Thames to Affinity Transfer SRO

Technical Supporting Document A1b

Concept Design Report

Beckton Reuse Indirect Option

Notice

Position Statement

- This document has been produced as the part of the process set out by RAPID for the development of the Strategic Resource Options (SROs). This is a regulatory gated process allowing there to be control and appropriate scrutiny on the activities that are undertaken by the water companies to investigate and develop efficient solutions on behalf of customers to meet future drought resilience challenges.
- This report forms part of suite of documents that make up the 'Gate 2 submission.' That submission details all the work undertaken by Thames Water and Affinity Water in the ongoing development of the proposed SROs. The intention of this stage is to provide RAPID with an update on the concept design, feasibility, cost estimates and programme for the schemes, allowing decisions to be made on their progress and future funding requirements.
- Should a scheme be selected and confirmed in the companies' final Water Resources Management Plan, in most cases it would need to enter a separate process to gain permission to build and run the final solution. That could be through either the Town and Country Planning Act 1990 or the Planning Act 2008 development consent order process. Both options require the designs to be fully appraised and in most cases an environmental statement to be produced. Where required that statement sets out the likely environmental impacts and what mitigation is required.
- Community and stakeholder engagement is crucial to the development of the SROs. Some high level activity has been undertaken to date. Much more detailed community engagement and formal consultation is required on all the schemes at the appropriate point. Before applying for permission Thames Water and Affinity Water will need to demonstrate that they have presented information about the proposals to the community, gathered feedback and considered the views of stakeholders. We will have regard to that feedback and, where possible, make changes to the designs as a result.
- The SROs are at a very early stage of development, despite some options having been considered for several years. The details set out in the Gate 2 documents are still at a formative stage and consideration should be given to that when reviewing the proposals. They are for the purposes of allocating further funding not seeking permission.

Disclaimer

This document has been written in line with the requirements of the RAPID Gate 2 Guidance and to comply with the regulatory process pursuant to Thames Water's and Affinity Water's statutory duties. The information presented relates to material or data which is still in the course of completion. Should the solution presented in this document be taken forward, Thames Water and Affinity Water will be subject to the statutory duties pursuant to the necessary consenting process, including environmental assessment and consultation as required. This document should be read with those duties in mind.

Contents

Figures and Tables

List of abbreviations

(Not all are used in this annex)

Abbreviation	Definition
ACWG	All Company Working Group
ADO	Average Deployable Output
AFW	Affinity Water
AIC	Average Incremental Cost
AMP	Asset Management Plan
BRI	Beckton Reuse Indirect (identifier for one of the T2AT options)
Capex	Capital Expenditure
CDR	Concept Design Report
CEMP	Construction Environmental Management Plan
CESWI	Civil Engineering Specification for the Water Industry
CSF	Chalk Streams First
DAPWL	Deepest Advisable Pumped Water Levels
D/A/S	Duty/Assist/Standby
DCO	Development Consent Order
DICL	Cement Lined Ductile Iron
DNO	Distribution Network Operator (Electrical Power Supplier)
DO	Deployable Output
DPC	Direct Procurement for Customers
DRA	Direct River Abstraction
DWI	Drinking Water Inspectorate
EA	Environment Agency
EAR	Environmental Assessment Report
FDC	Flow-Duration Curve
FTE	Full Time Equivalent
fWRMP19	Final Water Resources Management Plan for PR19
GAC	Granular Activated Carbon
GUC	Grand Union Canal
H&S	Health and Safety
HLPS	High Lift Pumping Station
HRA	Habitats Regulation Assessment
HS2	High Speed 2
IBC	Intermediate Bulk Containers
INNS	Invasive Non-Native Species

Abbreviation	Definition
LNR	Local Nature Reserves
LTR	Lower Thames Reservoir (Identifier for one of the T2AT options, refers to a group of strategic raw water storage reservoirs situated to the west of London)
LRMC	Long Run Marginal Cost
MCC	Motor Control Centre
MDO	Minimum Deployable Output
Ml/d	Megalitres per Day
NEUB	Non-Essential Use Ban
NIC	National Infrastructure Commission
NNR	National Nature Reserves
NPV	Net Present Value
OB	Optimism Bias
Opex	Operational Expenditure
PR19	Price Review 2019
PR24	Price Review 2024
PS	Pumping Station
QCRA	Quantified Costed Risk Assessment
RAPID	Regulators' Alliance for Progressing Infrastructure Development
RGF	Rapid Gravity Filtration
RMU	Ring Main Unit
RSS	Regional System Simulation
RWPS	Raw Water Pumping Station
RWTM	Raw Water Transfer Main
SAC	Special Areas of Conservation
SCADA	Supervisory Control and Data Acquisition
SEA	Strategic Environmental Assessment
SESRO	South East Strategic Reservoir Option
SPA	Special Protection Areas
SR	Service Reservoir (drinking water storage)
SRO	Strategic Regional Option
SSSI	Site of Special Scientific Interest
STT	Severn Thames Transfer
STW	Sewage Treatment Works
T2AT	Thames to Affinity Transfer
TOC	Total Organic Carbon
TUB	Temporary Use Ban

Abbreviation	Definition
TW or TWUL	Thames Water
TWTM	Treated Water Transfer Main
UV	Ultraviolet
WFD	Water Framework Directive
WIMES	Water Industry Mechanical and Electrical Specification
WRMP19	Water Resource Management Plan for PR19
WRMP24	Water Resource Management Plan for PR24
WRPG	Water Resources Planning Guidelines
WRSE	Water Resources South East
WTW	Water Treatment Works
WRZ	Water Resource Zone
WQRA	(Drinking) Water Quality Risk Assessment

1. Introduction

1.1 Background

1.1. The Thames to Affinity Transfer (T2AT) scheme is a prospective project with the objective of abstracting available raw water from the Thames Water catchment in west, south, and east London; treating it to drinking water standards; and delivering to Affinity Water customers in the area to the north-west, north and north-east of London.

1.2. T2AT is one of the Strategic Resource Options (SROs) identified by Ofwat in its Price Review 2019 (PR19) final determination which are being investigated as potential solutions to meet the forecast water supply requirements across England over the next forty to eighty years.

1.3. Affinity Water and Thames Water are developing the T2AT scheme under the guidance of the Regulators' Alliance for Progressing Infrastructure Development (RAPID). RAPID was formed to help accelerate the development of new water infrastructure and design future regulatory frameworks, with collaboration between Ofwat, the Environment Agency (EA) and the Drinking Water Inspectorate (DWI).

1.4. RAPID has defined a gated process for developing the SROs to identify the optimum set of solutions through which each region will meet their future water supply challenge:

- Gate 1 – Initial feasibility, design and multi-solution decision making (Completed in July 2021).
- Gate 2 – Detailed feasibility, design and multi-solution decision making.
- Gate 3 – Finalised feasibility, pre-planning investigations and planning applications.
- Gate 4 – Planning applications, procurement strategy and land purchase.

1.5. In order to foster consistency in approach across all of the SROs, and drive efficiency through collaboration, the water companies involved have formed an All Company Working Group (ACWG). The ACWG has prepared guidance, in consultation with RAPID, for the teams working on individual SROs on each of the significant topics which need to be covered in the gated submissions.

1.6. Eight options for achieving the objectives of the T2AT scheme were presented at Gate 1. These options were also included within the water resources planning process carried out by Water Resources South East (WRSE); the regional water resource planning alliance that covers the South East of England and comprises the six water companies that operate in this region.

1.7. Further to an option appraisal process, two of the options have been identified as preferential for development to Gate 2, namely the Lower Thames Reservoir (LTR)

option and the Beckton Reuse Indirect (BRI) option. The preference for these two options reinforces the selection made in the emerging regional plan prepared by WRSE.

1.8. This concept design report (CDR) sets out the working solution at Gate 2 of the T2AT BRI option. The CDR forms part of a suite of technical documents that support the main T2AT RAPID Gate 2 report. The list of documents that make up the submission, along with a short synopsis of the contents, may be found in the main T2AT RAPID Gate 2 report.

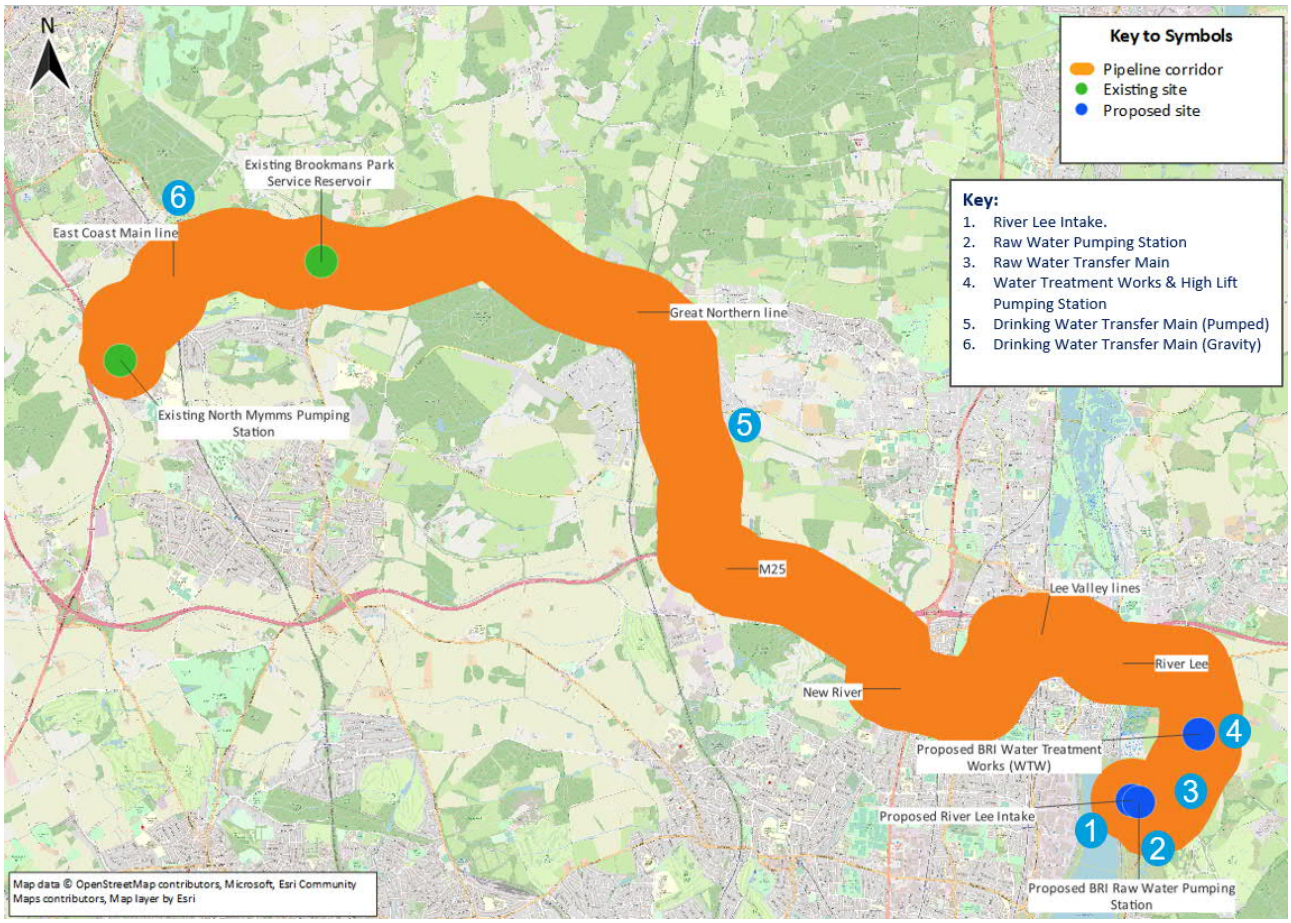
1.9. Readers are asked to bear the following points in mind:

- The working solutions are not fixed and final solutions, they are used for the purposes of modelling and assessing the scheme for the RAPID gated process; there are alternatives to the selected corridors and sites which are available to be consulted upon at a later stage in the project life.
- Consultation with stakeholders will be key to finalising the sites and pipeline routes.
- The working solutions are not the detailed design; there are still numerous studies that will have to be undertaken prior to finalising design decisions if the T2AT scheme is to be implemented.
- The concept design report applies to the T2AT BRI option on its own; the transfer scheme will require enabling infrastructure to be built both upstream and downstream to create a complete system.

1.2 Scheme overview and location

1.10. An overall view of the scheme location is provided in Figure 1.1.

Figure 1.1 BRI option location map



1.11. Raw water for the T2AT BRI option will be abstracted from the River Lee flood relief channel. As the natural flow in the river is insufficient, the operation of this concept design is assumed to be dependent on recycled water being fed into the river from the Beckton Water Recycling option of the London Effluent Reuse SRO. Implementation of this option is therefore a pre-requisite for the BRI, hence the name of this T2AT option. An alternative raw water source discussed further in section 2.3.1, is the Teddington DRA option of the London Effluent Reuse SRO.

1.12. The Beckton Water Recycling option of the London Effluent Reuse SRO entails the construction of an advanced water recycling plant (AWRP) at Thames Water's Beckton Sewage Treatment Plant. The recycled water will be conveyed via tunnel to the existing Lockwood pumping station site, with a second tunnel from the Lockwood site to pump the recycled water to discharge into the river Lee upstream of the King George V reservoir abstraction point (KGV river Lee intake). The second tunnel could also be utilised to convey flow currently received at the Lockwood PS site from the Thames Lee tunnel to the KGV river Lee intake. The gate one submission for the London Effluent Reuse SRO is here.

1.13. At the River Lee flood relief channel intake, the concept design proposes a passive wedge wire screen located in the riverbed. The necessary equipment for backflushing or "airburst" will be housed away from the riverbank to ensure that there is minimal visual intrusion at the intake site. However it is anticipated that, as a minimum, an access track and kiosk for monitoring will be required on the riverbank. The passive screens and connecting pipework will be configured such that half of the screens can be taken out of service for maintenance when required.

1.14. Water will flow by gravity within buried pipes to a new raw water pumping station (BRI-RWPS) set back from the riverbank.

1.15. The raw water will be conveyed in a new buried transfer main (BRI-RWTM) to a new water treatment works (BRI-WTW). Drinking water produced by the WTW will pass through a storage tank before entering a high-lift pumping station (BRI-HLPS), from where it will be conveyed via a buried drinking water transfer main (BRI-DWTM) to an existing service reservoir (SR) in the vicinity of Brookmans Park.

1.16. A proportion of the water will then be able to flow under gravity to the existing booster pumping station in the vicinity of North Mymms.

1.17. There are several major crossings along the route of the drinking water pipelines including the M25 motorway, four railway lines and three major watercourses within the Lee Valley. However, the main technical challenge to constructing the selected pipeline route is that it passes through the dense urban area of Enfield.

1.18. The main delivery point for the BRI option is an existing SR in the vicinity of Brookmans Park, which is a distribution hub within the Affinity Water network. Modifications to the network downstream from the reservoir, which will be required to distribute the additional water to customers, are currently being determined by Affinity Water and form part of their wider water resources planning and investment programme.

1.3 Sizing and phasing

1.19. Two alternative capacities have been considered for the BRI option which are sized to provide an increase of 50Ml/d and 100Ml/d respectively of average deployable output (ADO) to Affinity Water.

1.20. For the 50Ml/d alternative it is assumed that the different components of the scheme would be built to come on stream at the same time. For the 100Ml/d alternative it is assumed that while the pipelines and major civil structures would be constructed to accommodate the ultimate capacity, investment would be delayed wherever possible on the process units and mechanical plant, half of which would be built in a second phase.

1.4 Links with other options, schemes and elements

1.21. As mentioned in paragraph 1.11 above, the BRI option is dependent on additional

water resource being made available for abstraction from the River Lee by the Beckton Water Recycling option of the London Reuse SRO.

1.22. Arrangements for sharing the additional water resource and available strategic storage volume, as well as the contribution towards investment in them, are the subject of negotiation between the Water Companies and Ofwat.

1.23. The anticipated earliest possible completion date for the Beckton Water Recycling option would be 2031[1]; further details can be found in Technical Supporting Document F, the Project Delivery Plan.

1.24. The BRI option will deliver additional drinking water into the existing SR in the vicinity of Brookmans Park. The BRI option will make use of existing SR capacity. However, a risk has been included in the risk register should modifications to the network downstream from the SR, currently being determined by Affinity Water, impact predicted demand and contingency arrangements.

1.25. To distribute the additional water to customers, enhancements to the existing network downstream from Brookmans Park will be required. The nature and timing of these enhancements may be dependent on the implementation of other schemes. Affinity Water is undertaking a long-term planning exercise (Connect 2050) to determine their bulk water transfer needs (within and between Affinity Water supply zones). Investments required to implement these strategies over the next AMP period (AMP8) will be included in Affinity Water's Water Resources Management Plan for the 2024 period review (WRMP24).

1.26. The BRI option is compatible with the water resources management concept proposed by Chalk Streams First initiative. The organisation highlights that reductions in groundwater abstractions will allow the aquifers to recharge allowing flows to recover, T2AT in combination with the London Reuse SRO help to facilitate this. A proportion of the flow increase in chalk streams surrounding London, will be available for abstraction as a water supply resource further downstream i.e. the River Lee. Affinity Water are currently determining what that proportion would be under different scenarios. While it may provide a resource for some towns and villages currently served by groundwater abstraction, it would not be sufficient on its own to reliably meet the full requirements of T2AT, especially under drought conditions, hence T2AT's reliance on either the Beckton Water Recycling or Teddington DRA option of the London Reuse SRO.

[1] Gate 1 Submission for: London Effluent Reuse SRO – July 2021

2. Conceptual Design

2.1 Design principles

2.1.1 Scheme requirements

2.1. In order to cover the range of new resources that are envisaged to be required by AFW, two capacities for the T2AT scheme have been developed, a 50Ml/d and a 100Ml/d of ADO variant. The ongoing water resources modelling and assessment that feed into the WRSE regional modelling shall determine which of these two variants is required; further details of this analysis are in Section 4

2.2. Potential sources of water for the scheme are the Beckton Water Recycling option or the Teddington DRA option of the London Effluent Reuse SRO. The process of selecting the BRI option for development out of a long list of 33 potential options is described in the Technical Supporting Document A4; the Options Appraisal Methodology Report. The majority of that process took place prior to Gate 1.

2.3. It is a requirement that the scheme will assure the supply of water to customers during drought conditions of a severity which is only expected once in 500 years. Further details of how this has been analysed are provided in Chapter 4.

2.4. The BRI option will abstract water from the River Lee flood relief channel, downstream of the outfall from the proposed Beckton Water Recycling option. The proposed concept design should not interfere with the current ability of Thames Water to obtain part of its supply from King George V (KGV) or any other downstream reservoir.

2.5. Water abstracted from the River Lee flood relief channel needs to be treated to Affinity Water's drinking water quality standards without undue risk of failure or undue risk of generating customer complaints.

2.6. The scheme should be designed such that its implementation, commissioning and operation does not cause a breach of any regulatory requirements or otherwise cause an unacceptable impact to the environment or affected communities. In fact, where practical, the design should identify areas where the scheme could create positive impacts on the environment (for instance improving the setting of a listed building) and benefits to the community beyond the basic objective of assuring the supply of safe drinking water to the public.

2.7. The design of the scheme should take into account the need to optimise the use of natural resources and energy, and to minimise greenhouse gas emissions, both in its implementation and operational phases.

2.1.2 Anticipated operational regime and utilisation

2.8. To meet the required alternative capacities of 50Ml/d and 100Ml/d of ADO to Affinity Water, a higher volume of raw water abstraction capacity needs to be provided to

account for losses in the system.

2.9. An allowance for operational losses in the WTW process of 5% (of the required increase in ADO) has been allowed.

2.10. As explained in Chapter 4, in order to provide an increase in ADO of 50Ml/d or 100Ml/d, the maximum drinking water output capacity of the scheme has to be approximately 10% higher.

2.11. The concept design is therefore based on the capacities shown in Table 2.1 below.

Table 2.1 Raw and drinking water capacities

Required increase in ADO	Drinking water output required	Raw water capacity required
50	55	57.5
100	110	115

2.12. As described in Chapter 4, it is not expected that the scheme will be used at 100% capacity for all of the time. If the T2AT scheme is modelled as the last source to be utilised, then there are significant periods during which the scheme is not called on at all. However, the nature of water treatment processes is that it takes a significant amount of time and cost to recommission a WTW from a complete standstill. Therefore, the scheme will always be operated at a minimum throughput of 25% of its full capacity. For the 100 Ml/d alternative this gives the utilisation frequency profile shown by the blue line in Figure 2.1 below.

Figure 2.1 Utilisation frequency profile for the 100Ml/d ADO alternative

2.13. For the purposes of calculating Opex for the T2AT scheme, the profile has been simplified as shown by the green line in Figure 2.1. The simplified utilisation profile for each alternative is shown in tabular form in Table 2.2.

Table 2.2 Simplified utilisation profile for 50Ml/d ADO and 100Ml/d ADO alternatives

Utilisation (% of Capacity)	Proportion of time spent at utilisation (% of time)	Raw water flow for 50Ml/d ADO alternative (Ml/d)	Raw water flow for 100Ml/d ADO alternative (Ml/d)
0%	0%	0	0
25%	60%	14.4	28.8
40%	15%	23	46
70%	20%	40.3	80.5
100%	5%	57.5	115

2.14. Note that the average utilisation is 40% for both alternatives, giving a long-term average raw water flow of 23Ml/d for the 50Ml/d ADO alternative and 46Ml/d for the 100Ml/d ADO alternative.

2.15. In practice, once the scheme is in place, it is likely that the operators will find that there is a cost-efficiency to be gained by sharing the demand for water between the existing facilities and the new scheme. For this reason the concept design has optimised pipe diameters for the scheme running at 100% capacity. There is some scope to refine this through further study of how the scheme might actually be used in the future, once there is an understanding of the cost of recycled water obtained from the Beckton Water Recycling option of the London Reuse SRO.

2.1.3 Applicable national and water company standards

2.16. The scheme will be designed to comply with applicable national standards and good practice guidelines. The main categories of standard are outlined in this section.

2.17. The engineering work will be designed in accordance with the most recent British Standards, many of which are still aligned with European Standards.

2.18. The design will follow regulations and guidance produced by national regulators, such as the Environment Agency, the Drinking Water Inspectorate and Natural England. This includes statutory regulations, such as the Water Supply (Water Quality) Regulations as well as best practice guidance on how to comply with regulations, such as the Environment Agency document; Screening at intakes and outfalls: measures to protect eel.

2.19. The water industry in the UK has developed specifications that have been agreed across water companies. These include the Civil Engineering Specification for the Water Industry (CESWI) and the Water Industry Mechanical and Electrical Specification (WIMES). Each Water Company has generated their own amendments to these documents. In the case of T2AT, it is the Affinity Water amendments that

will be applicable.

2.20. Affinity Water have also developed their own suite of detailed standard specifications and design standards to supplement CESWI and WIMES. For some items a suitable standard specification was not available from Affinity Water. In these cases Thames Water standard specifications have been used for guidance.

2.1.4 ACWG and other SRO specific guidance

2.21. The ACWG has set high-level design objectives for the SRO projects[2]. These objectives have been derived from the National Infrastructure Commission's (NIC) Design Principles structure, which considers design under four headings: Climate, People, Places and Value. They have been arrived at through discussion, policy review and precedent study to represent best practice for the SRO projects.

2.22. The design objectives fall under the following categories:

- Cross Cutting Design Principles; including health and safety in design
- Climate; mitigate greenhouse gas emissions and adapt to climate change
- People; reflect what society wants and share benefits widely
- Place; provide a sense of identity and improve our environment
- Value; achieve multiple benefits and solve problems well

2.23. The guidance outlines nine steps in an iterative process towards completing the project design:

1. understand the nature, objectives, requirements and components of the project
2. understand the places that the project will affect
3. understand the people that will be affected by the project
4. identify the opportunities arising from the project
5. identify the key considerations arising from steps 1 to 4, constraints and opportunities
6. develop the project design vision and principles
7. embed the vision and the design principles into the host organisation
8. design to maximise benefits and minimise adverse effects
9. capture important design decisions

2.24. These iterations take place across the following design stages:

A. site/corridor optioneering
B. identification of the preferred site/corridor

[2] Design Principles, Process and Gate 2 Interim Guidance – ACWG - December 2021

C. concept design and options testing

D. design development to Development Consent Order (DCO)/planning application

E. design development post-planning

F. technical design for construction

G. management plans, maintenance, specifications etc.

2.25. During Gate 2 development, the multidisciplinary project team (including environmental, planning and engineering specialists) held workshops framed around the design principles to develop the concept design.

2.26. In accordance with the ACWG guidance, the Gate 2 option development has focussed on steps 2 to 6 of the iterative process and, also in line with the guidance note, has passed through design maturity stages A and B and is presented at Gate 2 while it is within stage C.

2.27. The scheme is likely to be progressed as a DCO under the Planning Act 2008 (PA2008) rather than via a conventional planning application under the Town and Country Planning Act 1990 (TCPA1990). The planning strategy is described in Technical Support Document G; Planning, consenting and land acquisition strategy.

2.1.5 Risk Management

2.28. As at Gate 1, we have continued to consider risk across the project. We have a qualitative risk register, which is used to record, track and manage pre-construction phase risks, mostly associated with consenting and delivery programme. This risk register informs the quarterly reporting to RAPID. We have also developed a Quantitative Costed Risk Assessment (QCRA), which has been used to help derive estimates of construction phase financial risks for Gate 2. Finally we have the Water Quality Risk Assessment (WQRA) which has been compiled using the All Companies Working Group (ACWG) approved spreadsheet tool. Both the WQRA and QCRA were reviewed via workshops.

2.29. Details of the qualitative risk register are provided in Supporting Document 1 - RAPID Gate 2 Report, whilst details of the WQRA are provided in Supporting Technical Document Ca: Drinking Water Risk Assessment, with details of the QCRA being provided in Supporting Technical Document A2a: Cost Report. To ensure a degree of consistency across the different SROs, the ACWG has provided guidance and a spreadsheet template for capturing the Quantitative Costed Risk Assessment (QCRA) and calculating Optimism Bias (OB)[3].

2.30. Throughout the WQRA process, the list of limiting hazards for each option has been reviewed and refined to give a representative, high-level view of the parameters which are likely to need treatment at this early stage of design. The WQRA process has also identified data gaps and residual risk considerations that can now be addressed moving forward into the next phase of works, and through to the

[3] ACWG (2021), Appendix A-1 - Optimism Bias and QCRA Template - Rev C.xlsx

development of a Drinking Water Safety Plan (DWSP) for any option to be progressed to scheme promotion.

2.31. In order to further develop our risk understanding, a number of Gate 3 activities have been identified, the proposed work breakdown is detailed in Supporting Document F: Project Delivery Plan. The Supporting Document F: Project Delivery Plan focuses on the key aspects of the risk registers, discussing the highest priority risks and what activity is being undertaken to mitigate the major cost and programme risks during future phases of the project.

2.32. Below are examples of the future activities, which would likely be used to inform future risk assessments;

- Environmental and engineering site surveys, including:
  - Walkover surveys
  - Ground investigations
  - Groundwater and surface water monitoring
  - Asset location and condition surveys
  - Geophysical survey and planning archaeological evaluation surveys
  - Ecological, biodiversity and arboriculture surveys
  - Further raw water quality sampling
- Topographical survey, especially of watercourses and river structures
- Initial non-statutory consultations and liaison with affected stakeholders
- Further early contractor engagement
- Further modelling of need and alternatives, as required, using WRSE regional system simulator and investment model, to reflect commentary from public consultations on WRSE and WRMP strategic plans.

2.2 Scheme components and operating philosophy

2.2.1 Intake site selection

2.33. The indicative location for the new intake, which has been adopted as the working solution for Gate 2 development, is on the east bank of the River Lee flood relief channel to the east of KGV reservoir, downstream of the outfall from the proposed Beckton Water Recycling option. This location was identified through a thorough review of two potential sites along the reach of river identified at Gate 1 and was found to be the best match to the technical, environmental, community and planning criteria considered. The identification and review process is described in Technical Supporting Document A5, the Options Refinement Report.

2.2.2 Raw water pumping station site selection

2.34. The indicative location for the new RWPS, which has been adopted as the working solution for Gate 2 development, is to the east of KGV reservoir, approximately 150m from the intake. This location was identified through a thorough review of two potential sites and was found to be the best match to the technical, environmental, community and planning criteria considered. In particular, the indicative location is less constrained and is located further away from potential contamination, as well as being preferable from an environmental perspective. The identification and review process is described in Technical Supporting Document A5, the Options Refinement Report.

2.35. The site is of sufficient size to accommodate pumps within a shaft, surge vessels, the necessary equipment for backflushing or "airbursting" the intake screens, and supporting buildings and infrastructure, including power supply and sustainable surface water drainage.

2.2.3 Intake design

2.36. There are no specific process requirements for the intake other than to prevent items of floating or suspended detritus from entering the plant and to minimise, as far as is reasonably practical, the intake of suspended sediment. Apart from preventing material from being drawn in which may affect the treatment process, screening is required at the intake to prevent damage to fish stocks and other wildlife.

2.37. It is envisaged that the visual impact of the intake plant will need to be minimised, a visually intrusive solution would not be acceptable to the local community or to the planning authority. Therefore, any additional structures associated with the intake should be sympathetic to, and in scale with, the wider river corridor landscape.

2.38. The indicative site is of sufficient size to accommodate an access track with turning head and a water monitoring kiosk on the riverbank. The passive screen shall be fully submerged and is designed to meet regulatory requirements for both entrainment and impingement of juvenile fish. They are periodically flushed by sending a combination of reverse flow and air back through the screen. The visual intrusion is low and the building containing the plant which serves the screen can be built some way back from the riverbank. One drawback of this type of intake is that a minimum depth of water must be maintained above the screen to prevent vortex formation and air entrainment. Most passive wedge wire screens are cylindrical in shape and positioned clear of the riverbed, however half-cylinder versions are positioned on the riverbed.

2.2.4 Design of connection and raw water pumping station

2.39. The concept design proposes that a new shaft is sunk at the elevated RWPS site; a tunnel would then be driven to connect this shaft to a tunnel boring machine (TBM) reception pit on east bank of the River Lee flood relief channel. The shaft depth is expected to be approximately 9m below ground level at the RWPS.

2.40. The KGV reservoir is potentially within the zone of influence for ground movement arising from the pipeline and intake construction. Design will need to ensure that anticipated ground movement is well within the allowable limits, and a suitable monitoring programme to detect actual movement against pre-agreed trigger levels will need to be agreed well in advance with Thames Water.

2.41. The method of construction of the cross-connecting tunnel will depend on the ground conditions identified during the geotechnical investigation.

2.42. The new shaft at the RWPS site will contain the low lift pumps, installed at a sufficiently low level that there will always be a positive pressure on the suction side of the pumps.

2.43. For the 50Ml/d ADO alternative, the raw water delivery to the WTW will be achieved by installing four (three duty plus one standby) pumps. For the 100Ml/d ADO alternative, the required flow rate will be achieved by installing six (five duty or assist, plus one standby) pumps.

2.44. Surge vessels will be needed to ensure that transient pressures in the raw water pumping main remain within acceptable limits. It is proposed to install four (three duty plus one standby) vessels for the first alternative, or for the first phase of the larger alternative, and to add a further vessel in the second phase of the larger alternative.

2.2.5 Raw water pumped transfer main

2.45. The raw water will be conveyed along a 1.7km long buried pipeline to the new WTW. For the 50Ml/d ADO alternative, the concept design is based on a DN900 ductile iron pipeline, for the 100Ml/d ADO alternative a DN1200 ductile iron pipeline is proposed.

2.46. As mentioned in Section 2.1.2, there is scope for optimising the pipeline diameter once the utilisation of the scheme, in conjunction with other drinking water sources, is better understood. Selection of the most appropriate pipe material will need to be left as late as possible in the procurement process as the relative price and embedded carbon emissions of ductile iron, steel and other materials is volatile.

2.47. It is expected that the raw water transfer main will be laid entirely in open-cut trench.

2.2.6 WTW site selection

2.48. The indicative location in Sewardstone for the new WTW, which has been adopted as the working solution for Gate 2 development, was identified through a thorough review of several potential sites and was found to be the best match to the technical, environmental, community and planning criteria considered. The indicative site is an existing brownfield site, thus reducing the impact of constructing within the greenbelt. It also benefits from lower-risk ground conditions and a shorter raw water pipeline than other options. The identification and review process is described in Technical Supporting Document A5, the Options Refinement Report.

2.49. The site is of sufficient size to accommodate the necessary treatment units and supporting buildings and infrastructure, including power supply, chemical storage and sustainable surface water drainage. There is also space for the necessary sludge treatment and storage, six hours of drinking water storage and the high lift pumping station.

2.50. The closest adequately sized watercourse to the site is the River Lee. It is considered that it will be possible to negotiate a consent for emergency discharges into this watercourse provided that adequate provision is made to guarantee that;

- discharges will be treated to a suitable standard as agreed with the regulatory authority and
- discharge flow will be less than the agreed maximum rate, so as not to cause any adverse impacts to the receiving water body.

2.2.7 Pipeline corridor selection

2.51. The Gate 2 working solution for the drinking water transfer main corridor is shown in Figure 1.1. The pipeline corridor will be routed alongside of the M25, crossing the M25 in the vicinity of Cuffley. The corridor then passes around Cuffley before heading northwest, north of Northaw Great Wood crossing the Great Northern line railway to the existing SR. From the SR the corridor passes through open countryside crossing the East Coast main line railway to the existing booster pumping station in the vicinity of North Mymms.

2.52. There are several major crossings along the route of the drinking water pipelines including the M25 motorway, four railway lines and three major watercourses within the Lee Valley. However, the main technical challenge to constructing the selected pipeline route is that it passes through the dense urban area of Enfield.

2.53. The working solution corridor was determined through a process of identifying a series of small segments and assessing them against a schedule of technical, environmental, community and planning criteria. The selected chain of segments which constitutes the working solution at Gate 2 is the corridor which best matches the criteria across all disciplines.

2.54. The main challenge for selecting the pipeline corridor was identifying the best place to cross the Lee Valley railway lines and Hackney Downs & Cheshunt railway line. In practice there is only one viable alternative for each railway line, within a reasonable search radius of the shortest direct route. Other alternatives would involve considerably more disruption to the public.

2.55. The identification process is described in Technical Supporting Document A5, the Options Refinement Report. The final choice of pipeline corridor for the option will be subject to further appraisal, environmental survey and consultation. The working solution documented within this CDR is not a fixed and final solution, as noted in paragraph 1.9 above.

2.2.8 Drinking water quality and process design

2.56. The proposed process for the WTW has been determined through a review of the risks associated with the key water quality parameters associated with the raw water source, the downstream distribution network, and ultimately the product delivered to customers. Essentially, the approach, which has been outlined by the ACWG, identifies the "Limiting hazards" and then determines the most appropriate means of reducing that hazard to below the level required by Affinity and Thames Water's standards.

2.57. The drinking water risk assessment process is described fully in Technical Support Document Cb; Drinking Water Risk Assessment Report - Beckton Reuse Indirect Option.

2.58. Further raw water quality monitoring is being undertaken in the River Lee flood relief channel just upstream of the proposed abstraction location, to increase the confidence in the available data set upon which the risk assessment is based.

2.59. UV treatment in conjunction with a conventional water treatment process is proposed. The process consists of clarification, rapid gravity filtration (RGF), ozone conditioning, granular activated carbon (GAC) filtration, ultraviolet (UV) and chlorination to provide residual disinfection as shown in Table 2.3. Inactivation of cryptosporidium has been considered in the BRI treatment design as a direct surface water abstraction to WTW will not provide an opportunity for attenuation of cryptosporidium before treatment; UV treatment shall provide the cryptosporidium removal.

Table 2.3 Proposed treatment processes

Process	Details
Pre-ozonation	For treatment of pesticides, to control the formation of trihalomethanes and to control taste and odour. Additionally, to aid in downstream coagulation.
Clarification	Consisting of coagulation, flocculation, and settlement. This process helps to remove colloidal material from water and reduce its turbidity, reducing the number of microorganisms and other organic matter passing to downstream treatment processes.
RGF	For removal of residual floc and residual turbidity,
Ozonation	For treatment of pesticides, to control the formation of trihalomethanes and to control taste and odour. Additionally, to aid effectiveness of downstream GAC filters.
GAC	For the removal of pesticides, taste and odour forming components and colour.
Disinfection	Via UV and chlorination for pathogen kill.

2.60. Clarifier sludge, as well as RGF and GAC dirty backwash water, will go into a wastewater system, which will consist of a wastewater holding tank, sludge

thickening and sludge centrifuge.

2.61. Supernatant from the wastewater system will be recycled through to the head of the works. The supernatant will be internally recycled at up to 10% of the works flow. If for any reason there is a raw water quality event that causes it to be high risk, and it has not been possible to obtain an emergency discharge consent to the local watercourse, then an arrangement will need to be made with Thames Water to discharge it to a sewer as trade effluent.

2.62. It is anticipated that the sludge cake will be taken off site by road, to a licenced waste disposal facility.

2.2.9 Civil design of BRI-WTW and BRI-HLPS

2.63. The main civil structures which will be required for the WTW are as follows:

- clarifiers
- RGF including clean washwater holding tanks
- interstage pumping station
- ozonation chamber
- GAC filters including clean washwater holding tanks
- UV reactor
- chlorine contact tank
- treated water storage tanks
- high lift pumping station building
- sludge and dirty washwater holding tanks
- sludge thickeners
- thickened sludge holding tank
- sludge dewatering building
- sludge cake storage and sludge truck loading facility
- supernatant holding tank and supernatant return pumping station
- chemical storage and dosing building (including sodium hypochlorite for chlorination)
- ozone generator including liquid oxygen storage
- step-down transformer and ring main unit bases and compounds.
- administration and control building
- site pipework
- service water and wash-down ring main

- electrical duct network
- surface water drainage including detention lagoon
- chemical interceptor tanks
- foul drainage
- emergency overflow and discharge pipework including attenuation storage (if required) and conditioning facility
- site access roads, car park, paths and security fencing
- hard and soft landscaping

2.64. The ACWG guidance on design requires a high quality of design for the WTW structures. If the indicative site is selected, then it is expected that the architectural treatment of the plant will be of particular interest to nearby residents. A high quality of architectural finish does not necessarily mean a large increase in cost, but value for money will need to be demonstrated by Affinity Water, especially where there are no sensitive receptors to visual impact.

2.2.10 Mechanical, Electrical, Instrumentation, Control and Automation (MEICA) design of BRI-WTW and BRI-HLPS

2.65. The main MEICA elements of the WTW are as follows:

- ozone generator
- pre-ozone static mixer
- clarifier mixers and scrapers
- RGF / GAC air scour blowers
- RGF backwash pumps
- interstage pumps with variable speed drives (for 50Ml/d ADO 2 duty +1 standby, for 100Ml/d ADO 4 duty + 1 standby)
- GAC backwash pumps
- UV reactor
- high lift pumps with variable speed drives (for 50Ml/d ADO 2 duty +1 standby, for 100Ml/d ADO 4 duty + 1 standby) and electric overhead travelling crane
- surge vessels and associated compressors (for 50Ml/d ADO 2 duty +1 standby, for 100Ml/d ADO 3 duty + 1 standby)
- sludge processing equipment including pumps, sludge thickeners, scrapers, centrifuges and sludge handling
- chemical storage, fill point, preparation and dosing plant. In particular:
  - Ozone generation equipment including liquid oxygen storage, ozone generators, vaporisers, refrigeration, dosing pumps and destructors.

- motorised valves for isolation and modulating flow, and other process control devices
- incoming Distribution Network Operator (DNO) supply switchgear and metering – twin feeds 1 duty + 1 standby
- Motor Control Centre (MCC) feeding high lift pumps via variable speed drive units
- Ring main feeding three ring main units (RMUs) each equipped with a step down transformer feeding the following MCCs:
  - RMU1
    - sludge treatment centre
  - RMU2
    - clarifiers
    - RGF
    - ozone generator
  - RMU3
    - interstage pumps / GAC
    - high lift pumping station ancillary equipment
- heating, ventilation and air conditioning
- internal and external building services and lighting
- supervisory control and data acquisition (SCADA) system communicating with distributed control in each MCC
- plant instrumentation including water quality, level and flow monitoring
- communication, telemetry and security systems

2.66. The Gate 2 concept design proposes dual electrical power feeds in lieu of a single feed with on-site standby generation. This avoids the operating costs and security risks associated with maintaining the generator units, purchasing and storing fuel, and managing unused, aging fuel. On the downside it means that Thames and Affinity Water cannot take advantage of the commercial benefits of on-site standby generators such as triad avoidance and spinning reserve.

2.67. Initial enquiries are being made with UK Power Networks, the DNO for the Sewardstone area, to establish the extent of network reinforcement that will be required to provide the dual supplies proposed.

2.68. The duty point of the high lift pumps proposed in the concept design requires 630kW motors. These are supplied at 11kV as would normally be the case for motors of this rating. However, Affinity Water prefer equipment to be supplied at 400V which does not require the attendance of HV qualified technicians. It would be possible to specify that the motors are designed to operate on 400V, or a larger number of smaller pumps could be provided, but there would be an associated capital cost

penalty.

2.2.11 Drinking water transfer main

2.69. The drinking water produced by the WTW will be conveyed along a 19km long buried pumped pipeline to the existing SR in the vicinity of Brookmans Park, then along a 4km long buried gravity pipeline to an existing booster pumping station in the vicinity of North Mymms. The pipeline corridor is described in Section 2.2.7. For the 50Ml/d ADO alternative, the concept design for the pumped transfer main is based on a DN800 cement lined ductile iron (DICL) pipeline; for the 100Ml/d ADO alternative a DN1100 DICL pipeline is proposed. The gravity pipeline from the existing SR to the existing PS is based on a DN800 DICL pipeline for both alternatives.

2.70. It is expected that the drinking water transfer main will be laid primarily in open-cut trench, micro tunnelling would likely be utilised at some of the more significant crossings.

2.71. As with the raw water pipeline there is scope for optimising the pipeline diameter once the strategy for use of the scheme in conjunction with other drinking water sources is further developed. Similarly, selection of the most appropriate pipe material will need to be left as late as possible in the procurement process as the relative price of ductile iron, steel and other materials is volatile.

2.72. The transfer main will generally be buried with a minimum depth of cover of approximately 900mm in open land and 1200mm under roads and trafficked areas. Once the ground has been reinstated, buried pipelines are generally non-intrusive with few visual clues to their whereabouts. The most significant permanent visual impact is where the corridor passes through a wooded area or line of trees where it is normal to leave a grass swathe, as it is not acceptable practice to reinstate trees close to the pipe as their roots may cause pipeline damage and may also pose an overhead hazard during emergency works. For this reason, the working solution pipe corridor avoids such areas as far as possible.

2.73. Isolation valves will be provided at regular intervals along the route. A drain valve and chamber, or flushing point with hydrant, will be provided at each low point on the pipeline and an air valve including chamber will be provided at each high point.

2.2.12 Modifications at Brookmans Park service reservoir

2.74. An initial assessment of the capacity of the existing SR in the vicinity of Brookmans Park, using existing demand and estimated growth, has identified spare contingency storage. The intention is to utilise this for the BRI option.

2.75. The contingency storage volume required at the SR is linked to downstream demand. Affinity Water are investigating how best to configure changes to the distribution network that is fed from the SR via the Connect 2050 programme. This reconfiguration will require further consideration during future project stages to ensure that T2AT demand is fully understood, and further, how the utilisation of

T2AT will interact with the utilisation of other sources.

2.76. The configuration of the exiting inlet and outlet at SR has been assessed and a new connection arrangement proposed. The final arrangement will need to be confirmed via modelling when flow rates are finalised, including an assessment of the possible impact on the existing system.

2.2.13 Control summary

2.77. The source of water for the BRI-WTW will be the River Lee flood relief channel, supported by recycled water from the Beckton Water Recycling option of the London Effluent Reuse SRO feeding into the river upstream of the abstraction point.

2.78. The concept design is based on an intake in the River Lee flood relief channel, consisting of two passive wedge wire screens for the 100Ml/d option and a single screen for the 50Ml/d option, each screen can abstract 57.5 Ml/d. When debris in the water is high, air burst cleaning of each screen will be automatically triggered by high head loss through the screen or by manual operator-controlled operation. During this operation the half of the screen being cleaned will be taken out of service and the raw water flow will be drawn through the other half and other screen (where applicable).

2.79. From each screen, a dedicated gravity pipeline will deliver water to the wet well of the BRI Raw Water Pumping Station (BRI-RWPS). Variable speed pumps within the BRI-RWPS will pump flows at a controlled rate to the BRI Water Treatment Works (BRI-WTW).

2.80. The required flow set point shall be automatically derived from the level in the service reservoir. It may also be set manually by the WTW operator or from the Affinity Water control centre.

2.81. The number and speed of the raw water pumps will vary automatically to control the delivery flow, as monitored on a local flowmeter, to match the required flow set point (derived from the SR level).

2.82. The flow set point will be automatically adjusted by unusually high or low levels in the treated water storage tank at the WTW. When these levels are reached, they will over-ride the flow control as set either manually or automatically from the service reservoir level. A broad “dead band” range of the level in the treated water storage tank is necessary to accommodate normal variations for filter backwash and to avoid conflict with the high lift pump’s control. High-High levels or overflows in the treated water storage tank or certain other free surfaces in the WTW will initiate a controlled shutdown of the raw water pumps and inhibit restart until the operator intervenes.

2.83. The number of pumps running and the speed of the high lift pumps at the BRI-HLPS will be adjusted automatically to maintain the level in the treated water storage tank. The number of pumps running and the speed of the high lift pumps will be adjusted incrementally when the water level in the treated water storage tank rises or falls relative to a target level.

2.84. A controlled shutdown of the high lift pumps will be initiated if a High-High level, overflow or loss of signal occurs at the SR. Should the reduced flow or shutdown condition persist then the water level in the treated water storage tank will rise, the raw water pumped flow will decrease and this will ultimately lead to a WTW shutdown.

2.85. If there is a requirement to bypass the SR and feed the downstream network directly, effectively "booster" pumping, then the high lift pumps will need to be run to a fixed, pre-determined discharge pressure to simulate the normal water level of the SR. This requires a pressure sensing device to be installed to monitor the pressure and transmit this to the PLC controlling the high lift pumps. The speed of the pumps will then be controlled to achieve that pressure.

2.86. The control of flow into the SR and the downstream network will need to be integrated with existing control systems.

2.87. At this stage in the development of the SROs it is envisaged that the BRI option, via the River Lee, will always require a supply of recycled water from the Beckton AWRP plant in order to comply with the abstraction licence. Therefore, the BRI-WTW will need to be in communication with the Beckton AWRP to ensure that sufficient recycled water is supplied to the River Lee, and to ensure that if there is an interruption to supply then the BRI-WTW operator can act accordingly.

2.3 Alternative options and opportunities

2.88. The working solution documented within this CDR is not a fixed and final solution as noted in paragraph 1.9, therefore the options and alternatives presented below are not discounted. We shall continue to develop our thinking and our approach managing scheme risks and if appropriate adjust the concept design during future gateways.

2.3.1 Teddington DRA - an alternative source of treated effluent

2.89. An alternative source of treated effluent for the River Lee, and therefore the BRI-option, is recycled water from the Teddington DRA option of the London Reuse SRO. As with the Beckton Water Recycling option, the Teddington DRA option would discharge into the River Lee upstream of the proposed River Lee flood relief channel intake for the BRI option.

2.90. The Teddington DRA option of the London Reuse SRO proposal involves discharging treated effluent from a new Tertiary Treatment Plant (TTP) at Thames Water's Mogden Sewage Treatment Works (STW) into the River Thames, just upstream of Teddington weir. Then, the same quantity of water will be abstracted from the River Thames immediately upstream of the discharge location and pumped into a shaft connecting into the Thames to Lee Tunnel (TLT), for transfer to the Lee Valley reservoirs in East London. An extension of the TLT from the Lockwood shaft to discharge into the River Lee, north of the KGV reservoir is required as per the Beckton Water Recycling option.

2.3.2 Alternative locations for BRI-WTW

2.91. During the process of option refinement, several possible WTW locations were identified. One possibility was a site adjacent to the intake, just outside the flood plain, currently occupied by a commercial property. This site would have further reduced the risks associated with longer length raw water mains and provided a single site for the RWPS and WTW; however it was discounted as it had greater constraints, including poorer ground conditions and abuts a local wildlife site and nature reserve site. The final selection of the WTW site will need to be made through a process of engagement with the public and other stakeholders.

2.92. Whilst the working solution for the site appears to be the most practical and the one with lowest adverse impact in the light of current knowledge, further information may arise during project development which challenges this conclusion. If the ground is severely contaminated because of its industrial history, then this would make the site less feasible. Given the site's position on the outskirts of London, within the M25 corridor, affordability could also be a factor driving re-consideration of alternative locations.

2.3.3 Carbon saving opportunities

2.93. Opportunities for reducing the embedded and operational carbon dioxide emissions associated with the T2AT scheme are discussed in detail in Technical Supporting Document A3b: Carbon Strategy - BRI Option.

2.94. The main opportunities for reducing embedded carbon emissions lie in the materials selected for construction, particularly for the pipeline. The main opportunities for reducing operational carbon emissions lie in reducing energy consumption. There is a tension between these two opportunities in selecting the correct pipe diameter and pump size to provide the optimum whole life carbon "cost", which in turn is dependent on how the scheme will be utilised. As stated in paragraphs 2.46 and 2.71, further study will be required to determine the optimum pipeline material and diameter.

3. Scheme delivery

3.1 Overview of construction process

3.1.1 Raw water intake and pumping station construction

3.1. The area where the intake screens will be installed will require a sheet piled cofferdam, or similar, in the river, and excavation for the screen installation. Dewatering pumps will be provided to drain the excavation while the screens are being installed. Where sheet piles are used, once construction / installation is complete, the sheet piles would be removed, and the ground levels reinstated.

3.2. It is likely that the RWPS shaft would be constructed using segmental shaft construction with caisson construction through the water bearing ground and potentially change to underpinning if required in the London Clay. Alternatively temporary sheet piling could be used to construct the shaft using underpinning for the full depth of the shaft.

3.3. The geotechnical desk study suggests that made ground/ alluvium overlying London Clay are likely to be encountered at the RWPS indicative site. Nearby boreholes indicated that London Clay was encountered between approximately 3 and 5m below ground level. Contamination is not considered a significant risk given the historic land use.

3.4. There may be floatation issues which would likely be overcome through a deep mass concrete plug or underpinning of the shaft. It is envisaged that there will be no impact to the KGV reservoir, however geotechnical modelling of the shaft and tunnel design will be required to demonstrate that adjacent ground movement will be within acceptable limits and does not extend to the toe of the reservoir. During construction this will need to be continuously monitored to verify that the ground behaviour is in line with predictions.

3.5. The short connection from the river to the RWPS will be via a horizontal tunnel at approximately 9m depth below ground level from the new shaft. The proposed construction methodology is likely to be trenchless in the form of auger boring or pipe jacking. A reception pit would be required close to the river for reception of the tunnelling machine. Any in-channel works or bank works that may include mobilising sediments or dewatering will need to consider the mobilisation of contaminants already present.

3.6. Installation of the MEICA equipment within the shaft pumping station, including pumps, motors, ventilation and electrical plant, will then be completed.

3.7. Excavation of the shaft will result in approximately 2,000m^3 of arisings. It is not expected that contaminated ground will be found in this area, but a precautionary allowance has been made for a further 2% of natural materials and 10% of made ground to be treated and disposed of as potentially hazardous material.

3.8. The principal areas of difficulty are that the zone of influence of intake and pipeline construction will include the existing adjacent KGV reservoir and the River Lee flood relief channel, the suggested approach to managing these risks is detailed in paragraphs 2.40 and 3.4 above.

3.1.2 BRI WTW and high lift pumping station construction

3.9. Prior to commencement of work on the new BRI WTW, the site will require clearance. On the Indicative site there are several existing commercial buildings to be demolished and there may be historical pockets of contaminated ground that have to be treated and disposed of off-site.

3.10. There is no existing borehole data in close vicinity of the site, the closest being 500m north and west which indicate that superficial River Terrace deposits overlying London Clay are likely to be encountered on the indicative site, with the potential for made ground to be present at unknown thicknesses. Nearby boreholes indicated that London Clay was encountered between approximately 6 and 10m below ground level. Contamination is not considered a significant risk given the historic land use.

3.11. This means that shallow foundations are likely to be appropriate, for all the structures except those in excavations. A void former / compressible fill layer beneath the foundation may be required to mitigate heave. Structures in excavations will likely require raft foundations; a void former / compressible fill layer beneath the pile cap may also be required to mitigate heave.

3.12. Excavation for the WTW will produce an estimated 12,000m^3 of non-hazardous arisings which cannot be re-used for construction or in landscaping. This is in addition to an estimated 300m^3 of hazardous material that will need to be treated and safely disposed of. This is based on assumptions regarding how much of the spoil can be absorbed in landscaping on site and the proportion of excavation that will be contaminated.

3.13. The indicative site incorporates an area of pasture lands to the north of the permanent site which would likely be used temporarily to accommodate welfare facilities for the construction staff, plant and laydown areas for storage of materials.

3.14. It has been assumed that the raw water intake and associated pipeline will be operation to deliver water for the WTW commissioning.

3.1.3 Pipeline construction

3.15. The three elements of pipeline construction which will have the biggest impact on programme are (a) construction within the dense urban area of Enfield, (b) ensuring that the environmental controls and mitigations are implemented correctly and (c) completing the major crossings.

3.16. The short connection from the river to the RWPS will be via a horizontal tunnel at approximately 9m depth below ground level from the new shaft. The proposed construction methodology is likely to be trenchless in the form of auger boring or

pipe jacking. A reception pit would be required close to the river for reception of the tunnelling machine.

3.17. Minor crossings will be carried out in open cut. For roads, this will usually be achieved in two halves with a traffic light system in place for a few days. For minor water courses it is normal to channel the water through a length of pipe and cut the trench underneath.

3.18. There are five significant watercourses which will need to be crossed, including the River Lee, New River Canal and Turkey Brook. The assumed crossing locations for these watercourses ranges from 15m to 35m in length. In these locations the concept design is for the pipe to be twinned to ensure resilience and installed in micro-tunnels bored under the watercourse.

3.19. An alternative to be considered for some of the major water course crossings is pipe bridges. There are several existing bridges next to Turkey Brook so the visual impact would be lessened. However, there are security issues with exposed pipes which may preclude this as an option on T2AT.

3.20. Although they are classified as a major crossings, it has been assumed that the A1000 and A112 will be crossed in open cut. If this is permitted it is likely that significant conditions will be stipulated by the highway authority, such as only being allowed to work and institute traffic control at night. If no form of traffic control is allowed, then the crossing will have to be undertaken by micro-tunnelling.

3.21. The other major road crossing is the M25 motorway. The concept design envisages that for this crossing the pipe to be twinned to ensure resilience and installed in micro-tunnels bored under the highway. A suitable monitoring programme, to provide early warning should unexpected movement occur, will need to be agreed well in advance with National Highways.

3.22. For all railway crossings, the concept design is for the pipe to be twinned to ensure resilience and installed in micro-tunnels bored under the railway and adjacent land owned by Network Rail.

3.2 Delivery programme

3.23. At Gate 2, the expectation is that the earliest possible completion date for the BRI option could be 2034[4]. This on the basis of the WRSE emerging regional plan and with the assumption that further design development would continue immediately after Gate 2.

3.24. Whilst theoretically there may be periods when the transfer scheme could potentially operate without additional resource being available, the scheme needs to be resilient under drought conditions, and this would not be achieved using only existing resource; therefore the Beckton reuse option would need to be delivered in advance

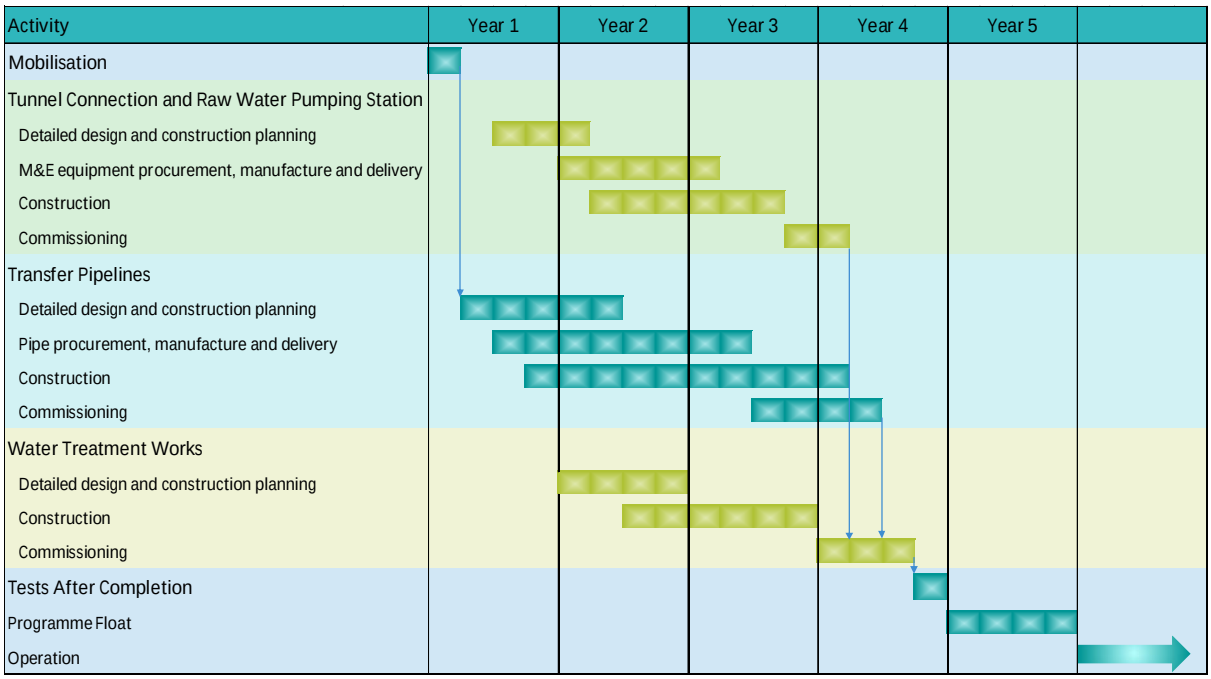
[4] For illustrative purpose only

of T2AT-BRI.

3.25. It is anticipated that the remainder of the RAPID gated process, obtaining a DCO, and establishing a project delivery organisation will take approximately six years. This will be followed by a detailed design, construction and commissioning period of approximately five years, making a minimum of eleven years.

3.26. An indicative programme for detailed design, construction and commissioning of the BRI option is shown in Figure 3.1.

Figure 3.1 Indicative implementation programme



4. Water resources assessment

4.1. As part of the Gate 2 investigations water resources modelling and assessment have been undertaken for T2AT, the outputs of which feed into the WRSE regional modelling and WRMP24 options appraisal processes.

4.2. The water resources modelling and assessment consists of the following main elements:

- Analysis of the infrastructure requirements to deliver the 1 in 500 year dry year ADO.
- Analysis of the long-term utilisation of the transfer scheme, to provide information on the likely operational requirements of the option and the minimum and maximum expected flows.
- Analysis of the conjunctive use benefit of operating the transfer in combination with Thames Water's London supply zone and how the two systems might interact during drought events.

4.3. Further details of this modelling exercise and the associated model set-ups may be found in Technical Supporting Document A1a - Concept Design Report - LTR Option.

5. Future scheme development

5.1 Engineering design development

5.1. Following the Gate 2 submission for the BRI option it is envisaged that if further design development were to continue immediately afterward, construction and commissioning would be complete by 2034[5], based on the WRSE emerging Regional Plan.

5.2. The scope of work and anticipated schedule is described fully in Technical Supporting Document F: Project Delivery Plan.

5.2 Integrated planning

5.3. Further development of the T2AT SRO will require close liaison with the London Reuse SRO to ensure that the water resource management and associated licencing arrangements with the Environment Agency are fully coordinated. Compiling the operational agreement for the BRI option will be complex as it will need to integrate with Thames Water's management strategy for the KGV reservoir, which in turn is integrated with management of water level, flows and water quality in the affected reaches of the river itself.

5.4. Subsidiary to the agreement of resource management and abstraction licences with the Environment Agency, a protocol and pricing structure will need to be established for water sharing between Thames Water and Affinity Water.

5.5. The Connect 2050 strategy being prepared by Affinity Water will both be influenced by the expected implementation of the BRI option and influence the way in which the scheme feeds into the distribution network. It is anticipated that further study will be required to estimate the extent to which the scheme will be utilised when working in parallel with other sources, which will also interact with the Connect 2050 proposals.

5.6. In the shorter term, Affinity Water's WRMP24 programme of work will include enhancements to the network, some of which will need to take into account the additional water made available by the BRI option.

[5] For illustrative purpose only

6. Conclusion

6.1. The BRI option for fulfilling the requirements of the T2AT scheme has been selected for further development by the WRSE regional modelling programme.

6.2. Two alternatives of the option have been developed to provide 50Ml/d or 100Ml/d of ADO to Affinity Water. These require raw water capacity of 57.5Ml/d and 115Ml/d and drinking water capacity of 55Ml/d and 110Ml/d respectively to achieve the required ADO.

6.3. The choice of the BRI option from amongst the other T2AT options has been confirmed through detailed options appraisal.

6.4. A working solution for the BRI option has been identified through a cross-discipline refinement process. The concept design for the BRI option has been developed on the basis of this working solution in order that the costs, challenges and risks associated with implementing the scheme can be better understood. It is recognised that the working solution will change and be further refined in the light of public consultation and additional information as the scheme progresses.

6.5. The main components of the working solution concept design are:

- River Lee flood relief channel intake; A passive screen located in the riverbed of the River Lee flood relief channel.
- BRI-RWPS; A raw water pumping station to lift water from the River Lee and pump it to the BRI-WTW
- BRI-RWTM; An approximately 1.7km long raw water transfer main from BRI-RWPS to BRI-WTW
- BRI-WTW; A new WTW in the Sewardstone area. UV treatment in conjunction with a conventional WTW process is proposed with:
  - Clarifiers
  - Rapid gravity filters
  - Ozone
  - Granulated activated carbon filters
  - UV
  - Chlorine disinfection
  - Drinking water storage
  - Sludge thickeners and dewatering plant
- BRI-HLPS; A high lift pumping station to pump drinking water from BRI-WTW to an existing SR in the vicinity of Brookmans Park

- BRI-DWTM; An approximately 19km transfer main from BRI-WTW to an existing SR, then an approximately 4km long transfer main from the SR to an existing booster pumping station in the vicinity of North Mymms

6.6. The drinking water pipeline will require several major crossings including:

- Three major watercourses, including the River Lee
- The M25 motorway
- The Lee Valley lines, Hackney Downs & Cheshant Line, Great Northern line and East Coast Main line railway

6.7. The main technical challenge to constructing the selected pipeline route is that it passes through the dense urban area of Enfield.

6.8. For the transfer pipes the material selected for the concept design is cement lined ductile iron.

6.9. The selected diameters for the raw water pipeline are DN900 and DN1200 for the two flow alternatives. For the pumped drinking water pipeline the selected diameters are DN800 and DN1100. For the gravity drinking water pipeline the selected diameter is DN800. Further study of how the BRI option is used in combination with other sources will be required to determine whether a whole life cost and carbon saving can be achieved by selecting a smaller diameter.

6.10. Modelling indicates that, if the BRI option is the least preferred source relative to other sources available to Affinity Water, then average utilisation will be about 40%. However it is likely that it will not be the least preferred source under all conditions and so average utilisation will be higher than 40%.

6.11. If the scheme were developed further without a break, then it is estimated that it could be brought on stream by 2034[6] based on WRSE emerging Regional Plan.

6.12. Development of the scheme will need to take place in association with development of the water resource sharing agreement with Thames Water. This in turn will be related to agreements on how the London Reuse SRO is operated and new abstraction agreements from the River Lee.

6.13. On the downstream side of the scheme, network enhancements will be required to distribute the additional drinking water. Over the longer term these are being developed by Affinity Water as part of their Connect 2050 strategy. More immediately, network enhancements that will interact with the BRI option are being proposed under Affinity Water's WRMP24 submission to Ofwat.

[6] For illustrative purposes only

Affinity Water

Taking care of your water

Thames Water