressed concerns over a potential double counting of the cost of carbon and that DECC guidance should be used in any carbon valuations.

***Next steps:** a check is being conducted to ensure that double counting has not occurred.*

When using either AIC or AISC a further consideration is how the volumes used for the numerator and denominator should be formulated. These volumes determine the scaling factor used to normalise cost (the denominator) but also impact on operating costs (included in the numerator). A summary of guidance on the calculation of AISCs is provided in Appendix C. Broadly speaking AISCs can be calculated using either:

- The capacity approach – where costs are based upon operation at full capacity and the scaling factor assumes full capacity; or
- The utilisation approach – where costs may be based upon expected usage under weighted average demand and the scaling factor may be based upon expected usage under dry year demand (as this is the relevant planning problem for London)

For the WRMP14 screening TW calculated AISCs using the capacity approach. The advantages and disadvantages of the capacity and utilisation approaches to AISC are summarised in the Table 3.

Table 3: Comparison of capacity and utilisation AISCs

AISC type	Advantages	Disadvantages
Capacity	<ul style="list-style-type: none"> • Simple to calculate • Easy to understand • Not influenced by changes in demand forecasts 	<ul style="list-style-type: none"> • Could unduly favour large options with surplus capacity. This issue can be addressed by only comparing options of similar capacity. • May unduly penalise options with high opex (e.g. desalination) if these would not in practice be used continuously. The materiality of this could be tested using sensitivity analysis.
Utilisation	<ul style="list-style-type: none"> • Potentially avoids unduly favouring options with significant spare capacity or those with unduly low opex costs. 	<ul style="list-style-type: none"> • The AISC will be impacted by changes in demand forecasts. As these are likely to change for WRMP19 there would be a knock on impact on the AISCs. • Utilisation for an individual option will depend upon other options selected in the preferred programme, and so utilisation can be difficult to assess with confidence.

It is proposed for the purpose of the fine screening that a capacity based AIC/AISC will again be used which is simple to calculate and transparent for stakeholders. To ensure this approach is applied fairly:

1. AISCs will only be compared with options of similar capacity so as to avoid unduly favouring large capacity options;
2. Sensitivity analysis will be undertaken to test the impact if a utilisation approach were used instead of a capacity approach for several leading options at opposite extremes of the capex opex balance (e.g. a reservoir option with high capex and low opex, and a desalination plant with low capex and high opex).

Stakeholder views were invited on the proposal to use the capacity approach, rather than the utilisation approach, to AIC/AISC. A summary of the discussions from the workshop on the 30th September 2014 is given below:

***+ves, -ves of capacity vs utilisation.** Stakeholders agreed that a capacity approach was reasonable, as long as utilisation was used later in the selection process (when comparing programmes of work).*

***Next steps:** Capacity based approach with sensitivity analysis (as described above) will be used for initial screening*

***Programme development.** Concerns were raised as to how TW ensures that options that could contribute to a lower overall programme cost are not screened out early.*

***Next steps:** A check will be included to ensure that options are not screened out where they are low cost and in the lower capacity bands.*

***OPEX calculation.** The stakeholders commented that OPEX should be based on average days/years.*

***Next steps:** The capacity approach will assume 365 days operation for cost (numerator) and also for the scaling factor (denominator). Sensitivity analysis on this assumption is proposed.*

4.1.4.2 Qualitative analysis

Although some environmental and social costs are included in the AISC, there are other risks associated with the options that are not reflected in the costs. In some cases these risks are such that it would not be an appropriate use of resources (and hence not in customers' interests) to expend further resources on more detailed investigations. Alongside the quantitative comparison of options, a qualitative comparison is proposed against a set of six dimensions that are described below.

1. **Environmental & Social:** The WRMP falls within scope of the Strategic Environmental Assessment (SEA) Directive. Evidence from the SEA, Habitats Regulations Assessment (HRA), and Water Framework Directive (WFD) Assessment is reviewed into a single indicator using professional judgement.
 - The SEA process promotes consideration of a wide range of environmental and social effects, requires full assessment of options making up the WRMP and helps identify potential cumulative effects with other plans and programmes. The SEA is informed by the HRA and WFD Assessment;
 - The WRMP is also subject to HRA to assess for likely significant effects on one or more European sites.
 - The assessment of option effects on water body status is also undertaken as required by the WFD.
2. **Cost:** Comparison of option AIC + carbon against the least cost option within the capacity band. The comparison will consider uncertainty ranges as well as the relative magnitude of point estimates.
3. **Promotability:** The Promotability criterion considers the scheme up to the point of planning permission being granted. It will draw on the WRMP14 Delivery Confidence Score⁵ and include professional judgement of:
 - Synergies (e.g. synergies with water resource needs of other water resource zones in the South East and synergies with third party developments)
 - Customer acceptability (e.g. in relation to wastewater reuse, including views of Customer Challenge Group);
 - Local acceptability (e.g. in relation to planning challenges); and
 - Regulatory acceptability (including DWI, EA, Ofwat).
4. **Flexibility:** Assessment of how flexible an option is to changes in requirements including in relation to:
 - Lead time: WRMP14 lead times will be used to inform this assessment;
 - Phasing: Potential for the scheme to be incrementally built and/or commissioned;
 - Adaptability: Whether the scheme is extendable once built; and
 - Ramp-up: How quickly the system can respond to changes in demand over its operational life.
5. **Deliverability:** The Deliverability criterion considers the option from the planning permission stage to commissioning and operation. It includes assessment of construction, technology and other implementation risks. Both the WRMP14 Delivery and Solution Confidence Scores⁵ will be used as part of this assessment.
 - Constructability: Uncertainties surrounding construction e.g. unknown technologies, land availability, or contamination risks;
 - Operability: Whether there is a track record of successfully using the technology and if it is a dependable and proven technology;
 - Dependencies: Dependencies on other assets, activities or third parties; and
 - Data confidence: Reliability and uncertainty of design data and DO assessment methodologies, etc.
6. **Resilience:** The Resilience criterion considers the option from the operation stage into the future. It will be an assessment of confidence that the option at the given cost will provide the stated deployable output, with the required water quality in the future, and include:
 - Vulnerability to hazards, including drought, climate change, commodity price rises (e.g. energy and chemicals) and human impacts (e.g. terrorism?); Vulnerability to regulatory changes (e.g. abstraction reform); and

⁵ Delivery Confidence Score and Solution Confidence Scores were assessed at WRMP14 and were used to inform the risk category of the project which then determined the optimism bias allowance

- Mitigations: Consideration of the options available to mitigate vulnerabilities.

Stakeholder views and comment on the dimensions were invited. A summary of the discussions from the workshop on the 30th September 2014 is given below:

A Flexibility criterion should be included. The stakeholder group felt that a Flexibility qualitative criterion should be included, to distinguish between options that can be phased and those where it is 'all or nothing'. The group discussed whether to incorporate this in the Lead Time criterion, but decided that re-naming this criterion 'Flexibility' was preferable.

***Next steps:** The Lead Time dimension has been renamed to Flexibility (see above) and phasing specifically included within its assessment.*

Abstraction reform. It was noted that the vulnerability of an option under abstraction reform scenarios should be a consideration under regulatory acceptability

***Next steps:** Reference to abstraction reform has been specifically included in the resilience dimension above*

Links to third-party developments. There was a question on how compatibility with other development has been incorporated in the qualitative criteria. One example was the Garden City Development in the SWOX area that could be prevented if Abingdon Reservoir was to be built. Cascade mentioned that these issues were addressed in the SEA (planning considerations) and any other synergies could be targeted through an Ecosystem Services approach.

***Next steps:** Synergies have been specifically included in the promotability dimension above*

Ensuring consistency in qualitative assessments. General feedback was that the qualitative criteria could be inconsistently assessed if there were no clear guidelines on scoring. The appraisal guidance used in the SEA was considered to be reasonable and it was suggested that a similar system should be considered for the rest of the qualitative criteria.

***Next steps:** Further appraisal guidance has been set out for each dimension above, and will be kept under review as the assessment process is applied*

Capturing potential impacts on existing regimes. It was commented that it was not very clear how any impact on the existing water resources will be captured in the appraisal process.

***Next steps:** Modelling of DO is being conducted by Thames Water. Options will need to be considered in terms of the extent that they increase Water Resource Zone DO (i.e. net of any DO reductions at other sources)*

Assessment of Resilience. Discussion on whether Resilience should have a quantitative element (especially on the DO uncertainty), however the group agreed that it could remain as it is but with better guidance on the scoring. A further suggestion was that adaptability might be featured under resilience.

***Next steps:** Adaptability has been added to the flexibility dimension. Further discussions will be had with Thames Water on the potential for including a quantitative analysis of DO uncertainty.*

It is proposed that all options that pass the coarse screening will be assessed against these dimensions. This will identify potential benefits/opportunities and dis-benefits/risks for each option. It is proposed that these will be categorised and visualised in the summary matrix using the categories shown in Table 4.

Table 4: Meaning of qualitative assessment categories

Symbol	Meaning (other)	Meaning (cost)
	Substantial benefit/opportunity	Least cost option
	Material benefit/opportunity	Confidence intervals overlap with those of least cost option
	Neutral	Confidence intervals do not overlap with those of least cost option (within size band) but point estimate < 1.5 x least cost option
	Material reducible disbenefit/risk	Confidence intervals do not overlap with those of least cost option (within size band) and point estimate > 2 x least cost option
	Material irreducible disbenefit/risk	Confidence intervals do not overlap with those of least cost option (within size band) and point estimate > 2.5 x least cost option
	Critical irreducible disbenefit/risk	Confidence intervals do not overlap with those of least cost option (within size band) and point estimate > 3 x least cost option

For any one dimension more than one symbol may be needed to capture the nature of the risks and benefits. For example under the environmental and social dimension some options (e.g. Cotswold canals transfer) may include material disbenefits during the construction stage, but material benefits during the operational phase.

4.1.4.3 Making screening decisions

It is proposed that rather than imposing rigid rules to make screening decisions, the focus will be on ensuring that there is a clear and robust reasoning for each screening decision which will then be reflected in the rejection register for WRMP19. It is expected that the nature of secondary screening may include:

- Rejection of options with critical irreducible dis-benefit/risk unless this may be offset by a substantial benefit/opportunity
- Where there are options of a similar type, then there may be a case for rejecting some such options that are less favourable than others. The most favourable option(s) of each type would then be carried forward.

The reasons for screening decisions within each capacity band will be recorded as a commentary in the scheme proformas for each option and summarised in the overall dashboard. Stakeholder views will be sought on the screening decisions and these decisions will be reviewed and updated in the light of stakeholder observations where necessary. Where it is concluded that further evidence is required to inform decision making then this will be identified for investigation in Phase 2. It is envisaged that the results of the Phase 2 investigations will then be fed back into the fine screening process.

4.2 Phase 2 – Detailed investigations

During Phase 2, targeted detailed investigations will be undertaken that will improve the state of knowledge and reduce uncertainty in the options. The intention is that the fine screening process be reapplied a number of times in Phase 2 as the detailed studies are completed. There may therefore be a further reduction in the number of options passing through to Phase 3, depending upon the results of the studies. It is also possible that new information from the detailed studies, including potentially a consideration of ecosystems services to identify whether options could provide multiple benefits to stakeholders, may throw into question the validity of past decisions to screen out options. It may therefore be necessary to bring options back into the mix, though we expect that the number of instances of this will be limited. Nevertheless, it is important that by the time Phase 4 is being progressed in 2018/19 that all screening decisions can still be justified based on the state of

knowledge of the options at that time (not just the earlier date when the screening decision was first made).

4.3 Phase 3 – programme appraisal

In Phase 3, the state of knowledge will improve again as new supply/demand forecasts will become available and detailed cost estimates are prepared for all the options then on the constrained list. These will then be subject to economic appraisal using optimal EBSD modelling to determine the best value solution(s). This is also when scenario analysis may be undertaken to examine the resilience of different solutions to different long-term future outcomes.

4.4 Phase 4 – Scheme selection, outline design and planning

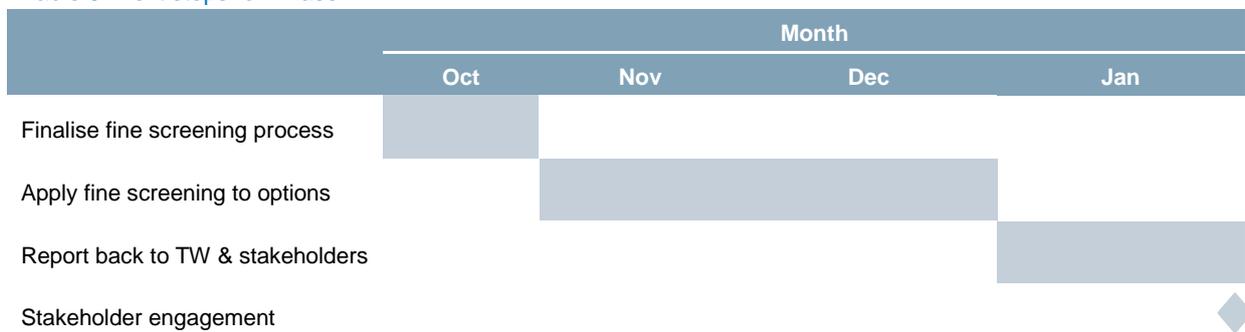
Depending upon the water resource position in WRMP19 Phase 4 would then entail selection of the preferred large scale option and, depending upon the lead time, progression through outline design and planning.

5 Conclusions and next steps

This working paper sets out proposals to take forward and further refine the large scale water resource options for London. The below table summarises the next steps in the process and the proposed timescales for their completion. They include:

1. finalising the fine screening process, taking into account the feedback received at the meeting held between Mott MacDonald, Cascade, TW and stakeholders on the 30th September 2014;
2. applying the fine screening to the options;
3. reporting back to TW and the stakeholders on the results of the fine screening; and
4. engaging with the stakeholders on the options being taken forward to Phase 2 of the assessment and the associated investigations.

Table 5: Next steps for Phase 1



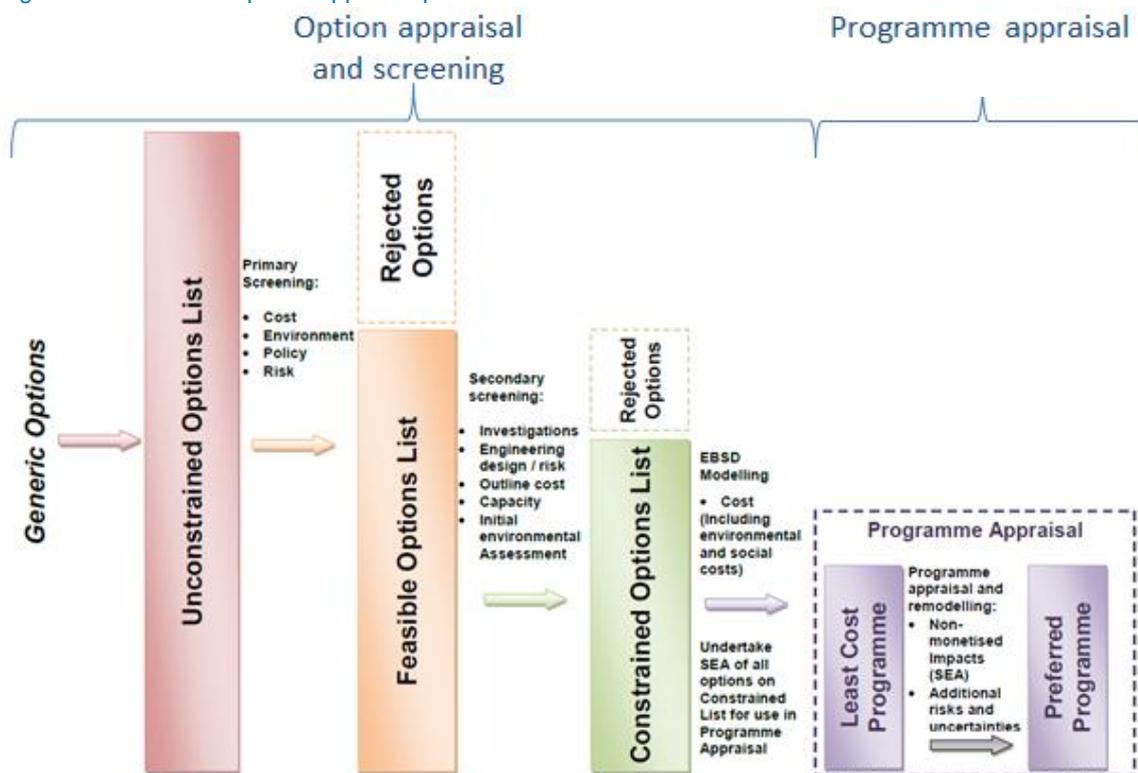
Appendices

Appendix A: Summary of WRMP14 screening approach

Introduction

The WRMP14 screening comprised three stages, progressing from a wide range of generic option types, through an unconstrained set, to a feasible set and finally a constrained set of options to be taken forward into the programme development and appraisal process. This process can be seen in Figure A.1.

Figure A.1: WRMP14 options appraisal process overview



Source: after TWUL WRMP14 Figure 7-1.

Generic screening – Generic option rejection

Thames Water sets out in Section 7.1.3 of WRMP14 its approach to generic option screening and development of the unconstrained list. Appendix 4 of the Water Resources Planning Guidelines (WRPG) sets out a list of generic resource option types. Thames Water set out in WRMP14 its own list of 23 generic option types⁶, and this corresponds with the WRPG in many, but not all areas. A generic screening process was followed to translate the generic options into an unconstrained list of specific options (which involved over 270 specific options). The unconstrained list builds on and takes into account:

- Those options identified and developed for WRMP09;
- Key findings of the public inquiry into WRMP09;

⁶ TWUL rdWRMP14. Table P-1, Appendix P: Options List Tables.

- Options proposed in the WRP;G;
- Options identified by water companies and third parties;
- Views of stakeholders, some of which were already set out in response to WRMP09;
- Responses to our WRMP14 public consultation;
- Options proposed via the Water Resources in the South East (WRSE) initiative.

Any of Thames Water’s generic options not qualifying for the unconstrained options list were included in a Scheme Rejection Register (WRMP14 Appendix Q). Example options that were rejected at the generic screening stage and a high-level description of the reasons for their rejection included:

- Icebergs: Techniques involved are not sufficiently advanced for commercial use;
- National Water Grid: Beyond the remit of Thames Water as regional water undertaker;
- Company mergers: Would not necessarily result in additional resources being made available; and
- Thames Barrage to impound fresh water: Significant ecological damage.

Primary screening – Unconstrained option rejection

The unconstrained options underwent the primary screening stage, based on 11 screening criteria, relevant to the following categories:

- Cost;
- Environmental & social impact,
- Risk & resilience; and
- Policy.

The questions were answered in a ‘Yes’/‘No’ format, based on existing information. If any single criteria scored a ‘No’, then the option was rejected. The 11 screening criteria identified in the WRMP14 documentation are presented in Table A.1. Table A.1 also shows the number of unconstrained options (of all sizes) where the answer to the screening question was ‘No’. Of the 46 unconstrained options screened out at the primary screening stage half failed against multiple criteria.

Table A.1: Primary screening criteria

WRMP14 criteria questions	Nr. ‘No’	Corresponding EBSD Stage 4.1 Criteria
1 Does the option avoid excessive cost?	15	
2 Is the option likely to be acceptable in terms of planning and environmental constraints (e.g. internationally or nationally designated sites)?	9	<i>“Does the option avoid breaching any unalterable constraints? For instance there are planning and environmental restrictions (for example, associated with an SSSI), health and safety regulations, non-discrimination provisions”</i>
3 Is the option likely to help meet WFD objectives and prevent deterioration of waterbody status?	11	
4 Does the option have an acceptable risk of social impact or inequality?	0	<i>“Is the option promotable (that is does it meet customer and regulatory expectations)? For example planners may rule out options that are likely to meet overwhelming public resistance”</i>
5 Does the option align with national policy objectives?	6	
6 Does the option provide flexibility / adaptability to climate change uncertainty?	4	
7 Is the option currently technically feasible? Are there conjunctive use benefits or other benefits to WR management?	8	
8 Does the option improve resilience against the specific supply-demand issues in the zone (i.e. meets peak week/ annual average shortfall)?	10	<i>“Does the option address the problem? For example is the problem identified in Stage 2 is a summer peak week shortfall, then options that provide no additional yield, or no reduction in demand during the peak week are not relevant to the solution.”</i>
9 Is the option lead time sufficiently flexible to planning or other uncertainties to ensure security of supply is maintained?	0	

WRMP14 criteria questions	Nr. 'No'	Corresponding EBSD Stage 4.1 Criteria
10 Are all other risks and uncertainties acceptable, e.g. are there contaminated land issues?	20	"Is the risk of the option failing acceptable?"
11 Can cost and benefit of the demand option be modelled for comparison with alternatives at DMA level?		

The risk rejection register in Appendix Q of the WRMP14: Scheme Rejection Register gives a brief description of the reasons for rejecting a scheme. Example criteria for rejection at the primary screening stage included:

- Northern Region Transfers: Estimated construction cost of pipelines and operational costs are excessively high therefore making them unlikely alternatives to more local solutions;
- Supported Severn-Thames Transfer from Craig Goch and Columbus (South Wales), Transfers A and B: Rejection by the Welsh Assembly Government in 2010, during the WRMP09 consultation process;
- Combined 30 Mm³ reservoir sites: Excessive cost, expected environmental impacts and associated planning problems; and
- Windsor STW reuse: A study commissioned by the Environment Agency concluded that effluent reuse schemes on the non-tidal Thames were likely to adversely impact on the resources available to London.

The resulting screened list of options from this stage formed the feasible list of options, taken forward to the secondary screening stage.

Secondary screening – Constrained option rejection

The feasible options list was then further appraised based on a secondary screening of three criteria, consisting of cost, environment and risk & resilience, to arrive at a Constrained List. The WRMP14 plan states that the secondary screening draws on the findings of engineering, environmental and feasibility assessments of schemes to inform the selection of the 'Yes'/'No' answers. Section 7 of the WRMP14 defines the appraisal criteria as being:

- Cost: Using available outline cost information from WRMP09 or subsequent investigations;
- Environment: Initial environmental assessment of schemes; and
- Risk & resilience: Capacity, engineering design and risk.

The three criteria that comprised this secondary screening are shown in Table A.2 together with the corresponding criteria from EBSD Stage 4.4. While the criteria are broadly consistent with the WRMP14 and the UKWIR Economics of Balancing Supply and Demand guidance it can be seen that there are differences. As with the previous screening stages, a single 'No' answer resulted in rejection of the option. Table A.2 shows the number of feasible options (of all sizes) where the answer to the screening question was 'No'. Of the 75 feasible options screened out at the secondary screening stage 59 failed against multiple criteria.

TableA.2: Secondary screening criteria

Criteria questions	Nr. 'No'	Corresponding EBSD Stage 4.4 Criteria
1 Does the option avoid excessive cost	51	"Are there any options that are considered 'Very high cost' in unit financial cost terms?"
2 Is the option likely to be acceptable in terms of planning and environmental constraints (e.g. internationally or nationally designated sites)?	29	'Are there any options that have particularly large environmental or social impacts?'
3 Through assessment of feasibility, capacity, engineering design	54	'Are there any options that are borderline

Criteria questions	Nr. 'No'	Corresponding EBSD Stage 4.4 Criteria according to the screening criteria'
and risk, does the option avoid excessive risk, and provide sufficient future resilience and net water resource benefit?		Stage 4.4 also provides for potentially screening out similar 'mutually exclusive' options.

The rejection register in Appendix Q of the WRMP14 gives a brief description of the reasons for rejection of a scheme, referring to other evidence. Example justifications for rejection at the secondary screening stage included:

- Unsupported Severn Thames Transfer (via Cotswold Canals): A feasibility assessment of the Cotswold Canals transfer options has determined that it would not be reasonable to take forward an option of 200MI/d or greater from an engineering design perspective;
- Marsh Gibbon, Ludgershall and Quainton New Reservoir Storage options: Screened out from any further analysis on the basis of a combination of overall environmental performance and scheme cost; and
- Mogden STW Reuse – 150MI/d: Environmental impact on R. Thames Tideway is yet to be fully established.

The resulting list of options formed the constrained options list taken forward into the optimisation undertaken using TW's EBSD model.

OJEU option appraisal and screening

In addition to those options developed following the process above, options identified through TWUL's advertisement in the Official Journal of the European Union (OJEU) were appraised and screened based on the same 11 primary screening criteria used for water resources options (see Table A.1) but with a 3 point scoring approach. It was noted in the WMRP14 documentation that very few of the options submitted had been developed in sufficient detail to enable their inclusion in the constrained options list. As such, only one OJEU option was subsequently considered as part of the programme appraisal process for the WMPR14, but this was less than 50 MI/d.

Appendix B: Example option appraisal proformas

			WRMP19 Fine Screening - option assessment template <i>DSL Estuary South 150 MI/d</i>		
Revision record					
Rev.	Originator		Checker		Description
	Name	Date	Name	Date	
A	D Spiller, A Grove, E Fri	25/09/2014	B Hume Smith	28/09/2014	Mock up for illustration purposes only
Option characteristics					
			Option name	DSL Estuary South 150 MI/d	
			Capacity	150 MI/d	
			Type of option	Desalination	
			Earliest potential option start date (Year)	2020-21	
Summary option description					
A new desalination plant with a yield of 150 MI/d. The plant is based on the existing Thames Gateway desalination plant but located on the southern bank of the estuary. The option also includes treated water transfer (18km) to a service reservoir in South London. Wastewater will be fed to a nearby STW outfall for dilution before discharge to the estuary.					
Quantitative assessment					
		P5	P50	P95	
AISC		65.29	75.03	90.11	p/m ³
NPV of WAFU			1,076,556		Ml
Total NPV		703,076	807,779	970,594	£k
CAPEX NPV		476,326	580,885	743,533	£k
OPEX NPV			106,231		£k
NPV of Opex savings			0		£k
NPV of carbon			119,468		£k
Social & Env. NPV		1,052	1,195	1,362	£k
Qualitative assessment					
Environmental & Social					
+ve ● -ve ●					
<i>Evidence from SEA, HRA, and WFD assessment, combined into a single indicator using professional judgement</i>					
Strategic Environmental Assessment (SEA)					
1. To protect and enhance biodiversity, ecological functions, capacity, and habitat connectivity. within Thames Water's supply and source area					
2. To strengthen the connections between people and nature and realise the value of biodiversity					
3. To improve human health and well-being of the area, improve access to recreation and the environment, and reduce inequalities					
4. To reduce, and make more efficient, the domestic, industrial and commercial consumption of resources, minimise the generation of waste, encourage its re-use and eliminate waste sent to landfill					
5. To maintain or improve the quality of rivers, lakes, groundwater, estuarine and coastal waterbodies					
6. To ensure appropriate and sustainable management of abstractions					
7. To reduce and manage flood risk					
8. To increase awareness of water sustainability, its efficient use and the ecosystem functions which rely on water resources					
9. To protect and enhance geology, the quality and quantity of soils and promote a catchment-wide approach to land management					
10. To reduce air pollutant and greenhouse gas emissions					
11. To adapt and improve resilience to the threats of climate change					
12. To conserve and enhance the historic environment, the heritage assets therein and their setting					
13. To protect, enhance the quality of, and improve access to designated and undesignated landscapes, townscapes and the countryside					
Scheme would result in some loss of the Greater Thames Marshes NIA, Erith Marshes BAP habitat and cause potential effects on the Crossness LNR. Scheme would require significant materials in construction and operation. The scheme makes use of a limitless water supply and would avoid drawing on stressed water resources. The scheme could cause significant disturbance to cultural heritage especially as the area is known to hold many archaeological deposits. Significant effects on recreational resources, energy use and climate change have been monetised and should not be considered again in programme appraisal at this stage.					
Habitats Regulations Assessment (HRA)					
No LSE					
Water Framework Directive (WFD) Assessment					
The scheme is unlikely to affect the status of nearby waterbodies.					
Cost					
● ●					
<i>Comparison of option AISC against the least cost option within the capacity band. The comparison will consider uncertainty ranges as well as the relative magnitude of point estimates.</i>					
The AISC is over double that of the least cost option.					

Promotability +ve -ve <i>Assessment using professional judgement of wider benefits to WRSE, customer acceptability (e.g. in relation to wastewater reuse, including views of Customer Challenge Group), local acceptability (e.g. in relation to planning challenges), regulatory acceptability (including DWI, EA, Ofwat)</i>						
The scheme should be promotable as the type is already in supply in London. It is of sufficient size to be strategically important and would be able to support wider transfers within the South East. Focus of any challenge would likely be relating to carbon emissions/energy use and any mitigation measures employed.						
Lead Time <i>Assessment of how quickly the option could be planned and constructed given uncertainties that exist in the supply-demand balance. WRMP14 lead times will be used to inform this assessment.</i>						
The scheme could be planned and built in 6 years. It would be flexible to uncertainties in the supply demand balance, but may not be the most cost effective option in the long term. Operating costs are likely to mean the option is not a 'baseload' scheme, but one that would only be utilised fully at times of shortage.						
Deliverability +ve -ve <i>Assessment of construction, technology and other implementation risks. The WRMP14 Delivery Confidence Score will be used as part of this assessment.</i>						
High confidence - Company has experience of delivery of a desalination plant of similar size, but it can create significant operation and maintenance challenges. TW owned land is available, but env. designated. Technology is proven. The treated water pipeline is long (18.2km) and through built up areas. The Company has considerable experience of delivering infrastructure in these conditions but local issues may be observed.						
Resilience +ve -ve <i>Assessment of confidence that the option will provide the stated deployable output, with the required water quality at the time that it is needed both now and in the future (i.e. taking account of climate change). The WRMP14 Solution Confidence Score5 will be used as part of this assessment.</i>						
High resilience. There are no raw water availability constraints even in the face of climate change. Water quality (inflow) will need investigation but no significant issues anticipated.						
Key Issues, Risks & Opportunities <i>Brief description to fit on the summary page</i>						
Desalination is a proven technology and a scheme for South London to match the existing North London plant is deliverable. Raw water availability is not an issue. High carbon emissions as well as long-term costs are known risks.						
<i>More detailed overview</i>						
1. Technology developments since construction of the TGWTP 2. Planning review wrt the site of the proposed scheme and it's designation. 3. Operating costs 4. Inflow quality						
Screening decision and reasoning <i>Brief description to fit on the summary page</i>						
Screen out as substantially more costly than wastewater reuse alternatives.						
<i>More detailed overview</i>						
Screen out as substantially more costly than wastewater reuse alternatives. Would need to screen back in if lower cost wastewater re-use options were ruled out at a later stage.						
Further investigations <i>Brief description to fit on the summary page</i>						
N/A						
Summary of issue/risk	Nature of investigation					
1. Inflow quality	To confirm quality of water at the proposed intake and any associated impacts					
2. Site issues	Review known site issues to reduce uncertainty					
3. Modular design	Review design to better understand the cost curve for larger to smaller plants					
4.	4.					
5.	5.					
6.	6.					
Legend Qualitative assessment categories						
Symbol						
Meaning	Substantial benefit/opportunity	Material benefit/opportunity	Neutral	Material reducible disbenefit/risk	Material irreducible disbenefit/risk	Critical irreducible disbenefit/risk
Meaning (cost)	Least cost option	Confidence intervals overlap with those of least cost option	Confidence intervals do not overlap with those of least cost option (within size band)			
			but point estimate < 1.5 x least cost option	and point estimate < 2 x least cost option	and point estimate < 2.5 x least cost option	and point estimate > 2.5 x least cost option
SEA categories						
Major Adverse	Moderate Adverse	Minor Adverse	Negligible	Minor Beneficial	Moderate Beneficial	Major Beneficial
Uncertain	Mixed	N/A				

			WRMP19 Fine Screening - option assessment template <i>IPR Beckton STW 150 MI/d RO</i>		
Revision record					
Rev.	Originator		Checker		Description
	Name	Date	Name	Date	
A	D Spiller, A Grove, E Fredenham	25/09/2014	B Hume Smith	28/09/2014	Mock up for illustration purposes only
Option characteristics				Option name	IPR Beckton STW 150 MI/d RO
				Capacity	150 MI/d
				Type of option	Indirect Potable Reuse
				Earliest potential option start date (Year)	2020-21
Summary option description					
A new wastewater reuse plant utilising reverse osmosis membrane treatment, with a yield of 150 MI/d. The option will take treated effluent from Beckton STW and subject it to further treatment, including reverse osmosis. Treated water will be discharged, via a new 23km pipeline, into the River Lee upstream of Keids Weir, for subsequent re-abstraction to the Lee Valley reservoir chain. Reject water will be fed to the outfall of Beckton STW for dilution before discharge into the estuary.					
Quantitative assessment					
		P5	P50	P95	
AISC		43.32	49.0742	57.94	p/m ³
NPV of WAFU			982,667		MI
Total NPV		425,840	482,236	569,888	£k
CAPEX NPV		256,029	312,230	399,655	£k
OPEX NPV			100,347		£k
NPV of Opex savings			0		£k
NPV of carbon			68,036		£k
Social & Env. NPV		1,428	1,623	1,850	£k
Qualitative assessment					
Environmental & Social				+ve	
				-ve	
<i>Evidence from SEA, HRA, and WFD assessment, combined into a single indicator using professional judgement</i>					
Strategic Environmental Assessment (SEA)					
1. To protect and enhance biodiversity, ecological functions, capacity, and habitat connectivity. within Thames Water's supply and source area					
2. To strengthen the connections between people and nature and realise the value of biodiversity					
3. To improve human health and well-being of the area, improve access to recreation and the environment, and reduce inequalities					
4. To reduce, and make more efficient, the domestic, industrial and commercial consumption of resources, minimise the generation of waste, encourage its re-use and eliminate waste sent to landfill					
5. To maintain or improve the quality of rivers, lakes, groundwater, estuarine and coastal waterbodies					
6. To ensure appropriate and sustainable management of abstractions					
7. To reduce and manage flood risk					
8. To increase awareness of water sustainability, its efficient use and the ecosystem functions which rely on water resources					
9. To protect and enhance geology, the quality and quantity of soils and promote a catchment-wide approach to land management					
10. To reduce air pollutant and greenhouse gas emissions					
11. To adapt and improve resilience to the threats of climate change					
12. To conserve and enhance the historic environment, the heritage assets therein and their setting					
13. To protect, enhance the quality of, and improve access to designated and undesignated landscapes, townscapes and the countryside					
Initially proposed pipeline route passed through Epping Forest SAC with consequent likely significant effects identified through HRA. Pipe now re-routed to avoid the SAC and likely significant effects. Pipeline route may also affect cultural heritage resources although effects may be mitigable, and a watching brief would need to be maintained in case buried assets were disturbed during construction. Reuse enables climate change resilience as source not vulnerable to climate change effects. Scheme makes use of a resource that would otherwise be lost to the tideway. Significant effects in relation to emissions and air quality have been monetised and are therefore not taken into account at this stage of programme appraisal.					
Habitats Regulations Assessment (HRA)					
Initially proposed pipeline route passed through Epping Forest SAC with consequent likely significant effects identified through HRA. Pipe now re-routed to avoid the SAC and likely significant effects.					
Water Framework Directive (WFD) Assessment					
No significant alterations to hydrodynamics or water quality, therefore no changes to WFD status of nearby waterbodies expected.					
Cost					
<i>Comparison of option AISC against the least cost option within the capacity band. The comparison will consider uncertainty ranges as well as the relative magnitude of point estimates.</i>					
The least cost option is the wastewater reuse option at Abbey Mills using membrane bioreactor (MBR) treatment technology. The costs for the Beckton scheme are less than 1.5* those of the least cost scheme and the uncertainty bands are close to overlapping.					

Promotability +ve -ve

Assessment using professional judgement of wider benefits to WRSE, customer acceptability (e.g. in relation to wastewater reuse, including views of Customer Challenge Group), local acceptability (e.g. in relation to planning challenges), regulatory acceptability (including DWI, EA, Ofwat)

IPR has not been used in the UK at this scale. It remains to be seen how the public will react when faced with an imminent scheme, but the use of reverse osmosis should allay some concerns. Acceptability will largely be based on proving the quality of the water and minimising risks. There have been international examples of success and failure. The scheme is of sufficient size to be strategically important and would be able to support wider transfers within the South East. Other than quality, concerns could be raised relating to carbon emissions/energy use.

Lead Time

Assessment of how quickly the option could be planned and constructed given uncertainties that exist in the supply-demand balance. WRMP14 lead times will be used to inform this assessment.

The scheme could be planned and built in 6 years. It would be flexible to uncertainties in the supply demand balance.

Deliverability +ve -ve

Assessment of construction, technology and other implementation risks. The WRMP14 Delivery Confidence Score will be used as part of this assessment.

Company has experience of delivery of membrane treatment, but it can create significant operation and maintenance challenges. Land is available. Technology is proven.

Potential issue with the provision of power supply to the area. The treated water pipeline is long (23km) and through built up areas. The Company has considerable experience of delivering infrastructure in these conditions but local issues may be observed.

Resilience +ve -ve

Assessment of confidence that the option will provide the stated deployable output, with the required water quality at the time that it is needed both now and in the future (i.e. taking account of climate change). The WRMP14 Solution Confidence Score5 will be used as part of this assessment.

Raw water supply should be resilient as the diversion to the IPR plant is less than 1/4 of minimum dry weather flow from Beckton STW. Influent quality should be stable/regulated by the STW processes.

Key Issues, Risks & Opportunities

Brief description to fit on the summary page

Technology is proven worldwide. Water would otherwise be lost to sea. Quality and perception issues are the main concerns. Power supply issues need further study eg. infrastructure/availability.

More detailed overview

- Public and political acceptability
- Treated water quality/risk of deterioration in water quality
- Power availability

Screening decision and reasoning

Brief description to fit on the summary page

Pass

More detailed overview

Re-use performs well in the financial assessment and reverse osmosis may be required in order to allay quality concerns. Beckton is an obvious choice for a re-use plant option and can contribute to water availability from the Lee Valley Reservoir chain.

Further studies should be undertaken to firm up on costs and reduce uncertainty - the majority of these are generic to the option type, rather than site specific.

Further investigations

Brief description to fit on the summary page

Continued option-type level study of quality and perceptions.

Summary of issue/risk	Nature of investigation
1. Quality	Taking forward the PR14 studies
2. Perception	Taking forward the PR14 studies
3. Power supply	Assessment of power supply availability and impact on scheme costs
4. Modular design	Review design to better understand the cost curve for larger to smaller plants

Legend

Qualitative assessment categories

Symbol	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Meaning	Substantial benefit/opportunity	Material benefit/opportunity	Neutral	Material reducible disbenefit/risk	Material irreducible disbenefit/risk	Critical irreducible disbenefit/risk
Meaning (cost)	Least cost option	Confidence intervals overlap with those of least cost option	Confidence intervals do not overlap with those of least cost option (within size band)			
			but point estimate < 1.5 x least cost option	and point estimate < 2 x least cost option	and point estimate < 2.5 x least cost option	and point estimate > 2.5 x least cost option

SEA categories

Major Adverse	Moderate Adverse	Minor Adverse	Negligible	Minor Beneficial	Moderate Beneficial	Major Beneficial	Uncertain	Mixed	N/A

Appendix C: Summary of guidance on calculation of AISC

The UKWIR Report Economics of Balancing Supply and Demand (EBS⁷) and the Water Resources Planning Guidelines (WRPG)⁸ provide background and guidance on the economic approach for assessing water resource options as well as specific guidelines for using the AISC as a measure. This section summarises key items from these guidelines relating to AISC:

1. The AISC is an established quantitative metric that was a requirement of the Water Resources Planning Guidelines for WRMP14.
2. AISC is a simple approach for the economic comparison of options. Although there are more sophisticated approaches to aid in options selection (such as linear/integer programming and stochastic programming), the AISC is still a useful metric for economic comparison.
3. There are several ways to calculate AISC (and AIC) that use either output or capacity as the scaling factor (denominator).
 - a. Where output is used as the scaling factor then it should match the planning problem (i.e. for a dry year demand planning problem, estimated usage should be calculated on the basis of dry year weather conditions). Estimating the output of options for use as the scaling factor requires certain assumptions to be made as it is dependent upon the other options that are selected and their costs relative to existing resources.
 - b. Using capacity as the AISC scaling factor is more straightforward, but can lead to erroneous conclusions, particularly if an option provides significantly more resource than is needed to address the planning problem
4. WRPG states that for the secondary screening companies should avoid the use of AISCs as criteria for screening. But where a company has used these, it should base its assessments on expected utilisation, and not capacity, of the option.
5. WRPG specifies that AISC should be calculated over 80 years from initial investment
6. WRPG specifies that a discount rate of 4.5% should be used, unless more up to date information is obtained from Ofwat or the EA. It is noted that the 4.5% discount rate is not consistent with subsequent guidance from the Joint Regulators Group⁹ on discounting which proposes use of the Weighted Average Cost of Capital (WACC) to convert capital costs into a stream of annual costs, following which the streams of costs and benefits are then discounted using the social time preference rate (currently 3.5% for the first 30 years, 3% for years 31-75 and 2.5% for years 76-125¹⁰).

In conclusion, AISC is an established approach currently required in water resource planning. It can be scaled using capacity or different formulations of usage as scaling factors. Equally different formulations of usage can be used to determine the variable costs included in calculating the numerator. While AISC has its limitations such as its consideration of individual options abstract wider options, it is considered that some simplifying assumptions can be made to substantially mitigate this.

⁷ UKWIR, The Economics of Balancing Supply & Demand (EBS⁷) Guidelines, 2002

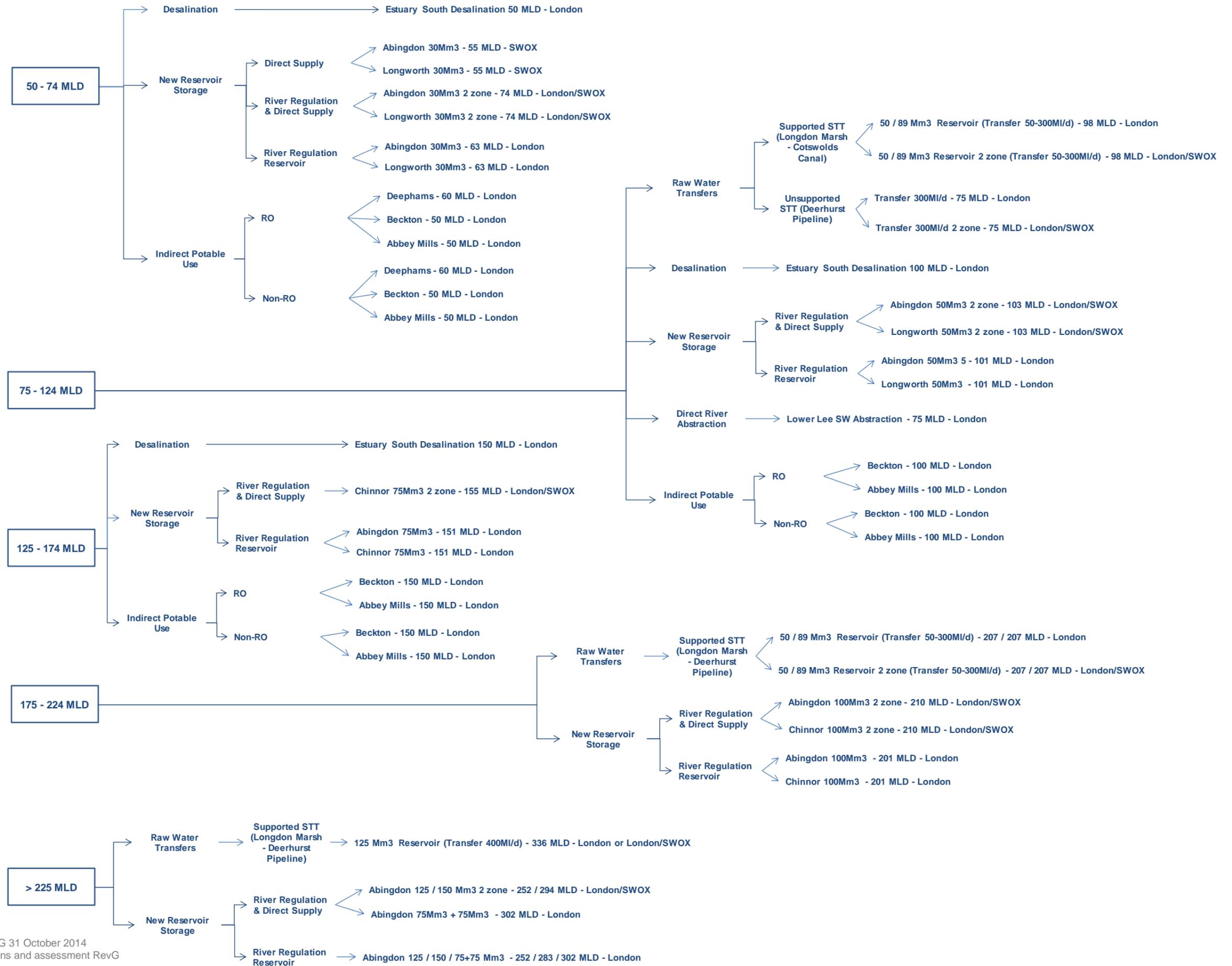
⁸ EA, Ofwat, Defra and the Welsh Government, Water resources planning guideline: The technical methods and instructions, 2012

⁹ Joint Regulators Group, Discounting for CBAs involving private investment, but public benefit, Statement, 25 July 2012

¹⁰ HM Treasury, The Green Book, Appraisal and Evaluation in Central Government, 2003, Partially updated July 2011

Appendix D: WRMP14 Constrained options by capacity bands

Constrained options >50 MLD



Appendix E: Minutes of stakeholders meeting on 30th September 2014

Record of meeting/discussion



Project Title WRMP19

Division WUD

Subject Stakeholders meeting (large scale options & appraisal process)

Project No.

Location TW Offices, Reading

Date of Meeting 30.09.14

Present

Recorded by Mott MacDonald	Distribution
Item	Text
1.0	Feedback on Large Scale (>50MLD) Options
1.1	Comments on other large scale options that have not been considered Transfer options: <ul style="list-style-type: none">• The potential was raised for a Severn transfer with support to the River Severn during low flows provided by third parties (e.g. Minworth STW effluent). This is already under consideration by Thames Water.• Question on whether Farmoor Reservoir is being used enough for supply of SWOX. May have a greater role to play in a Severn Transfer (for example synergies between Cotswold Canal transfer with Farmoor Reservoir for flow regulation)• It was suggested that there may be wider canal options worthy of consideration (including using the Grand Union Canal) which could potentially transfer water (e.g. from Minworth) east to the Anglian region potentially freeing up water from the River Thames for London. The Canals & Rivers Trust (CRT) referred to a paper on alternative canal options. The CRT also noted that it has hydraulic ISIS models for much of the canal network.• It was noted that typically flows in the range of 50-100MI/d were likely to be the limit to maintain navigation on narrow canals. The CRT noted that it has a statutory duty to maintain navigation and so an option that did not facilitate navigation could cause of breach of this duty and so would be unlikely to be acceptable.• The CRT noted that there can be control challenges when pumping large volumes through numerous lock gates in series. It was also noted that the requirement to run large numbers of pumps in series could also raise reliability issues that could require stand-by pumps and power supplies.

**Record of meeting/discussion
Continuation sheet**



Project No.

Date of Meeting

Item	Text	
<p>1.2</p> <p>1.3</p>	<ul style="list-style-type: none"> • It was noted that the width of the Cotswold Canal is such that larger volumes were thought to be potentially possible. It was also noted that there are various possible future operating models for the Cotswold Canal which would not need to necessarily transfer to the CRT and so need not necessarily have the same constraints around maintaining navigation. <p>Groundwater conjunctive use:</p> <ul style="list-style-type: none"> • A possible ground water conjunctive use option was suggested where Anglian Water supplies Thames Water with groundwater at times of low flows in the River Thames, with the supply reversed when river flows recover. <p>Wastewater reuse</p> <ul style="list-style-type: none"> • A question was raised around potential for synergies between large-scale options (e.g. Re-use and transfers) and particularly implications of the phasing of these • There was a question on whether further consideration is needed on the discharge point under re-use options (e.g. river or impounding reservoir). TW stated that this is part of the current water re-use investigations so it is under consideration. <p>Existing reservoirs:</p> <ul style="list-style-type: none"> • Question on whether options for obtaining more DO from existing reservoirs had been explored (e.g. issues around DO constraints due to limits on fill rate arising from structural considerations) <p>Comments on large scale resource options in the WRMP14 rejection register that should be revisited</p> <p>National water grid:</p> <ul style="list-style-type: none"> • National Grid option has previously been rejected on cost/benefit grounds, however some concerns were expressed over the reliability of the cost estimates adopted. Some stakeholders felt that a variation of a National Grid option (e.g. linking Cumbria to London) may need to be considered <p>Tankering</p> <ul style="list-style-type: none"> • Albion Water proposed that its tankering option should be given further consideration. It proposed to run 1 tanker per week initially to prove the capability, but could readily increase this to 150MI/d by providing one 150,000 tonne tanker per day. The proposal is to offload the water at a deepwater port in Essex and it is thought that this might be able to reduce or eliminate the need for water transfers from Thames Water to Essex & Suffolk. The view was also expressed that tankering is a resilient option as there are several water sources potentially available. <p>Any other feedback on large scale options</p>	

Record of meeting/discussion

Continuation sheet



Project No.

Date of Meeting

Item	Text
	<ul style="list-style-type: none"> • Question on timescale for considering any new Third Party Options • Question on Third Party confidentiality issues – the group felt that the technical details should be shared with the Stakeholders • The (new) flow compensation options seem reasonable but would require further investigations and should be further assessed against the Lower Thames Operating Agreement as well as any WFD requirements
2.0	Feedback on WRMP19 Appraisal Process
2.1	<p>Comments on the proposed overall process for option screening (focusing on fine screening stage)</p> <ul style="list-style-type: none"> • No specific concerns were raised on the proposed inclusion of the fine screening stage • The group were reminded that the proposed appraisal process is built on work done in WRMP14 and not a completely separate process • The stakeholders saw the proposed overall appraisal process being reasonable – further points/issues highlighted in the detailed questions below.
2.2	<p>Comments on choice of quantitative indicator (i.e. AISC or AIC+carbon)</p> <ul style="list-style-type: none"> • Stakeholders in both groups expressed a preference for the “AIC+Carbon” approach. • Discussion around pros/cons of AISC and AIC+carbon approach. Stakeholders were informed that the monetary value of environmental and social costs in AISC usually accounted for less than 5% of the options capex/opex hence did not affect the decision going forward, on cost grounds. • TW gave some insight from their understanding of the WRMPG - elements of the WRMPG were being reviewed and the direction they were heading was towards more freedom to the approach undertaken, providing there is sound justification. • Stakeholders expressed concerns over a potential double counting of the cost of carbon and that DECC guidance should be used in any carbon valuations
2.3	<p>Comments on the proposal to use the capacity approach rather than the utilisation approach, to AIC/AISC</p> <ul style="list-style-type: none"> • Discussion around pros/cons of capacity vs utilisation in the screening process. Stakeholders agreed that a capacity approach was reasonable, as long as utilisation was used later in the selection process (when comparing programmes of work).

Record of meeting/discussion

Continuation sheet



Project No.

Date of Meeting

Item	Text
2.4	<ul style="list-style-type: none"> • Concern on how would TW ensure that options that would give a lower programme cost are not screened out early • Stakeholder comment that opex should be based on average days/yr <p>Comments on the dimensions proposed for the qualitative analysis</p> <ul style="list-style-type: none"> • The Group felt that a Flexibility qualitative criterion should be included (to capture any 2-phase option implementation, etc). The group discussed that this was incorporated in the Lead Time criterion, however re-naming this criterion Flexibility would be a better name. • It was noted that the vulnerability of an option under abstraction reform scenarios should be a consideration under regulatory acceptability • Question on how synergies and dependencies would be taken into account. For example the Garden City Development in the SWOX area that could be prevented if Abingdon Reservoir was to be built. Cascade mentioned that these issues were addressed in the SEA (planning considerations) and any other synergies could be targeted through an Ecosystem Services approach. • General feedback was that the qualitative criteria could be subjective without clear guidelines on scoring. Scoring guidance for SEA seemed reasonable and a similar system should be considered for the rest of the qualitative criteria. • It was not very clear how any impact on existing water resources was captured in the appraisal process • Discussion on whether Resilience should have a quantitative element (especially on the DO), however the group agreed that it could remain as it is but with better guidance on the scoring. A further suggestion was that adaptability might be featured under resilience.
2.5	<p>Any other feedback on the Appraisal Process</p> <ul style="list-style-type: none"> • The group suggested that the evidence sources used behind any scoring should be included in the form. The group went through the sources of evidence used behind each criterion. These are: <ul style="list-style-type: none"> ○ Cost: F909 forms ○ Promotability: Professional judgement with relevant factual evidence attached to it ○ Flexibility (prev. lead time): Evidence on lead times for all options ○ Deliverability: every scheme has a risk register ○ Resilience: more subjective, so more guidance required

Record of meeting/discussion Continuation sheet



Project No.

Date of Meeting

Item	Text	
3.0	<p>Any Other Feedback on WRMP19 Phase 1</p> <ul style="list-style-type: none">○ The stakeholders emphasised the importance of information transparency and that all outputs from key investigation reports (past and future) should be summarised in one place for the stakeholders to easily access; it was felt that currently the options information is quite fragmented. The group suggested that TW should consider how to address this issue in WRMP19.○ Stakeholders suggested that a clear list of investigations studies/requirements for the options should be a Phase 1 output.	