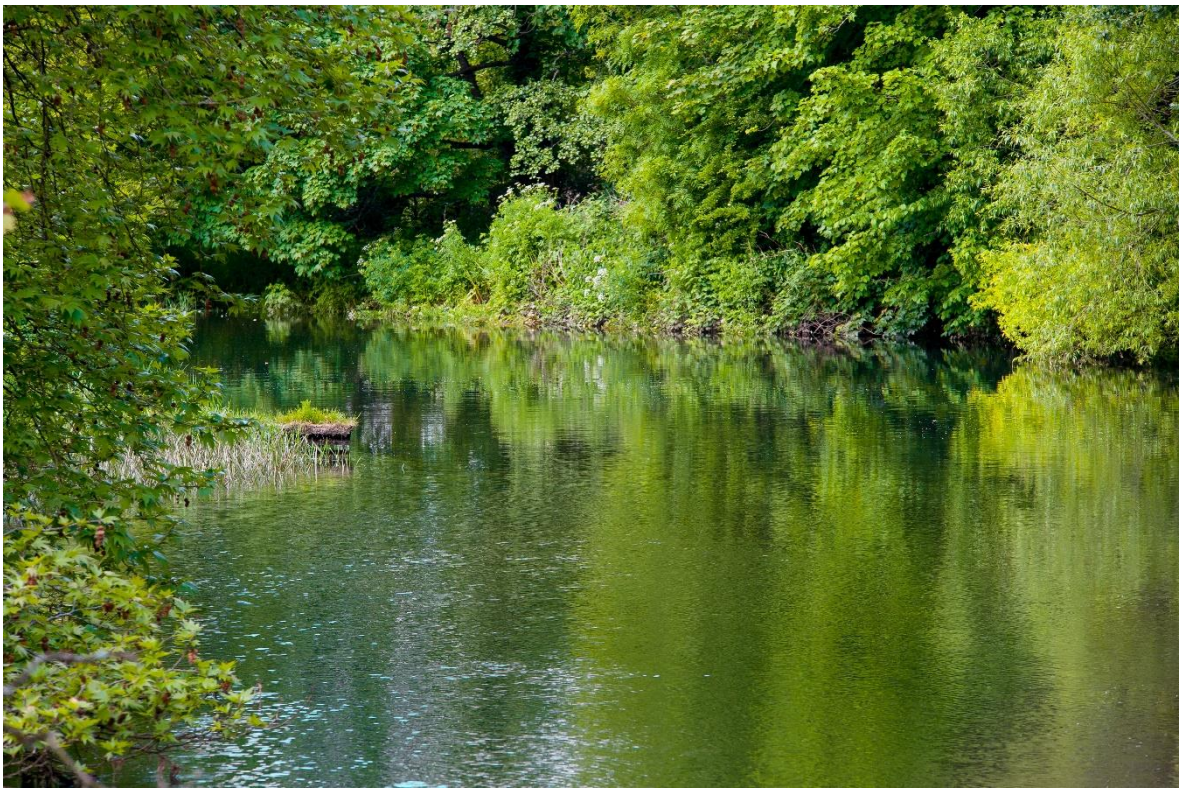
Strategic Regional Water Resource Solutions: Annex A3 Concept Design Report

Standard Gate Two Submission for Thames to Southern Transfer (T2ST)

Date: November 2022



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 Southern 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 Thames Water and Southern Water final Water Resources Management Plans, 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 Southern 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.*

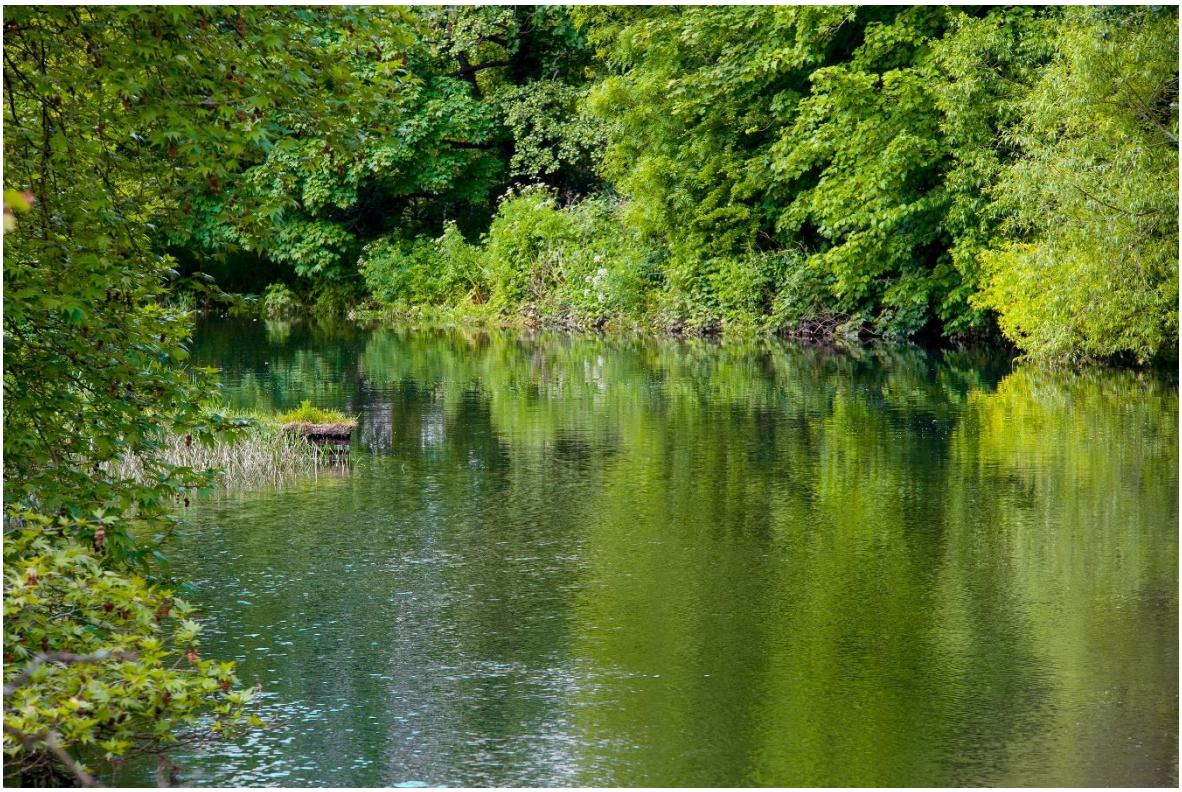
Disclaimer

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 Southern 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 Southern 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.

ATKINS
Member of the SNC-Lavalin Group

Thames to Southern Transfer
Concept Design Report
T2ST-G2-REP-07 (Annex A3)

November 2022



THAMES TO SOUTHERN TRANSFER (T2ST)

Annex A3 Concept Design Report

Atkins Ref: T2ST-G2-REP-07 (Annex A3)

November 2022

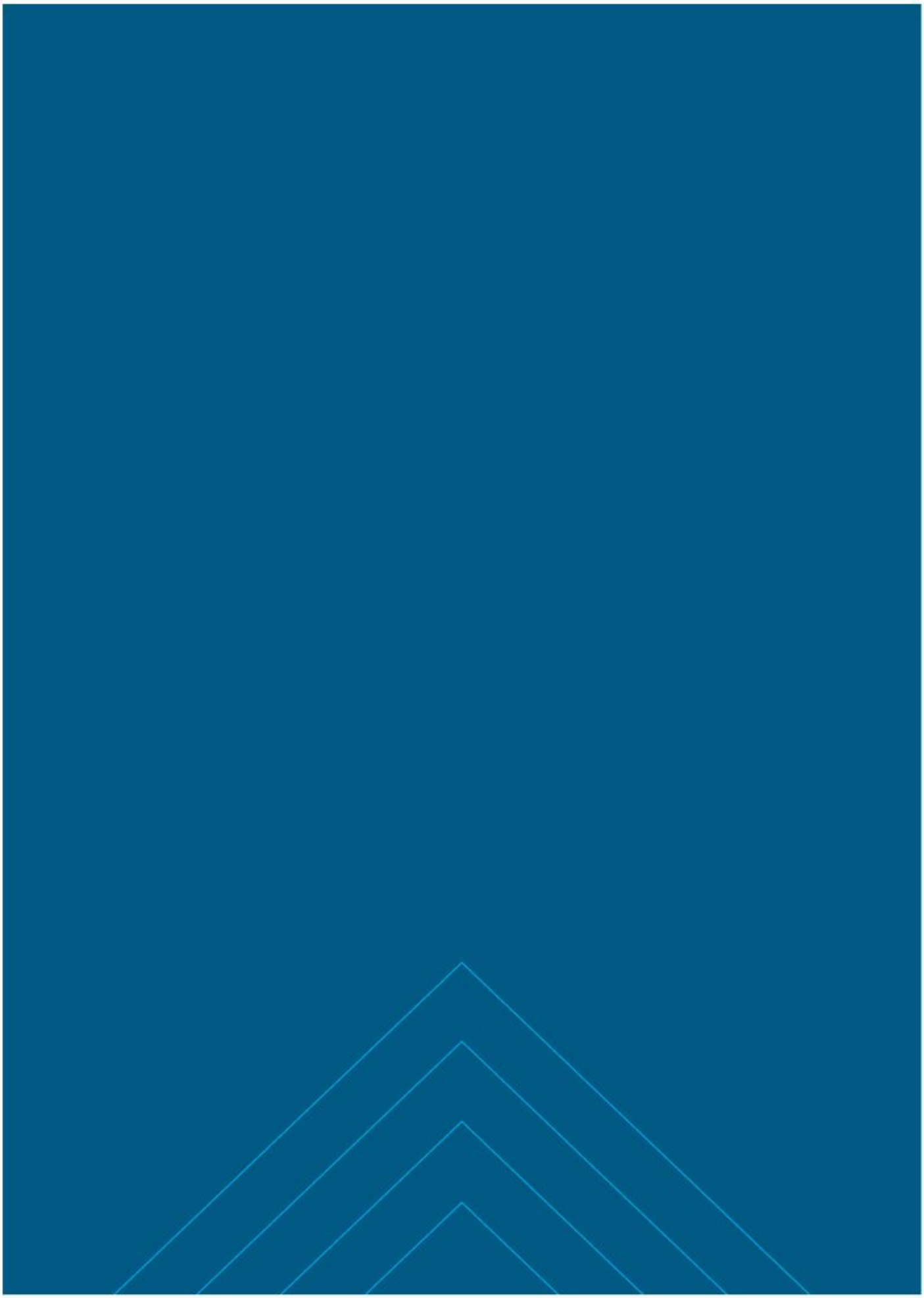
Atkins Limited, Woodcote Grove, Ashley Road, Epsom, Surrey, KT18 5BW | Tel. +44 1372 726140 | atkinsglobal.com | snclavalin.com
Registered company no. 00688424 | VAT no. GB 209 8612 53

Contents

EXECUTIVE SUMMARY

Tables

Figures



Executive Summary

Introduction

The Thames to Southern Transfer (T2ST) option has been identified as a Strategic Regional Water Resource Option (SRO) in the PR19 Final Determination, with funding allocated between Thames Water and Southern Water.

The aim of this report is to investigate T2ST options for transferring available water from the Severn Thames Transfer (STT) and/or SESRO from the Thames Water SWOX water resource zone to Southern Water's Hampshire area. T2ST is dependent on the prior development and commissioning of a water resource option to provide additional water in the River Thames (STT or SESRO) and hence is unlikely to be available until the 2040s depending on the outcome of the WRSE Regional Plan. T2ST is a long-term resilience option that could form a key strategic link within the south-east region.

The SROs need to progress through a formal gated process of review and approval. The Gate 1 report for T2ST and supporting annexes was submitted to RAPID in July 2021. The assessment process for Gate 1 was overseen by RAPID, with input from the partner regulators Ofwat, the Environment Agency and the Drinking Water Inspectorate (DWI). The Environment Agency together with Natural England also reviewed the environmental sections of the submissions and provided feedback to RAPID. The Consumer Council for Water also provided input to the assessment on customer engagement. The final decision by RAPID was published in December 2021 and concluded that further funding should be allowed for T2ST to progress to Gate 2. This Gate 2 Concept Design Report (CDR) details the development of the T2ST solution since completion of Gate 1 in July 2021.

Gate 2 Option Appraisal

Following commencement of the Gate 2 assessment for T2ST in August 2021 an options appraisal was completed to address key questions concerning the viability and operation of the 6No. options identified at Gate 1. The Gate 2 options appraisal was completed in December 2021 and involved a number of workshops with representatives from Thames Water and Southern Water and the T2ST project team. This appraisal process enabled an informed decision to be made on preferred options to take forward into the Gate 2 concept design stage that commenced in January 2022. The options appraisal methodology and conclusions of this work are documented within the Gate 2 Options Appraisal Report, Annex A1 (doc ref: T2ST-REP-G2-01). The report concluded that the two potable T2ST options (Option 1: Culham to Otterbourne and Option 4: Reading to Otterbourne) should be taken forward into concept design. The 4No. raw water transfer options were screened out as part of the Gate 2 options appraisal process. The requirements for multiple treatment sites and pre-treatment measures result in raw water options having higher capex and opex compared to potable options, and hence only the potable options passed through the secondary screening stage of the option appraisal.

Route and Site Selection

Following identification of the two preferred T2ST potable options to take forward into the Gate 2 concept design stage (Options 1 and 4), a route and site selection process was undertaken to establish preferred route corridors for both options. This work is documented within the Route and Site Assessment - Preferred Option Report, Annex A2 (doc ref: T2ST-G2-REP-02). As a result of this process Option 4 (Reading to Otterbourne) was held back due to high planning risk associated with construction of a new river intake on the south bank of the River Thames within the North Wessex Downs AONB and planning constraints concerning the location of the associated water treatment works. Two variants of Option 1, named as Options B and C, have been identified as preferred potable water options for T2ST to take forward to Gate 2 as follows:

- **Option B – Potable water transfer from land west of the A34 near Drayton to Southern Water supply network in Hampshire. Route west of Newbury, remaining west of the A34. Water source from SESRO or STT**

- **Option C – Potable water transfer from land west of the A34 near Drayton to Southern Water supply network in Hampshire. Route west of Newbury, crossing east of the A34. Water source from SESRO or STT**

The planning risk between B and C is considered to be similar and insufficient evidence was available to identify a single preferred option as part of the route and site selection process. Both Options B and C were therefore carried forward for further detailed assessment within the concept design stage for T2ST.

The pipeline route corridors for Options B and C are shown in Figure A, which also shows the water company boundaries, the indicative location for the water treatment works, and proposed connection points to the Southern Water network. Other alternative options A, D and E were also considered but ruled out on grounds of cost and planning risk as set out within the Route and Site Assessment Preferred Option Report (Annex A2).

Figure A - T2ST Preferred Options B and C

Scheme delivery

Due to uncertainties concerning the timing and need of T2ST it was agreed with Thames Water and Southern Water at the outset of the concept design stage that a range of T2ST option capacities should be assessed at 50, 80 and 120Ml/d.

The draft Water Resources South East (WRSE) Regional Plan sets out the overall need for T2ST and this feeds into the relevant Water Resource Management Plans (WRMPs) from both Thames Water and Southern Water. The draft WRSE Regional Plan has determined a need for a T2ST scheme of up to 120Ml/d by 2040-2053 depending on the scenario in the adaptive plan. Therefore, at this stage, it is envisaged the project will not be operational until at least 2040. Further consideration of the T2ST scheme delivery programme is provided by Section 7 of the Gate 2 report, which shows that T2ST would require a minimum lead in time of 7 years post Gate 2 for completion of planning and development work, including planning consent and procurement prior to commencement of construction. A 5 year construction period is expected prior to commissioning of the T2ST scheme.

Concept design

The concept design of the T2ST preferred options for Gate 2 has been undertaken in accordance with the All Company Working Group (ACWG) Design Principles as set out in Appendix B, meeting the guidance criteria for Climate, People, Place and Value. These design principles will continue to shape the development of the T2ST design solution as work progresses through the gated process.

Section 3 of this report provides details on the pipeline route, infrastructure requirements, water treatment, hydraulic analysis and connectivity to the Southern Water network for both preferred options. Section 4 provides an assessment of the T2ST scheme operation including water storage and sweetening flow requirements.

Section 5 sets out the approach to cost and carbon estimating for the Gate 2 options. At Gate 1, capital and operational cost estimates for T2ST were derived using Thames Water costs as provided by the TW Engineering Estimating System (EES). Embedded and operational carbon values were also derived using the EES model. For Gate 2 the cost and carbon estimates for the preferred options (B and C) have been priced by the Southern Water Cost Intelligence Team (CIT) using Southern Water cost and carbon data, in accordance with the ACWG cost consistency methodology. The output from this work is documented by the Gate 2 Costs and Carbon Report, Annex A4. Estimates have been provided at 50, 80 and 120Ml/d capacity for both options.

Section 6 provides information on the Gate 2 Deployable Output Assessment analysis carried out for the T2ST options at Gate 2. Information on the construction phase of T2ST including detail on the draft construction programme is provided in Section 7.

Next steps

The concept design of the 2No. preferred options (B and C) for T2ST has been developed and set out within Section 3 of this report. The concept design carried out for Gate 2 has demonstrated that both options are feasible for the bulk transfer of water from Thames Water to the Southern Water network in Hampshire.

It is however too early to confirm the final preferred option and further work will be required post Gate 2 to establish the final preferred T2ST option. Key areas for further option development are set out as follows:

1. T2ST timing and capacity	The required capacity and timing of T2ST is dependent on the outcome of the WRSE Regional Plan. This will confirm any requirements for spur connections to South East Water or Thames Water Kennet Valley. At this stage it is expected that the transfer would only be required in periods of extreme drought but increased utilisation of the transfer may be required to meet the longer term supply demand balance of the Hampshire region depending on the implementation and timing of other schemes and future environmental ambition targets.
2. T2ST utilisation	Utilisation of T2ST during drought events will be confirmed by a Pywr water resources model of the Hampshire supply area that is currently being developed by Southern Water and Portsmouth Water. Model outputs from this model are expected in the autumn of 2022.
3. Site Selection and Route Corridor	The Route and Site Assessment - Preferred Option Report, Annex A2 (doc ref: T2ST-G2-REP-02), has established the 2No. preferred options B and C. Consultation on these two routes has commenced with local planning authorities and other stakeholders including the NAU and North Wessex Downs AONB unit. Post Gate 2 further detailed assessment will be required to assess feedback from this consultation process and to gain full understanding of planning consent risks of the route corridors and above ground infrastructure sites, particularly at pinch points, where options for route deviation are limited. This will include work to further define the locations of water treatment works, break pressure tanks and pumping stations; landowner referencing for above ground sites; statutory utility searches for pipelines and infrastructure sites; and connection details to the abstraction source and the Southern Water supply network. This work will allow an informed decision to be taken on the final preferred option.
4. Receiving Network improvements	Through consultation with Southern Water the destination points for T2ST and interface with the Southern Water network have been agreed. Further work will be required post Gate 2 to assess requirements for distribution of T2ST water within the receiving treated water network, once the final timing and capacity of T2ST is known. This will include water quality assessments to ensure there are no residual risks such as taste/odour or corrosivity issues. Further work will also be required to confirm sweetening flow requirements once the scheme capacity and utilisation has been finalised.

1. Introduction

1.1. Previous work

The Thames to Southern Transfer (T2ST) option has been identified as a Strategic Regional Water Resource Option (SRO) in the PR19 Final Determination, with funding allocated between Thames Water and Southern Water.

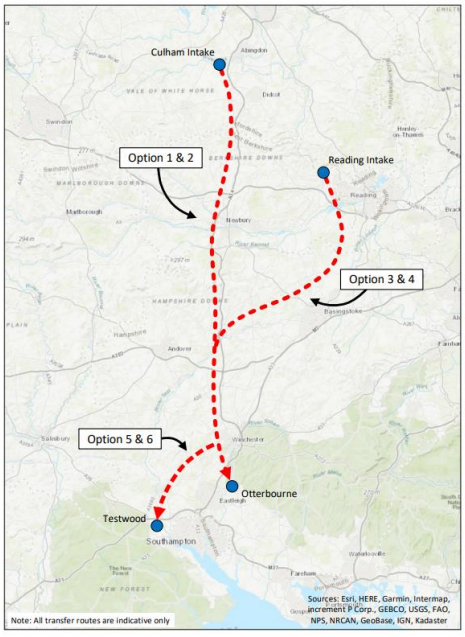
The aim of this report is to investigate T2ST options for transferring available water from the Severn Thames Transfer (STT) and/or SESRO from the Thames Water SWOX water resource zone to Southern Water's Hampshire area. T2ST is dependent on the prior development and commissioning of a water resource option to provide additional water in the River Thames (STT or SESRO) and hence is unlikely to be available until the 2040s depending on the outcome of the WRSE Regional Plan. T2ST is a long-term resilience option that could form a key strategic link within the south-east region.

The SROs need to progress through a formal gated process of review and approval. The Gate 1 report for T2ST and supporting annexes was submitted to RAPID in July 2021. The assessment process for Gate 1 was overseen by RAPID, with input from the partner regulators Ofwat, the Environment Agency and the Drinking Water Inspectorate (DWI). The Environment Agency together with Natural England also reviewed the environmental sections of the submissions and provided feedback to RAPID. The Consumer Council for Water also provided input to the assessment on customer engagement. The final decision by RAPID was published in December 2021 and concluded that further funding should be allowed for T2ST to progress to Gate 2.

This Gate 2 Concept design report details the development of the T2ST solution since completion of Gate 1 in July 2021. The aim of this design stage for T2ST is to further assess the options identified at Gate 1 and to identify a preferred option or options to take forward to Gate 2. This design process is detailed in the following sections of this report.

1.2. Gate 1 Options

6No. T2ST options were identified and assessed at Gate 1 - as summarised below in Figure 1.1. Each option was assessed at 50, 80 and 120Ml/d capacity. Each Gate 1 option also included 10Ml/d spur connections to the Southern Water Kingsclere and Andover water resource zones (WRZ).



Option 1: Potable water transfer from Culham to Otterbourne

Option 2: Raw water transfer from Culham to Otterbourne

Option 3: Raw water transfer from Reading to Otterbourne

Option 4: Potable water transfer from Reading to Otterbourne

Option 5: Raw water transfer from Culham to Testwood

Option 6: Raw water transfer from Reading to Testwood

Figure 1.1 - Key Plan, T2ST constrained options at Gate 1 (Options 1-6)

1.3. Gate 2 Options Appraisal

Following commencement of the Gate 2 assessment for T2ST in August 2021 an options appraisal was completed to address key questions concerning the viability and operation of the 6No. options identified at Gate

1. The Gate 2 options appraisal was completed in December 2021 and involved a number of workshops with representatives from Thames Water and Southern Water and the T2ST project team. This appraisal process enabled an informed decision to be made on preferred options to take forward into the Gate 2 concept design stage that commenced in January 2022.

The screening methodology for the T2ST Gate 2 options appraisal has followed the same screening approach as used for the Thames to Affinity (T2AT) SRO, to provide consistency across the SRO options. The screening criteria was updated to be consistent with the WRMP24 process to ensure that a common, robust process was used to screen all options. The updates have been completed based on the latest WRPG requirements and options appraisal work undertaken for WRSE.

The screening process is a multi-stage approach, with initial screening followed by a secondary screening stage to progressively determine a list of constrained options to take forward into the concept design stage for the T2ST SRO. The initial stage of the option screening removes all options from the list that are not technically, or environmentally feasible, on a pass/fail basis. The secondary screening stage uses a RAG system (red/amber/green) to present the findings of the assessment and to demonstrate how the options perform against the assessment criteria. The assessment criteria ensures consistency with the Strategic Environmental Assessment (SEA), Habitats Regulations Assessment (HRA) and Water Framework Directive (WFD), that underpin the environmental assessment of options consistent with the approach taken for WRMP24.

The options appraisal methodology and conclusions of this work are documented within the Gate 2 Options Appraisal Report, Annex A1 (doc ref: T2ST-REP-G2-01). The report concluded that the two potable T2ST options (Option 1: Culham to Otterbourne and Option 4: Reading to Otterbourne) should be taken forward into concept design. The 4No. raw water transfer options were screened out as part of the Gate 2 options appraisal process. The justification for selection of the potable transfers as preferred T2ST options and reasons for screening out the raw water transfers is set out within Annex A1, and summarised below:

- *Potable water options for T2ST are preferred to raw water options, on the basis that potable options would only require one treatment site, compared to multiple treatment sites for the raw water options. Potable options therefore have less land take requirements and less associated social and environmental impact than raw water options. Raw water options to either Testwood or Otterbourne would also require pre-treatment works at the abstraction locations to reduce INNS transfer risk. The requirements for multiple treatment sites and pre-treatment measures result in raw water options having higher capex and opex compared to potable options. Only the potable options (1 and 4) pass through the secondary screening stage of the option appraisal.*

The Gate 2 Options Appraisal report (Annex 1) recognised that there were different consenting risks associated with Option 1 and Option 4 and at that stage (December 2021) there was insufficient evidence to conclude that one option was preferable to the other in consenting terms. Hence both potable options (1 and 4) were taken forward into the concept design stage for further detailed assessment.

1.4. Route and site selection process

Following identification of the two preferred T2ST potable options to take forward into the Gate 2 concept design stage (1 and 4), a route and site selection process was undertaken to establish preferred route corridors for both options. This work is documented within the Route and Site Assessment - Preferred Option Report, Annex A2 (doc ref: T2ST-G2-REP-02).

The route and site selection process included a multi-stage approach using a web-based GIS system to map designated sites and key constraints. A number of exclusionary criteria were then applied to avoid and take account of key constraints and designations to define potential pipeline corridor sections for assessment. Over 100 individual corridor sections were identified for assessment by the project team and mapped in the GIS system. The development of the pipeline corridors has also taken into account hydraulic requirements concerning the location of pumping stations and break pressure tanks, the location of major crossings and site access requirements during construction.

The T2ST Engineering, Environmental and Planning teams then undertook a desk-based assessment of the route corridor sections. This was achieved using a RAG spreadsheet assessment matrix to record the assessment against pre-determined engineering, environment and social, planning and land criteria. Where necessary, comments relating to the RAG assessment were recorded alongside the matrix.

This work resulted in five route options being identified for Options 1 and 4, as summarised below:

- Option A – route from land west of the A34 near Drayton to Winchester, to the west of Swindon to avoid the majority of the North Wessex Downs Area of Outstanding Natural Beauty (AONB)
- Option B – route from land west of the A34 near Drayton to Winchester, to the west of Newbury and remaining west of the A34
- Option C - route from land west of the A34 near Drayton to Winchester, to the west of Newbury and crossing to the east of the A34
- Option D - route from land west of the A34 near Drayton to Winchester, to the east of Newbury and crossing to the east of the A34
- Option E – route from Pangbourne, to the west of Basingstoke, to Winchester

Route Options A, B, C and D relate to Option 1 for the potable transfer from a Culham to Otterbourne. Route option E relates to Option 4 for the potable transfer from Reading to Otterbourne.

The route options are shown below in Figure 1.2 which is taken from the Route and Site Assessment - Preferred Option Report, Annex A2.

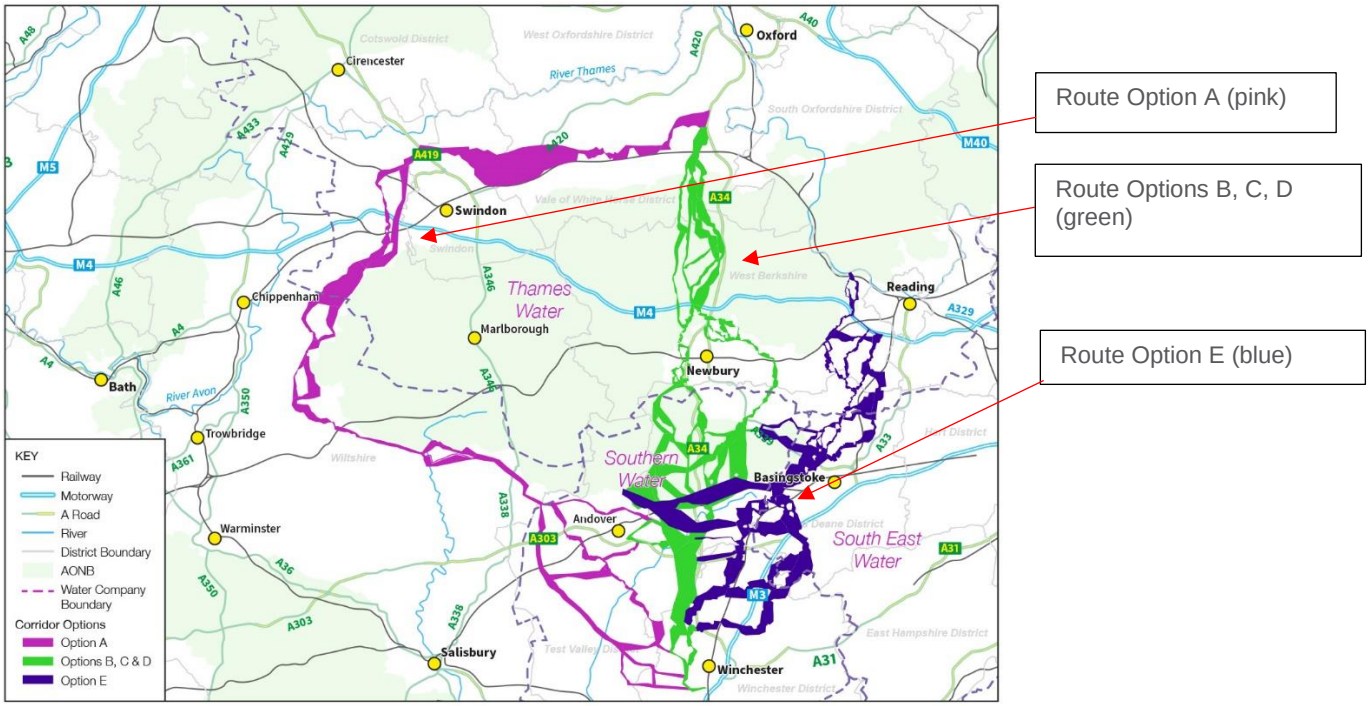


Figure 1.2 - Route Corridors A-E

Option A avoids impact on the North Wessex Downs AONB but is substantially longer than the alternative route options. Option A was consequently held back early in the assessment process on the basis of its length, associated increase in capital and operating costs, and impact on the environment and community. The Option D route to the east of Newbury was also held back due to high planning risk to the north of Thatcham where the route corridor crosses land designated for housing development. The remaining options following initial assessment are B, C and E as shown in Figure 1.3.

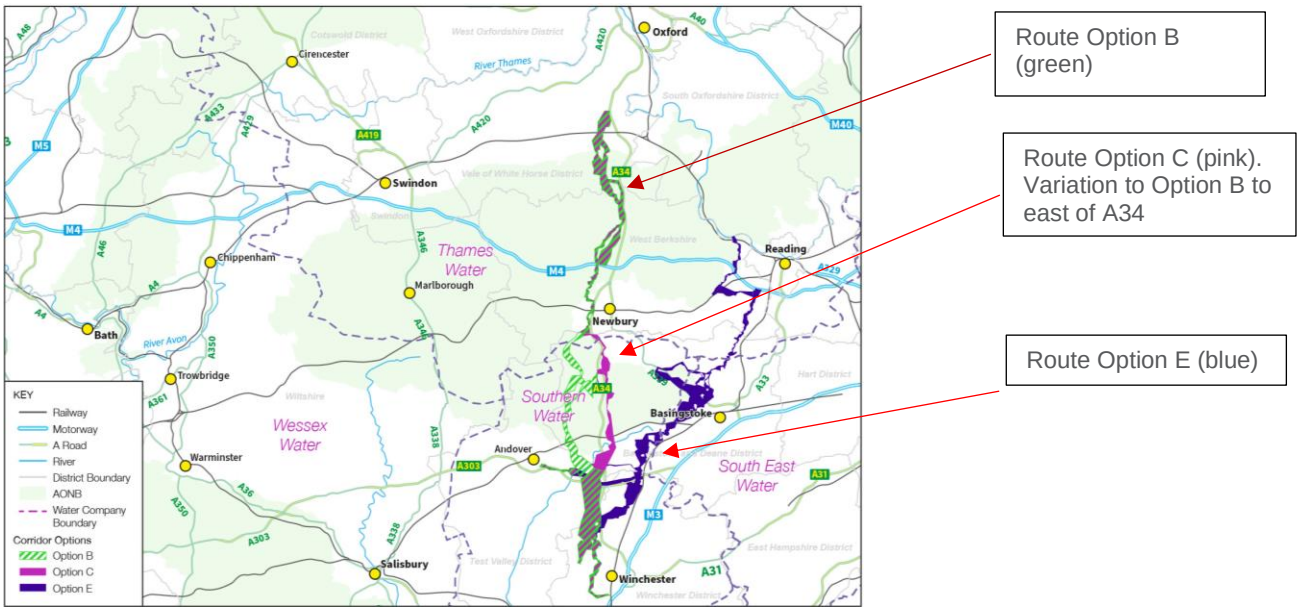


Figure 1.3 - Route Corridors B, C and E

Upon further engineering, planning and environmental assessment of the options, Option E was held back and only Options B and C taken forward as preferred options into concept design. These options comprise a potable water transfer from either SESRO or STT from a site located to the west of the A34 near Drayton in Oxfordshire to the Southern Water supply network in Hampshire.

Option E was held back due to high planning risk associated with the construction of a new river intake on the south bank of the River Thames between Pangbourne and Reading located within the North Wessex Downs AONB; and planning constraints concerning the location of the associated water treatment works. No new river abstraction would be required for Options B and C, where water for transfer to Southern Water would be provided from either a connection to SESRO or a connection from STT on land to the west of the A34 near Drayton.

The overall planning conclusion is that on the basis of available information, a T2ST scheme based on Option B or C is likely to be consentable, whereas a T2ST scheme based on Option E has risks relating to its future consentability - particularly relating to the above ground infrastructure within the AONB at Pangbourne. Whilst there are land issues to be explored further beyond Gate 2, including the acquisition of land for permanent above ground infrastructure, the land issues are not considered to be more complex than would be expected for a scheme of this scale. Risks are considered to be higher for Option E than for Option B and C. Further detail on the justification for holding back Option E and to progress with Option B and C as preferred options into concept design is provided within the Route and Site Assessment - Preferred Option Report, Annex A2. The preferred route corridors for Options B and C are shown in Figure 1.4.

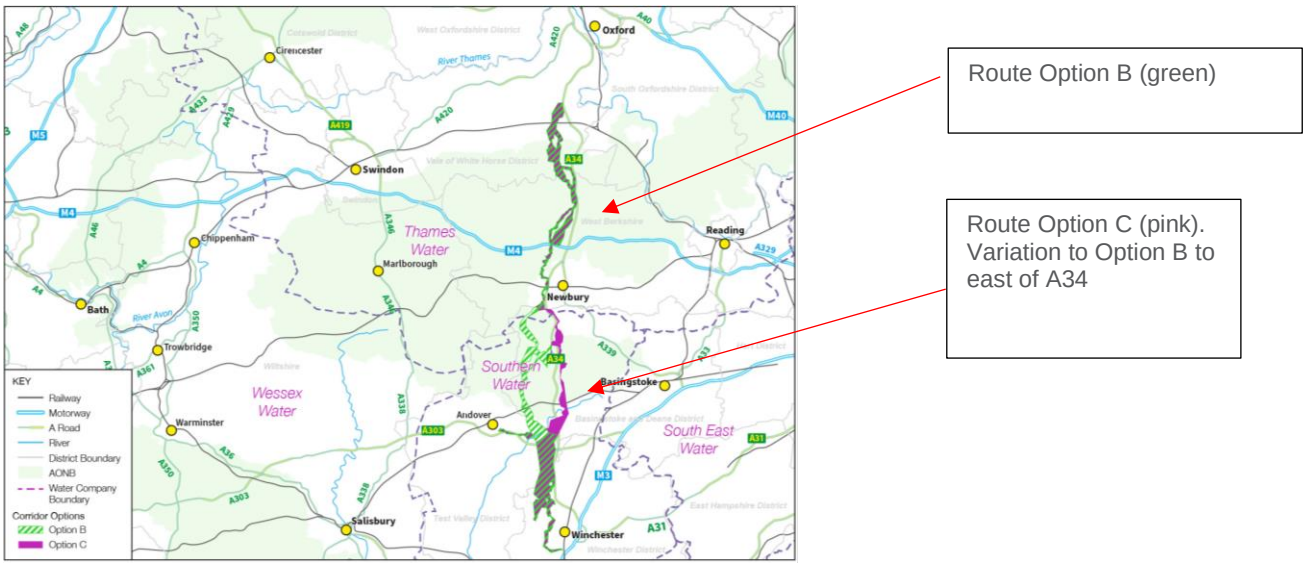


Figure 1.4 - Route Corridors for preferred T2ST Options B and C

Whilst planning risk is considered to be materially higher for Option E, when compared to Options B and C, the planning risk between B and C is considered to be similar and insufficient evidence was available to identify a single preferred option as part of the route and site selection process. Both Options B and C were therefore carried forward for further detailed assessment within the concept design stage for T2ST, as detailed by the following sections of this report.

For the remainder of this report the two preferred T2ST potable transfer Options B and C are described as follows. Further description of the option routes, engineering infrastructure and connectivity to the Southern Water network is set out in Section 3.

- **Option B – Potable water transfer from land west of the A34 near Drayton to Southern Water supply network in Hampshire. Route west of Newbury, remaining west of the A34. Water source from SESRO or STT**

- **Option C – Potable water transfer from land west of the A34 near Drayton to Southern Water supply network in Hampshire. Route west of Newbury, crossing east of the A34. Water source from SESRO or STT**

2. Scheme Delivery

The purpose of this section of the report is to provide an overview of the key issues regarding the preferred planning route and scheme delivery for T2ST.

Due to uncertainties concerning the timing and need of T2ST it was agreed with Thames Water and Southern Water at the outset of the concept design stage that a range of T2ST option capacities should be assessed at 50, 80 and 120Ml/d.

WRSE and the water companies have undertaken extensive modelling to inform the draft Regional Plan. The latest WRSE results show a need for a T2ST scheme of up to 120Ml/d by 2040-2053 with the timing and utilisation depending on the adaptive plan scenario selected. This is the basis on which T2ST has been identified in the WRSE draft Regional Plan and draft WRMPs for consultation in November 2022.

Further consideration of the T2ST scheme delivery programme is provided by Section 7 of the Gate 2 report, which shows that T2ST would require a minimum lead in time of 7 years post Gate 2 for completion of planning and development work, including planning consent and procurement prior to commencement of construction. A 5 year construction period is expected prior to commissioning of the T2ST scheme.

3. Concept Design

3.1. Introduction

This section provides information on the concept design development of each preferred option and key design issues considered for submission at Gate 2. This is the main technical section of this document and has been structured to describe the development of the design process as follows:

- Section 3.2: Overview of preferred Options B and C – provides a summary of the two preferred options B and C as identified from the gate 2 options appraisal stage.
- Section 3.3: Design principles – details of how the ACWG design principles have been adopted for the T2ST Gate 2 concept design stage
- Section 3.4: Connectivity to Southern Water Hampshire supply network – information on how T2ST will link to the existing Southern Water supply system
- Section 3.5: Scheme Capacity - details of the scheme capacity range considered for T2ST (50,80 and 120Ml/d)
- Section 3.6: Scheme dependences – an overview of other strategic water resource options that may affect the timing and need of the T2ST scheme
- Section 3.7: Water Treatment – details of the water source scenarios and treatment requirements for the T2ST options
- Section 3.8: Conveyance – design information on the conveyance of water from the point of abstraction to the Southern Water supply network, including pipeline route selection, pipeline crossings, geology, hydraulic analysis, water storage, surge analysis and infrastructure requirements

Conclusions concerning the viability of each option, risks and recommendations for further work between Gate 2 (November 2022) and Gate 3 are set out in Section 8.

3.2. Overview of preferred Options B and C

As discussed in Section 1, 2No. preferred T2ST options (B and C) were identified following completion of the Gate 2 options appraisal as part of the route and site assessment process (Annex A2). Options B and C are described as follows:

- **Option B – Potable water transfer from land west of the A34 near Drayton to Southern Water supply network in Hampshire. Route west of Newbury, remaining west of the A34. Water source from SESRO or STT**

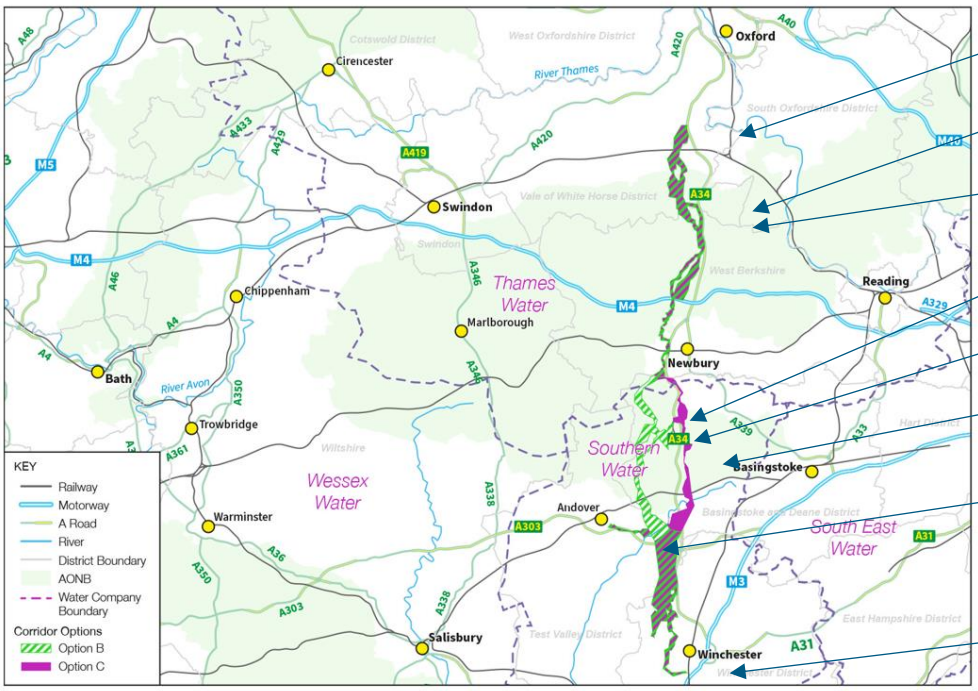
- **Option C – Potable water transfer from land west of the A34 near Drayton to Southern Water supply network in Hampshire. Route west of Newbury, crossing east of the A34. Water source from SESRO or STT**

Figure 3.1 and Figure 3.2 show the indicative routes of Options B and C, together with indicative locations of water treatment, break pressure tanks, pumping stations and connections to existing Southern Water assets. Further discussion on the development of the options including scheme capacity, spur connections and hydraulic analysis are provided in the sections below.

Option B comprises a water treatment works at the point of abstraction from either SESRO or STT on land to the west of the A34 near Drayton. Following treatment, water would then be transferred to the Southern Water Hampshire supply network through a ductile iron or welded steel pressure pipeline. As shown in Figure 3.1, a high lift pumping station would be required at the water treatment works site (pumping station 1) and a further 3No. intermediate pumping stations (PS2, PS3 and PS4). 2No. break pressure tanks would also be required.

Option C is a variation to Option B, the only difference being the pipe route through the central section to the south of Newbury. This option would require a pumping station at the water treatment works, 3No. intermediate pumping stations and 1No. break pressure tank as shown in Figure 3.2.

Figure 3.1 - T2ST Option B: Infrastructure sites and connectivity to Southern Water network



WTW located on land to the west of the A34 near Drayton. Pumping station 1

Break pressure tank 1

Pumping station 2

Pumping station 3

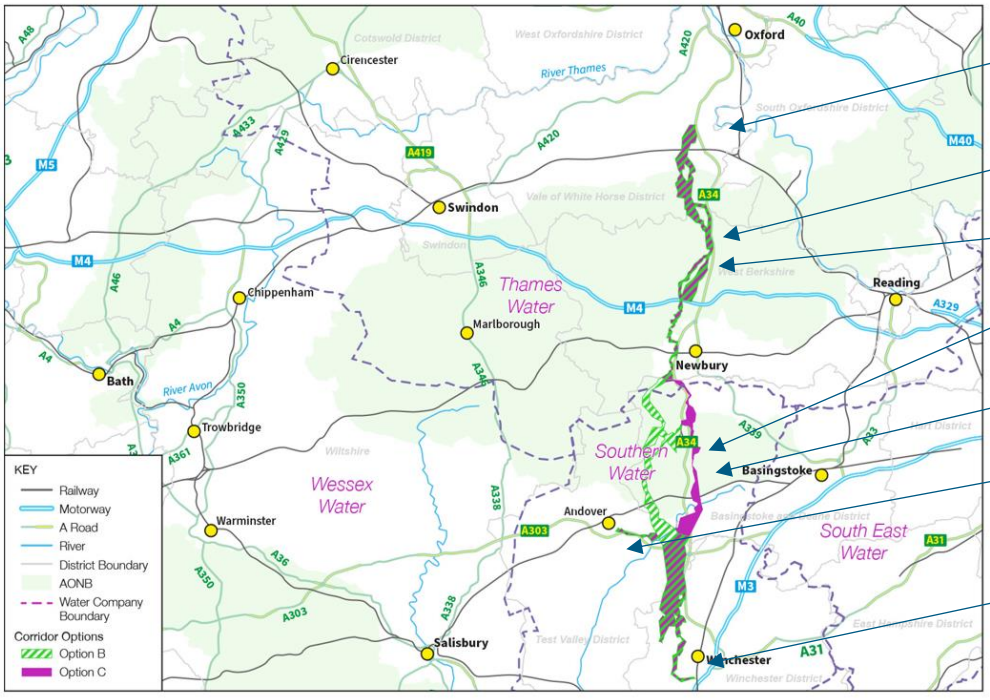
Break pressure tank 2

Connection to Kingsclere WRZ at Beacon Hill WSR

Connection to Andover WRZ at Andover WSR and Andover Link main. Pumping station 4

Connection to Hampshire Winchester WRZ at Crabwood WSR and Hampshire Southampton East WRZ at Yew Hill WSR

Figure 3.2 - T2ST Option C: Infrastructure sites and connectivity to Southern Water network



WTW located on land to the west of the A34 near Drayton. Pumping station 1

Break pressure tank 1

Pumping station 2

Connection to Kingsclere WRZ at Beacon Hill WSR

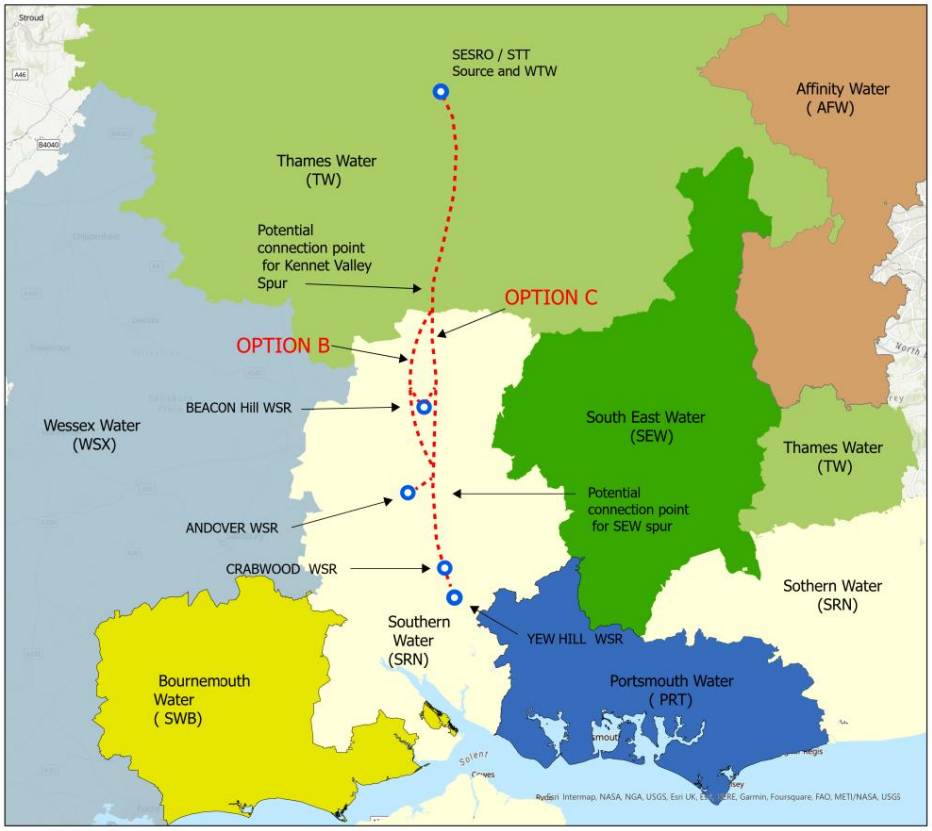
Pumping station 3

Connection to Andover WRZ at Andover WSR and Andover Link main. Pumping station 4

Connection to Hampshire Winchester WRZ at Crabwood WSR and to Hampshire Southampton East WRZ at Yew Hill WSR

The pipeline route corridors for Options B and C are shown together in Figure 3.3, which also shows the water company boundaries, the indicative location for the water treatment works and proposed connection points to the Southern Water network.

Figure 3.3 - T2ST preferred Options B and C



3.3. Design Principles

The concept design of the T2ST preferred options for Gate 2 has been undertaken in accordance with the ACWG Design Principles as set out in Appendix A, meeting the guidance criteria for Climate, People, Place and Value. These design principles will continue to shape the development of the T2ST design solution as work progresses through the gated process.

Examples of how the concept design has followed the ACWG Design principles are set out within the Appendix A tables.

3.4. Connectivity to Southern Water Hampshire supply network

Through discussion and agreement with the Southern WaterN water resources team the following T2ST connections have been developed for Gate 2 with reference to the latest Southern Water demand forecasts for WRMP24.

- **Hampshire Winchester WRZ**: A direct connection from the T2ST transfer main to the existing Crabwood and water supply reservoir (WSR) near Winchester (80 and 120Ml/d capacity only).
- **Hampshire Southampton East WRZ**: A direct connection from the T2ST transfer main to the existing Yew Hill water supply reservoir (WSR) near Winchester (80 and 120Ml/d capacity only).
- **Kingsclere WRZ**: A 5Ml/d spur connection from the T2ST transfer main has been provided for both Options B and C to supply the existing Beacon Hill service reservoir within the Kingsclere WRZ, as required by Southern Water to the meet long term supply demand balance in the Kingsclere WRZ.
- **Andover WRZ**: A 45Ml/d spur connection from the T2ST transfer main has been provided for both options B and C to supply an existing service reservoir to the south-east of Andover on Micheldever Road, as

required by Southern Water to the meet long term supply demand balance in the Andover WRZ. In drought conditions, T2ST could then supply 20Ml/d to meet the demand requirements of Andover, with the remaining 25Ml/d pumped from the Andover service reservoir to Crabwood service reservoir through the proposed Andover link main that is planned for construction by Southern Water by 2027. The proposed Andover to Crabwood pipeline is part of Southern Water's Water for Life enhancement of the Hampshire water supply grid in AMP8. Utilising the capacity of the proposed Andover link main part of the T2ST SRO would optimise the use of existing Southern Water assets and reduce the required capacity of the T2ST transfer main for the final section between Andover to and Yew Hill WSR.

The 5Ml/d and 45Ml/d spur connections are constant for all T2ST scheme capacities (50, 80 and 120Ml/d). Hence for a T2ST capacity of 80Ml/d, the capacity of the connection to Crabwood and Yew Hill is 30Ml/d, increasing to 70Ml/d for T2ST capacity at 120Ml/d. At T2ST capacity of 50Ml/d all water is supplied to Beacon Hill and Andover water resource zones and there is no direct T2ST connection to Crabwood or Yew Hill service reservoirs. Design capacities for each flow case are summarised in Table 3-1. Schematics of each option are also presented in Appendix B.

The capacity of all T2ST connections will be reviewed again post Gate 2 once final design sizing is confirmed for the proposed transfers. This will ensure consistency with the WRSE Regional Plan and Southern Water's WRMP24, the proposed Southern Water internal transfers (particularly the Andover link main) and further planned water resources modelling.

Table 3-1 - T2ST design capacities for Options B and C (Ml/d)

T2ST capacity	50Ml/d	80Ml/d	120Ml/d
Pipeline Section	Section capacity (Ml/d)		
WTW to Beacon Hill spur connection	50	80	120
Beacon Hill spur	5	5	5
Beacon Hill to Andover spur connection	45	75	115
Andover spur	45	45	45
Andover spur to Crabwood WSR	0	30	70
Crabwood WSR to Yew Hill WSR	0	30	70

3.4.1. Thames Water supply to Kennet Valley

Thames Water have also identified a potential spur connection from the T2ST pipeline to provide support to the Kennet Valley water resource zone, at Newbury (10Ml/d) and Reading (40Ml/d). These options have been included in the WRSE modelling.

The 10Ml/d Newbury spur has been selected from 2040 at the earliest while the Reading spur has not been selected in the WRSE draft Regional Plan. The regional modelling of the spurs was finalised towards the end of this Gate 2 submission being closed out. Consequently, a detailed assessment has not been carried out of potential spurs to Reading or Newbury within the Gate 2 T2ST concept design or environmental assessments for preferred Options B and C.

The potential need for a spur connection to Kennet Valley will, however, be kept under review post-Gate 2 as the WRSE Regional Plan is finalised. In particular, a more detailed assessment of the Newbury spur (approximately 2km potable spur) will be undertaken after Gate 2.

3.4.2. South East Water supply to Basingstoke

South East Water (SEW) and WRSE have developed an option for a spur connection from the T2ST transfer main to supply Northgate WSR to the south of Basingstoke at 10Ml/d and 20Ml/d capacity. While WRSE has modelled this option, the offtake has not been selected in the WRSE draft Regional Plan. Therefore, no consideration of this spur has been included as part of the T2ST concept design for Gate 2. As for the potential Kennet Valley spur, a spur connection to SEW will also be kept under review post Gate 2 as the Regional Plan is finalised.

3.5. Scheme Dependencies

T2ST is dependent on the prior construction and commissioning of either SESRO or STT to provide a reliable water source for transfer to the Southern Water Hampshire supply area.

For the **SESRO source** water for T2ST would be provided from a connection within the SESRO pumping station which has a proposed location to the northeast of the reservoir embankment on land to the west of the A34 near Drayton. The SESRO pumping station is being designed by the SESRO SRO team to pump water into the reservoir from the River Thames, via a gravity tunnel connected to a new river abstraction on the south bank of the River Thames near Culham. Within the SESRO pumping station space is being provided for a set of low lift pumps to supply raw water from the reservoir to the T2ST water treatment works, located approximately 300-400m north of the pumping station within the SESRO operational site area. A treated water storage tank with 6hrs storage has been assumed at this stage of the design at the outlet of the water treatment works, consistent with standard industry practice to provide buffer storage within the transfer system. A high lift pumping station would also be constructed at the SESRO site downstream of the storage tank to pump treated T2ST water to Hampshire.

For the **STT source** scenario the same location for the water treatment works is proposed on land to the west of the A34 near Drayton. The route of the proposed STT main passes approximately 2km to the north of the SESRO site prior to discharge to the River Thames at a new outfall near Culham. In this scenario a pipeline connection from the STT main into the T2ST water treatment works would be constructed. Treated water would then be pumped to Hampshire through the T2ST main as for the SESRO source option. At this stage of the T2ST concept design no advantage has been identified in moving the location of the T2ST water treatment works closer to the STT main, as this would increase the T2ST transfer length. The proposed water treatment site on land to the west of the A34 near Drayton comprises flat open agricultural land outside of Flood risk zone 2, with construction access from the A34.

Depending on the outcome of the WRSE Regional Plan there may be scope for phased construction of the T2ST water treatment works, where separate treatment streams could be built and commissioned to meet demand need within the Southern Water supply area. There is also a possible requirement for a separate Thames Water water treatment works located at SESRO to increase resilience of the SWOX WRZ, although this option has not to date been selected by the WRSE modelling.

Through discussion with the SESRO SRO design team it is expected that the first 2km section of the T2ST main from the high lift pumping station to the boundary of the SESRO site, would be constructed as part of the SESRO works along the east side of the reservoir between the reservoir embankment and A34. This would avoid future disturbance of the site on the assumption that T2ST would be constructed some years after construction of SESRO, dependent on the outcome of the Regional Plan.

3.6. T2ST Scheme capacity

Through discussion and agreement with Thames Water and Sothern Water, 50, 80 and 120Ml/d scheme capacities have been considered for each of the two preferred options at Gate 2 (B and C). This is considered to be an appropriate range of scheme capacity for T2ST at Gate 2, given the current uncertainties in the WRSE Regional Plan modelling as described earlier in Section 2. This is the same range of scheme capacity as assessed for T2ST at Gate 1 in July 2021.

3.7. Water Treatment

3.7.1. Treatment location and source scenarios

For Options B and C a new water treatment works would be required located on land to the west of the A34 near Drayton, to fully treat the source water from either SESRO or STT prior to transfer to the Southern Water Hampshire supply network.

The treatment processes required for water treatment for T2ST have been determined in accordance with the All Company Working Group (ACWG) Water Quality Risk Framework methodology. Full details of the adopted approach are set out within the T2ST Gate 2 Water Quality Assessment Report, Annex C (doc ref: T2ST-G2-REP-06).

The T2ST SRO preferred Options B and C may each be supplied by several different water sources, each with differing water quality risk profiles. These include raw water abstracted directly from SESRO or from the Severn to Thames Transfer (STT) SRO. Therefore, to undertake a source-to-tap water safety risk assessment, four water source scenarios have been defined for Gate 2 as follows, each with varying risk profiles:

1. Abstraction from **SESRO** – sourced from the River Thames at Culham at high flow.
2. Abstraction from **STT transfer** – flows sourced directly from the River Severn **(STT) with pipeline** conveyance.
3. Abstraction from **STT transfer** – flows sourced directly from the River Severn **(STT) with canal** conveyance.
4. Abstraction from **STT transfer** – flows sourced directly from the River Severn transfer **(STT) with support from WwTW effluent** (conveyance by either pipeline or canal).

SESRO Source (Scenario 1)

The proposed location of SESRO is to the west of the A34 near Drayton. For water source scenario 1, stored water within SESRO would be abstracted from the reservoir and treated at the SESRO source prior to transfer to Hampshire through the T2ST transmission pipeline.

SESRO has a planned storage capacity of between 75-150 million m^3. Although the actual turnover period of SESRO will depend on the rate of drawdown for T2ST and other schemes, it is expected that the retention time in the reservoir will be sufficiently large to alter the water quality of the water at the outlet of the reservoir compared to the inlet of the reservoir. For example, the large retention time will allow heavy suspended solids such as silt to settle, reducing the expected average turbidity. However, reservoir storage can result in an increase in the risk of algal blooms and associated by-products.

SESRO would be fed by the River Thames when at high flow, with discharge back to the River Thames when the river is at low flow to supplement other downstream SRO schemes.

The risk assessment for source scenario 1 is informed by the Water Quality Risk Assessment (WQRA) produced by the SESRO SRO. Additionally, existing River Thames Drinking Water Safety Plans (DWSPs) have been referred to - particularly that for Farmoor WTW, which is located upstream of the proposed abstraction point for SESRO.

The water quality monitoring data provided by the Gate 2 monitoring scheme provides quantifiable data from the River Thames, which has been used to update the T2ST Water Quality Risk Assessments for Gate 2, as detailed in Annex C.

Water quality data from the River Thames monitoring scheme and updated risk assessments from SESRO will continue to be used to update the T2ST Water Quality Risk Assessment as the T2ST scheme design develops beyond Gate 2.

STT Source (Scenarios 2, 3 and 4)

Within the STT SRO there are a number of sources of water currently being assessed, each of which present different water quality risks to T2ST, including:

- River Severn raw water transfer via pipeline (water source scenario 2) with a water quality risk profile of the River Severn.
- River Severn raw water transfer via navigable canals (water source scenario 3), which may increase risks including pesticides, oil and fuel etc.
- River Severn supported by treated wastewater effluent (from Minworth Sewage Treatment Works) described as water source scenario 4, which would be expected to increase microbiological risks.

The STT SRO design scope includes for a pre-treatment works at Deerhurst prior to discharge to the River Thames to avoid water quality impacts. Further water treatment processes will be required as part of T2ST to treat STT water to drinking water standards prior to transfer to the Southern Water network.

The T2ST risk assessments for the STT source scenarios have been updated based on latest risk assessment data provided by the STT SRO team, as detailed in Annex C. The T2ST risk assessments for the STT source scenarios will continue to be updated beyond Gate 2 as revised STT risk assessment data becomes available.

Receiving areas

T2ST will supply water to the Hampshire Southampton East WRZ, which is supplied from a combination of surface water sources (River Itchen) and groundwater sources. T2ST will also supply water to the Kingsclere WRZ and Andover WRZ which are both groundwater zones. Hence, irrespective of the source scenario, T2ST will supply treated water from a new source into a combination of groundwater fed and surface water fed regions.

Changes in water source can affect aesthetic risks such as taste and odour, as well as corrosivity. These risks will require closer investigation during subsequent phases of work. Potential control measures include pro-active consumer engagement, and there may also be a requirement for additional chemical conditioning prior to entering supply. Further work to establish the need for, and nature of, such conditioning will be required in as the T2ST design is developed.

3.7.2. Treatment processes

Detailed information on the water source scenarios for T2ST, completed water quality risk assessments, and required treatment processes for each T2ST water source scenario are set out in Annex C including process block diagrams.

At this stage of the design development the required treatment processes for water source scenario 1 (abstraction from SESRO) would include:

- coagulation and flocculation
- dissolved air flotation (DAF)
- rapid gravity filters (RGF)
- granular activated carbon (GAC) filters
- Ozonation is proposed prior to both the flocculation tanks and the GAC units to provide disinfection and improve coagulation of particles
- Ultraviolet disinfection units and chlorine contact tanks would be required at the end of the treatment to provide full disinfection to the treated water before entering the supply network
- Sludge thickening using lamellas and disposal to sewer

For the STT water source scenarios, scenario 2 (STT pipeline conveyance) has the same treatment process as scenario 1 for SESRO as shown above. Scenario 3 (STT canal conveyance) includes high rate lamella clarifiers instead of dissolved air flotation.

Water source 4 with planned support from Minworth STW effluent requires additional treatment due to elevated Bromide concentrations, microbiological risks, and increased risks of endocrine disrupting compounds from pharmaceutical and personal care products. The treatment process for water source 4 is similar to Scenario 3 but excludes ozonation to avoid potentially high levels of Bromate being generated from oxidised Bromide. PAC dosing and Ultrafiltration (UF) membrane filtration may also be required for water source 4 subject to further investigation as detailed within Annex C.

3.7.3. Wastewater discharge

Whilst a proportion of the supernatant from the sludge process can be recycled through the works, it would be difficult to recycle all of the wastewater from the water treatment process. At this stage of the concept design it has been assumed that a 200mm diameter sewer connection from the T2ST water treatment works to Abingdon STW would be required to transfer thickened sludge from the lamellas for treatment. The thickened sludge from the Lamella Thickeners would be expected to be 3% w/w dry solids, producing maximum a thickened sludge flow rate of around 70 m^3/day (0.07Ml/d) for the 120Ml/d T2ST option. In outline design in may be possible to avoid a sewer connection by dewatering the sludge to (say) 20% w/w dry solids with a centrifuge and exporting the sludge cake by road. A cost-benefit analysis for wastewater handling options will be required as the design progresses to confirm the optimal disposal route.

3.7.4. Invasive Non-Native Species (INNS)

As the raw water from SESRO or STT will be fully treated at source to drinking water standards, all organic content from the source water will be removed during the treatment process. There will therefore be no operational risk of INNS transfer along the T2ST main between the Thames and Southern supply areas.

3.8. Conveyance

For the preferred T2ST Options B and C, preliminary pipeline routes and sites for pumping stations and break pressure tanks have been identified for the conveyance elements of the concept design, as detailed within the following section.

3.8.1. Pipeline route selection

As set out above in Section 1.4, a route and site selection process has been undertaken to establish preferred route corridors for both preferred Options B and C. This work is documented within the Route and Site Assessment - Preferred Option Report, Annex A2 (doc ref: T2ST-G2-REP-02).

The route and site selection process included a multi-stage approach using a web-based GIS system to map designated sites and key constraints. A number of exclusionary criteria were then applied to avoid and take account of key constraints and designations to define potential pipeline corridor sections for assessment. Designations and constraints included ancient woodlands, SSSIs, SACs, SPAs, scheduled ancient monuments, development land and existing built infrastructure such as roads, railways, towns and villages. The preferred pipeline route corridors for Option B and C, as determined from the route and site selection process, is shown above in Figure 1.3 and Figure 1.4.

At this stage of the concept design the identified pipe route corridors are preliminary and further work will be required after Gate 2 to establish the final preferred T2ST option, including definition of the red line boundary, land referencing and environmental impact assessment to support the planning application. Further detail on the next steps beyond Gate 2 are set out in Section 9. For the Gate 2 concept design preliminary pipeline centrelines within the preferred route corridors were also developed using the GIS web-based tool in order to derive pipe lengths for cost estimating purposes and to enable hydraulic analysis of the transfer system. The pipe lengths for Option B and C are set out in Table 3-2 and Table 3-3, showing section lengths between pumping stations (PS) and break pressure tanks (BPT), for the main transfer pipeline between the water treatment works and Yew Hill WSR in Hampshire. Pipe lengths of the spur connections to Beacon Hill WSR and Andover WSR are also shown.

Table 3-2 - Option B: Pipeline lengths

Pipeline Section	Pipeline length (km)
A: PS1 to BPT1	13.7
B: BPT1 to PS2	4.3
C: PS2 to PS3	25.0
D: PS3 to BPT2	5.5
E: BPT2 to Andover spur connection	12.3
F: Andover spur connection to Crabwood WSR	20.3
G: Crabwood WSR to Yew Hill WSR	3.8
Total T2ST spine main length	85.0
H: Beacon Hill spur main	1.8
I: Andover spur main	7.0
Total pipeline length (Option B)	93.8

Table 3-3 - Option C: Pipeline lengths

Pipeline Section	Pipeline length (km)
A: PS1 to BPT1	13.7
B: BPT1 to PS2	4.3
C: PS2 to PS3	31.1
D: PS3 to Andover spur connection	9.8
E: Andover spur connection to Crabwood WSR	18.1
F: Crabwood WSR to Yew Hill WSR	3.8
Total T2ST spine main length	80.8
G: Beacon Hill spur main	4.2
H: Andover spur main	9.2
Total pipeline length (Option C)	94.2

3.8.1.1. Option B Pipeline Route

The Option B pipeline route has a total pipe length of approximately 93.8km. From the water treatment works site on land to the west of the A34 near Drayton the pipe route runs south keeping to the west of the A34 to Newbury. The route then continues south to the west of Newbury and Highclere, keeping west of the A34 before connecting to Crabwood WSR and Yew Hill WSR near Winchester. Option B also includes spur connections to Beacon Hill WSR and Andover WSR.

3.8.1.2. Option C Pipeline Route

The Option C pipeline route has a total pipe length of approximately 94.2km. From the water treatment works site on land to the west of the A34 near Drayton the pipe route runs south keeping to the west of the A34 to Newbury – this section of the route is the same as Option B. At Newbury the pipe route crosses the A34 to the south of Newbury and then runs south to the east of the A34 before crossing back across the A34 to connect to Crabwood WSR and Yew Hill WSR. Option C also includes spur connections to Beacon Hill WSR and Andover WSR.

3.8.2. Pipeline crossings

There are several major road, rail and river crossings located along the preliminary pipeline routes for Option B and C, which will require trenchless technology.

Through consultation with Thames Water and Southern Water it has been assumed at concept design stage that all trenchless crossings will comprise a single tunnelled crossing, using pipe jacking and micro tunnelling. Launch and reception shafts would be constructed either side of the surface feature and a concrete tunnel section then constructed between the two shafts. The T2ST pipeline would then be constructed, comprising a welded steel pipe section through the concrete tunnel, with vertical riser pipework within the shafts and pipework connections made to the T2ST pipeline sections on either side of the surface feature. This is a standard construction technique for major pipeline crossings within the UK water industry. The welded steel pipeline through the tunnel section would be pulled through from one shaft to the other using a proprietary roller support system. The pipe section and support system through the tunnel would be designed with a standard design life of at least 80 years with anti-corrosion coatings and cathodic protection.

Given the high level of protection provided through robust design, single bore crossings rather than twin bore crossings, are considered to provide the required level of resilience for the T2ST SRO. This is also consistent with the approach taken on other SROs (including West Country North and West Country South).

For costing estimating purposes, cross sections of each pipe jack/micro tunnel crossing have been developed to establish the positions and depth of the launch and reception pits, and temporary construction access requirements to each crossing location. Launch and reception shafts would be constructed using concrete segmental rings with a required diameter of 9m for the launch shaft and 6m for the reception shaft. The depths

of the reception and launch pits will be dependent on the local topography of the crossing alignment and will vary depending on the river depth and height of road/rail crossings compared to adjacent land.

It has been assumed at this design stage that pipejacking/micro tunnelling will be used for all major crossings, including a number of crossings for single carriageway A and B roads. For subsequent stages of design, post Gate 2, there may be opportunities to change the construction type to open cut for some of these road crossings through consultation with the local highway authority, provided that road closures and local traffic diversions are acceptable.

Detailed ground investigation will be required during subsequent stages of design development to confirm the required tunnelling technique taking into account the soil type, groundwater table and tunnel drive length. Tunnel boring machine cutterheads can be configured to suit a wide range of ground conditions. Excavation of trial pits on either side of the tunnel will be required to verify the existing soil conditions and strata levels along the tunnel alignment.

Table 3-4 and

Table 3-5 provide the totalled tunnelled length for each major crossing for Option B and C. The tunnelled lengths have been determined for each crossing using GIS mapping to determine the location of launch and reception shaft locations and taking full account of environmental constraints and site access.

For the river crossings, the shaft locations would be located outside of any environmentally protected areas along the river alignment to avoid any impacts on designated sites and sensitive riverine habitats. This will be a key element of the T2ST design and will require close consultation after Gate 2 with the Environment Agency and Natural England to obtain agreement on the shaft locations, construction methods and tunnel alignments once the preferred option alignment has been identified. Protecting the environment will be of paramount importance for the T2ST scheme.

Table 3-4 - Tunnelled lengths at major crossings: Option B

Pipeline crossing	Option B Total tunnelled length (m)
Railway (Didcot to Swindon main line)	64
A417	52
M4	68
River Lambourn (main river)	251
A4	64
River Kennet (main river) and railway (Newbury to Hungerford line)	698
River Enbourne (main river)	161
A343	38
Bourne Rivulet (main river)	39
Railway (Andover to Whitchurch line)	61
River Test (main river)	342
A303	86
River Dever (main river)	281
A30	34
A272	90
A3090	41
A303 (2) Andover spur	83
A303 (3) Andover spur	341
Ancient woodland crossings	135 (1No.)
B Roads (6No.)	296 (6No.)
Number of tunnelled crossings	25
Total tunnelled length	3,225m

Table 3-5 - Tunnelled lengths at major crossings: Option C

Pipeline crossing	Option C Total tunnelled length (m)
Railway (Didcot to Swindon main line)	64
A417	52
M4	68
River Lambourn (main river)	251
A4	64
River Kennet (main river) and railway (Newbury to Hungerford line)	698
River Enbourne (main river)	91
A34	239
A343	63
Railway (Andover to Whitchurch line)	43
River Test (main river)	341
A34	115
A303	86
River Dever (main river)	281
A30	34
A272	90
A3090	41
A34 (Beacon Hill spur)	80
River Test (main river)	342
A303 (2) Andover spur	83
A303 (3) Andover spur	341
Ancient woodland crossings	651 (3No.)
B Roads (6No.)	406 (7No.)
Number of tunnelled crossings	31
Total tunnelled length	4,524m

3.8.3. Geology

From north to south, the proposed pipeline routes for Options B and C cross the western edges of the London Basin and the Weald Anticline and into the northern part of the Hampshire Basin. The superficial deposits predominantly comprise Alluvium, River Terrace Deposits and Head Deposits.

The predominant bedrock strata are the Chalk Group and the Thames Group (largely comprising the London Clay Formation). The Selborne Group, comprising Gault Formation and Upper Greensand Formation, is present at the northernmost section of the pipeline; the Lambeth Group is present in the middle and south of the pipeline sections; and the Bracklesham Group is present at the southern end of the transfer routes. Areas of artificial deposits, including Made Ground and Worked Ground are also likely to be encountered along the proposed pipeline routes.

3.8.4. Hydraulic analysis

Hydraulic analysis has been undertaken for Option B and C to establish the required pipe diameter and preliminary hydraulic grade line, for each flow rate (50, 80 and 120Ml/d) using the Cole-Brook White equation for pressure pipelines and a roughness value of 0.15mm. At this stage of the concept design, it is too early to select the final pipeline material, which could be either ductile iron or welded steel for the range of pipeline diameters and pressure rating required. Final pipe material selection will be completed at detailed design stage including a detailed cost benefit analysis of ductile iron vs welded steel including commercial negotiation with pipe suppliers.

A roughness value of 0.15mm is considered appropriate at this stage of the design for initial pipe sizing. To define the hydraulic design profile, it has been assumed at this stage that working pressure along the pipelines would not exceed 16Bar (PN16 pipework). Other hydraulic design assumptions for the Gate 2 analysis include:

- Peak flowrates in Ml/d and are delivered over a 20-hour period
- The water temperature is 10 degrees C and therefore has a kinematic viscosity of $1.323x10^{-6}m^2/s$
- The discontinuity coefficient is 3.00 per kilometre of pipeline for losses due to bends and valves
- A pump and motor efficiency of 65%

It has also been assumed for Gate 2 that the locations of pumping station and break pressure tanks along the T2ST pipeline for Options B and C are common across the range of scheme capacities considered (50,80 and 120Ml/d). Further hydraulic analysis will be required after Gate 2 once the final preferred option and capacity has been selected and final pipeline alignments and location of pumping stations and break pressure tanks have been finalised. This will require further consultation with NAU, land referencing and consultation with landowners.

The hydraulic analysis also included modelling of the 5Ml/d spur connections to Beacon Hill WSR and 45Ml/d spur connection to Andover for both options.

3.8.4.1. Option B

The hydraulic profile for Option B for the 120Ml/d case is shown in Figure 3.4. Ground level is represented by the blue line, the 16Bar pressure envelope is shown by the red line, and the hydraulic profile by the green line within the 16Bar working pressure limit. Hydraulic profiles for the 50 and 80Ml/d flow options have also been prepared as part of the hydraulic modelling and are similar to the 120Ml/d flow case shown below, with the same ground profile, location of break tanks/pumping stations and hydraulic profile within the 16Bar working pressure limit.

To transfer the T2ST flows (at 50,80 and 120Ml/d) a pumping station (PS1) will be required at the water treatment works site to lift the water to a new break-pressure tank (BPT1) at chainage 13,700m. From BPT1 water would then gravitate through the next section of pipeline to a second pumping station (PS2) at chainage 18,000, where water is pumped to a third pumping station (PS3) at chainage 43,000. Water is then lifted from PS3 to a new break pressure tank at BPT2 at chainage 48,600, from where water gravitates to Crabwood WSR at chainage 81,100 and Yew Hill WSR at chainage 85,000.

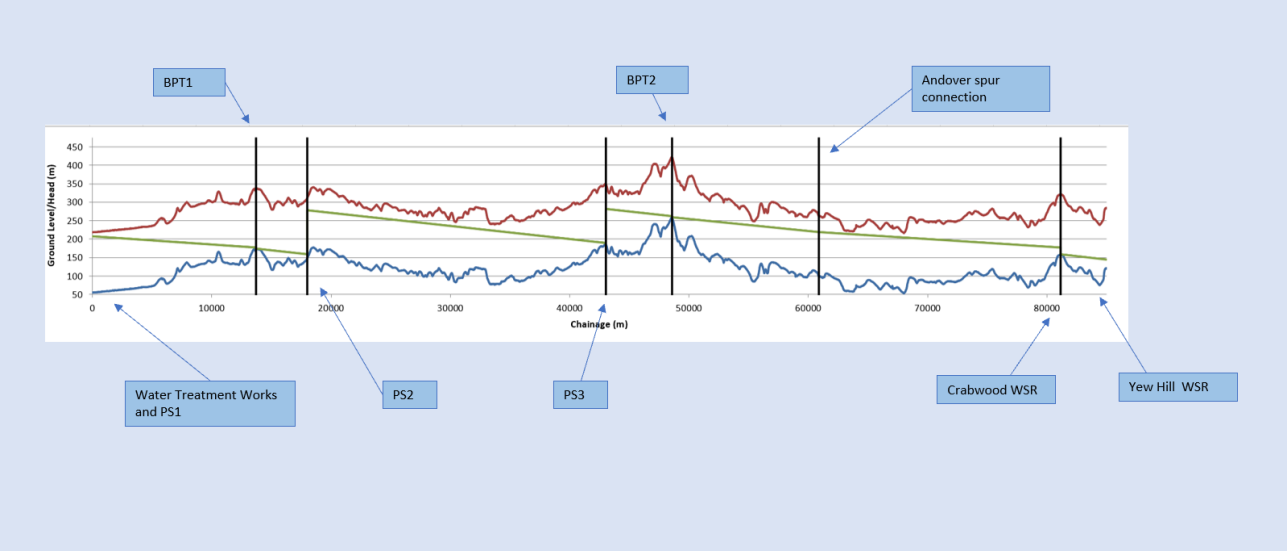


Figure 3.4 - Option B Hydraulic profile

The 5Ml/d Kingsclere WRZ spur for Option B to supply Beacon Hill WSR comprises a 1.8km gravity connection from break pressure tank 2 (BPT2) at chainage 48,600 to Beacon Hill WSR, as shown by the hydraulic profile in Figure 3.5.

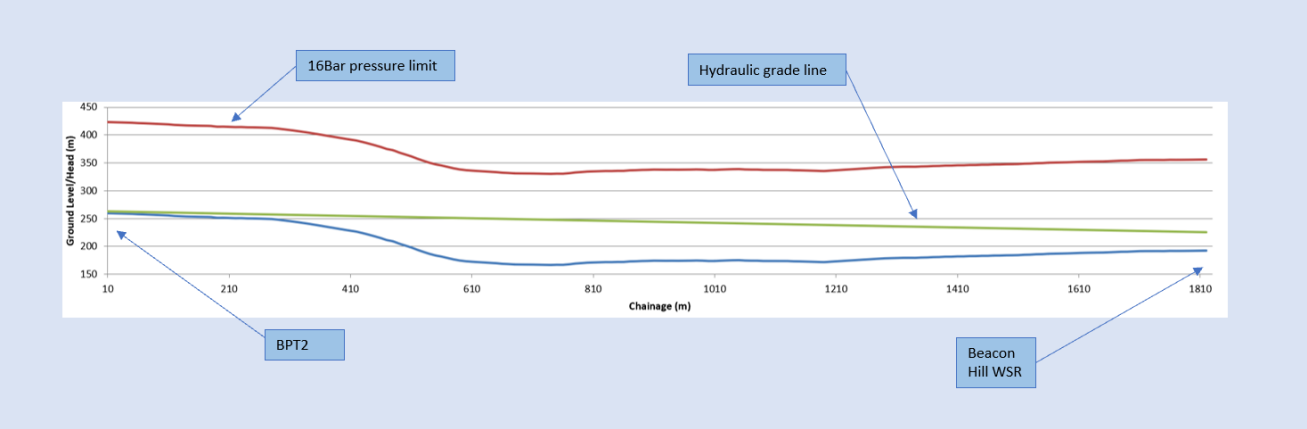


Figure 3.5 - Kingsclere spur hydraulic profile: Option B

The 45Ml/d Andover WRZ spur for Option B comprises a 7km gravity main from a connection to the T2ST pipeline at chainage 60,900 (see Figure 3.3) to the Andover WSR on Micheldever Road, as shown by the hydraulic profile in Figure 3.6.

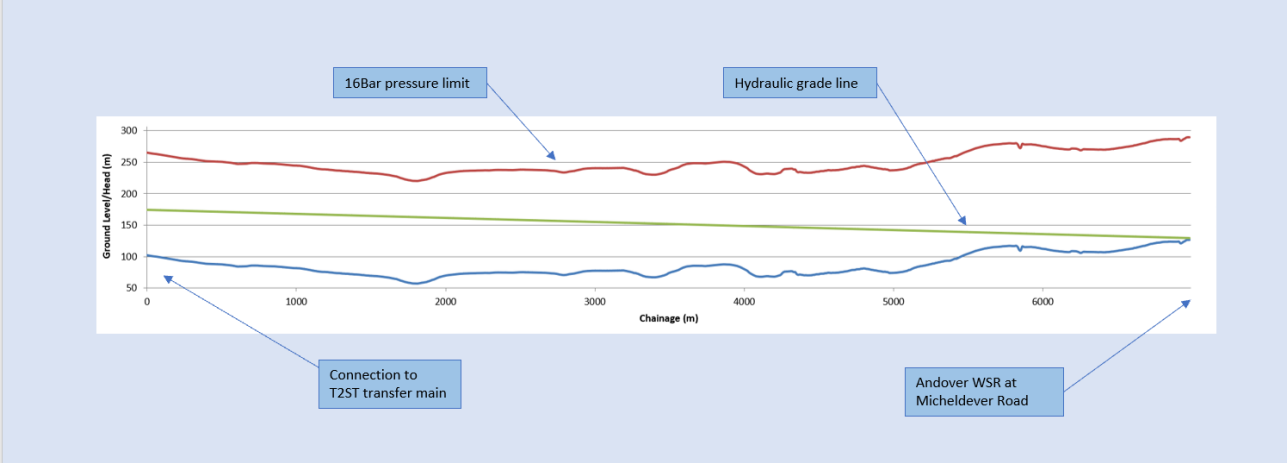


Figure 3.6 - Andover spur hydraulic profile: Option B

3.8.4.2. Option C

The hydraulic profile for Option C for the 120Ml/d case is shown in Figure 3.7. As for Option B ground level is represented by the blue line, the 16Bar pressure envelope shown by the red line, and the hydraulic profile by the green line within the 16Bar working pressure limit. Hydraulic profiles for the 50 and 80Ml/d flow options have also been prepared as part of the hydraulic modelling and are similar to the 120Ml/d flow case shown below.

To transfer the T2ST flows (at 50,80 and 120Ml/d) a pumping station (PS1) will be required at the water treatment works site to lift the water to a new break-pressure tank (BPT1) at chainage 13,700m. From BPT1 water would then gravitate through the next section of pipeline to a second pumping station (PS2) at chainage 18,000, where water is pumped to a third pumping station (PS3) at chainage 49,100. Water is then pumped from PS3 to Crabwood WSR at chainage 77,000, and then gravitates from Crabwood WSR to Yew Hill WSR at chainage 80,800.

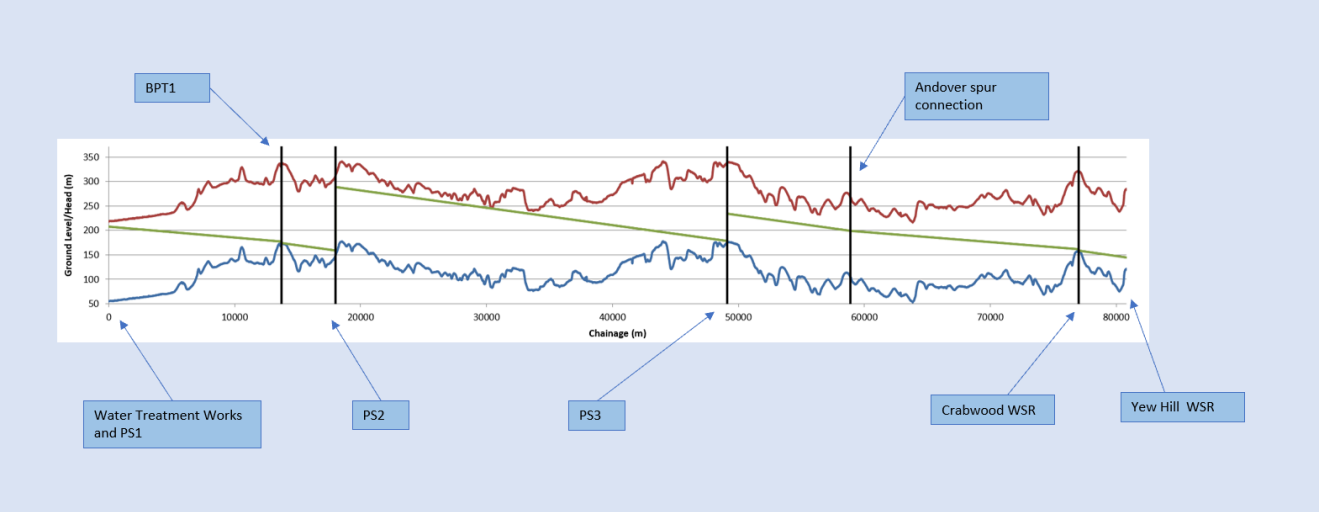


Figure 3.7 - Option C Hydraulic profile

The 5Ml/d Kingsclere WRZ spur for Option C to supply Beacon Hill WSR comprises a 7.0km pumped connection from pumping station 3 (PS3) at chainage 49,100 (see Figure 3.7) to Beacon Hill WSR, as shown by the hydraulic profile in Figure 3.8.

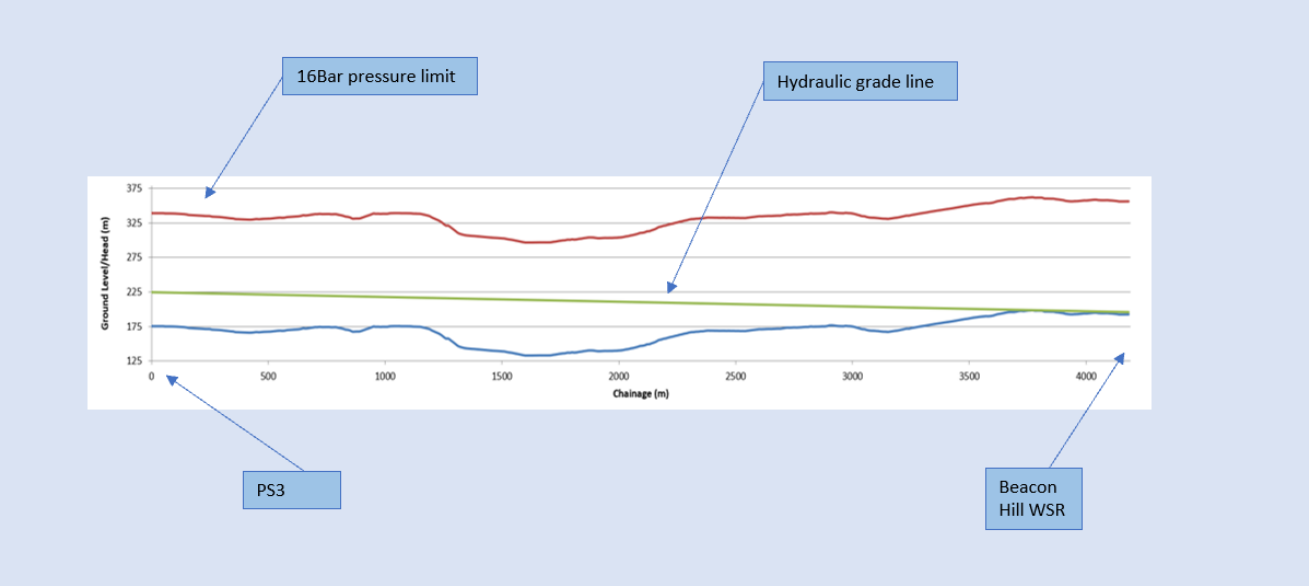


Figure 3.8 - Kingsclere spur hydraulic profile: Option C

The 45Ml/d Andover WRZ spur for Option C comprises a 9.2km gravity main from a connection to the T2ST pipeline at chainage 58.900 (see Fig 3.7) to the Andover WSR on Micheldever Road, as shown by the hydraulic profile in Figure 3.9.

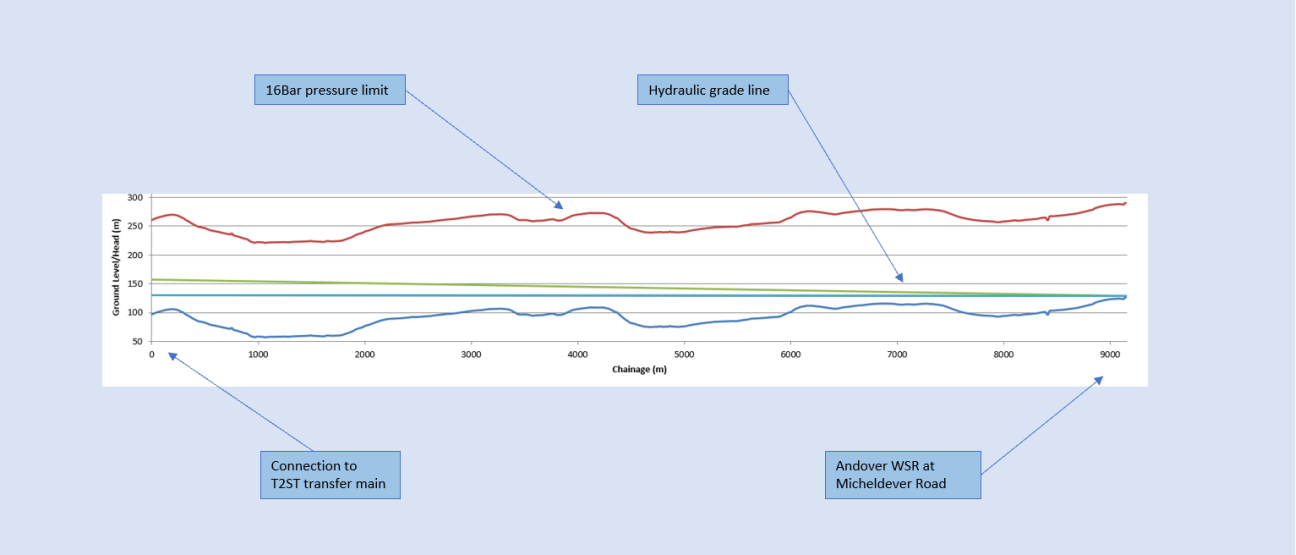


Figure 3.9 - Andover spur hydraulic profile: Option C

3.8.4.3. Pipe diameters, flow velocity and power ratings

Preliminary pipeline diameters, flow velocity and pumping station power ratings for Option B and C are shown below in Table 3-6 and Table 3-7. At this stage of design development flow velocity has been limited to around 2m/s at peak flow rate for preliminary pipeline sizing. Optimisation of pipe diameters will be undertaken post Gate 2 based on whole life costs of the transfer system, once the final T2ST preferred option is determined and the final scheme capacity and utilisation of the transfer has been finalised. Subject to optimisation analysis pipe diameters could be marginally reduced and flow velocities increased to reduce the whole life cost of the transfer.

Table 3-6 - Pipe diameters, pumping station power requirements and storage tank volumes (Option B)

Option B Conveyance	Flow Rate Ml/d		
	50	80	120
WTW treated storage tank capacity (Ml) – 6hr storage	12.5	20.0	30.0
PS1 (kW)	1,556	2,667	3,841
PS1 to BPT1 - internal pipe diameter (mm)	800	900	1100
PS1 to BPT1 - flow velocity (m/s)	1.33	1.69	1.69
BPT1 capacity (Ml) – 1hr storage	2.0	3.5	5.0
BPT1 to PS2 - internal pipe diameter (mm)	700	900	1000
BPT1 to PS2 - flow velocity (m/s)	1.74	1.69	2.05
PS2 (kW)	1,410	1,825	3,281
PS2 – storage tank capacity – 1hr storage	2.0	3.5	5.0
PS2 to PS3 - internal pipe diameter (mm)	700	900	1000
PS2 to PS3 - flow velocity (m/s)	1.74	1.69	2.05
PS3 (kW)	1,008	1,712	2,397
PS3 – storage tank capacity – 1hr storage	2.0	3.5	5.0
PS3 to BPT2 - internal pipe diameter (mm)	700	800	1000
PS3 to BPT2 - flow velocity (m/s)	1.74	2.13	2.05
BPT2 capacity (Ml) – 1hr storage	2.0	3.5	5.0

Option B Conveyance	Flow Rate Ml/d		
	50	80	120
BPT2 to Andover spur - internal pipe diameter (mm)	600	800	1000
BPT2 to Andover spur - flow velocity (m/s)	2.13	2.0	1.97
Andover spur to Crabwood WSR - internal pipe diameter (mm)	-	700	900
Andover spur to Crabwood WSR - flow velocity (m/s)	-	1.05	1.47
Crabwood WSR to Yew Hill WSR - internal pipe diameter (mm)	-	600	800
Crabwood WSR - flow velocity (m/s)	-	1.42	1.86
BPT2 to Beacon Hill WSR - internal pipe diameter (mm)	250	250	250
BPT2 to Beacon Hill WSR – flow velocity (m/s)	1.33	1.33	1.33
T2ST main to Andover WSR - internal pipe diameter (mm)	700	700	700
T2ST main to Andover WSR – flow velocity (m/s)	1.57	1.57	1.57
PS at Andover WSR to Crabwood (kW)	710	710	710

Table 3-7 - Pipe diameters, pumping station power requirements and storage tank volumes (Option C)

Option C Conveyance	Flow Rate Ml/d		
	50	80	120
WTW treated storage tank capacity (Ml) – 6hr storage	12.5	20.0	30.0
PS1 (kW)	1,556	2,667	3,841
PS1 to BPT1 - internal pipe diameter (mm)	800	900	1100
PS1 to BPT1 - flow velocity (m/s)	1.33	1.69	1.69
BPT1 capacity (Ml) – 1hr storage	2.0	3.5	5.0
BPT1 to PS2 - internal pipe diameter (mm)	700	900	1000
BPT1 to PS2 - flow velocity (m/s)	1.74	1.69	2.05
PS2 (kW)	1,521	1,898	3,522
PS2 – storage tank capacity – 1hr storage	2.0	3.5	5.0
PS2 to PS3 - internal pipe diameter (mm)	700	900	1000
PS2 to PS3 - flow velocity (m/s)	1.74	1.69	2.05
PS3 (kW)	464	821	1,414
PS3 – storage tank capacity – 1hr storage	2.0	3.5	5.0
PS3 to Andover spur - internal pipe diameter (mm)	600	800	1000
PS3 to Andover spur - flow velocity (m/s)	2.13	2.0	1.97
Andover spur to Crabwood WSR - internal pipe diameter (mm)	-	700	900
Andover spur to Crabwood WSR - flow velocity (m/s)	-	1.05	1.47
Crabwood WSR to Yew Hill WSR - internal pipe diameter (mm)	-	600	800
Crabwood WSR - flow velocity (m/s)	-	1.42	1.86
BPT2 to Beacon Hill WSR - internal pipe diameter (mm)	250	250	250
BPT2 to Beacon Hill WSR – flow velocity (m/s)	1.33	1.33	1.33
T2ST main to Andover WSR - internal pipe diameter (mm)	700	700	700

Option C Conveyance	Flow Rate Ml/d		
	50	80	120
T2ST main to Andover WSR – flow velocity (m/s)	1.57	1.57	1.57
PS at Andover WSR to Crabwood (kW)	710	710	710

3.8.5. Water Storage

At this stage of concept design, it is expected that the transfer would only be required in periods of extreme drought, but increased utilisation of the transfer may be required to meet longer term supply demand balance needs of the Hampshire region, depending on the implementation and timing of other schemes and future environmental ambition targets. Given the expected infrequent use of the scheme at peak flow the approach to water storage at Gate 2 has been to minimise storage volumes within the transfer to minimise sweetening flows.

For Gate 2 it has been assumed that a 6hr treated water storage tank would be provided at the outlet of the water treatment works, to provide sufficient buffer storage for planned and unplanned outage of the treatment process. This a standard minimum storage level for water treatment works within the UK water industry and is consistent with the approach being adopted by other SRO schemes. Break pressure tanks have been sized at a minimum capacity of 1hr storage, including at each of the intermediate pumping station along the transfer main. Breaking the pressure head at the pumping stations will provide greater hydraulic control of the transfer system and allow for dosing points for booster chlorination if required.

Southern Water have advised that no additional storage will be required at the T2ST receiving service reservoirs within the Southern Water supply network, at Beacon Hill WSR, Andover WSR, Crabwood WSR and Yew Hill WSR.

3.8.6. Surge analysis

Surge analysis has been undertaken using VariSim (version 4.0) by Simulation Software Limited, for Option B and C. The simulated flow analysis shows the head fluctuations which arise in the system following a power failure of the pumping stations with no surge vessels in place. This analysis has confirmed that without surge vessels installed pressures fluctuate throughout the pumped sections of the system with significant portions of sub-atmospheric pressures down to vapour pressure resulting in cavitation. The pressures also rise above the 16bar operating pressure of the system.

Surge vessel volumes for both options are shown in Table 3-8 and Table 3-9 below at the maximum 120Ml/d flow case. purposes. With the surge vessels in place, pressure head fluctuations are more gradual as flow out of the vessels compensates for the loss of flow from the pumps; no sub-atmospheric pressures occur, and the maximum pressures stay below the 16bar operating pressure limit of the pipework. A standby tank has been allowed at each pumping station site to allow for maintenance during operation.

Table 3-8 - Surge tank sizing: Option B

Pumping Station	Total surge volume required (m^3)	Vessel volume (m^3)	Vessel No.
PS1	375	125	4
PS2	550	137.5	5
PS3	175	87.5	3

Table 3-9 - Surge tank sizing: Option C

Pumping Station	Total surge volume required (m^3)	Vessel volume (m^3)	Vessel No.
PS1	375	125	4
PS2	675	137.5	6
PS3	250	87.5	4

3.8.7. Summary of Infrastructure requirements

A summary of the water treatment and transmission elements for Option B and C is provided in Table 3-10

Table 3-10 - Summary of Infrastructure requirements Option B and C

Option B (50,80 and 120Ml/d)	Option C (50,80 and 120Ml/d)
WTW west of A34 near Drayton. Intake from SESRO or STT	WTW west of A34 near Drayton. Intake from SESRO or STT
Treated Water storage tank (6hr)	Treated Water storage tank (6hr)
Pumping Station at WTW (PS1)	Pumping Station at WTW (PS1)
Pipeline to break pressure tank 1 (BPT1) 13.7km 800, 900 or 1100mm diameter	Pipeline to break pressure tank 1 (BPT1) 13.7km 800, 900 or 1100mm diameter
Break pressure tank BPT1 (1hr)	Break pressure tank BPT1 (1hr)
Gravity pipeline BPT1 to Pumping station 2 (PS2) 4.3km 700, 900 or 1000mm diameter	Gravity pipeline BPT1 to Pumping station 2 (PS2) 4.3km 700, 900 or 1000mm diameter
PS2 and break pressure tank (1hr)	PS2 and break pressure tank (1hr)
Pipeline from PS2 to Pumping Station 3 (PS3) 25km 700, 900 or 1000mm diameter	Pipeline from PS2 to Pumping Station 3 (PS3) 25km 700, 900 or 1000mm diameter
PS3 and break pressure tank (1hr)	PS3 and break pressure tank (1hr)
Pipeline from PS3 to break pressure tank 2 (BPT2) 5.5km 700, 800 or 1000mm diameter	Pipeline from PS3 to Andover spur 9.8km 600, 800 or 1000mm diameter
Break pressure tank BPT2 (1hr)	
Pipeline from BPT2 to Andover spur 12.3km 600, 800 or 1000mm diameter	
Pipeline from Andover spur to Crabwood WSR 20.2km 700 or 800mm diameter	Pipeline from Andover spur to Crabwood WSR 18.1km 700 or 800mm diameter
Gravity pipeline from Crabwood WSR to Yew Hill WSR (80 and 120Ml/d cases only) 600 or 800mm diameter	Gravity pipeline from Crabwood WSR to Yew Hill WSR (80 and 120Ml/d cases only)
T2ST spur to Kingsclere WRZ. Gravity pipeline from BPT2 to Beacon Hill WSR 250mm diameter	T2ST spur to Kingsclere WRZ. Pipeline from PS3 to Beacon Hill WSR
T2ST spur to Andover WRZ. Pipeline from T2ST main to Andover WSR at Micheldever Road 700mm diameter	T2ST spur to Andover WRZ. Pipeline from T2ST main to Andover WSR at Micheldever Road
Pumping station at Andover WRZ to reverse flow to Crabwood WSR through proposed Andover Link Main.	Pumping station at Andover WRZ to reverse flow to Crabwood WSR through proposed Andover Link Main

Details of pipe sizes, pipe lengths, break tank sizing and pumping station power ratings are also provided in Table 3-2, Table 3-3, Table 3-7 and Table 3-8.

4. Scheme Operation

It is expected that in normal year operation, T2ST will not be required to meet demand in Hampshire and that the transfer will be operated at a minimum sweetening flow only to maintain water quality within the transfer system. The transfer is only expected to be required at peak flow at times of extreme drought.

Utilisation of T2ST during drought events will be provided by a Pywr water resources model of the Hampshire supply area that is currently being developed by Southern Water and Portsmouth Water. This model is expected to confirm utilisation of T2ST in the autumn of 2022.

The total storage of the T2ST system between the water treatment works and Yew Hill WSR for Options B and C is shown below in Table 4-1 for the 120Ml/d flow case, comprising the volume of the T2ST pipeline and storage/break pressure tanks.

Table 4-1 - T2ST total storage: Options B and C at 120Ml/d)

	Option B storage (Ml)	Option C storage (Ml)
T2ST pipeline volume	65	62
WTW treated water tank (6hr storage)	30	30
BPT1 (1hr storage)	5	5
PS2 break tank (1hr storage)	5	5
PS3 break tank (1hr storage)	5	5
BPT2 (1hr storage)	5	-
Total storage	115	107
Time of travel at peak flow	23hrs (<1day)	21hrs (<1day)
Time of travel at sweetening flow of 30%	3.2 days	3.0 days
Time of travel at sweetening flow of 15%	6.4 days	5.9 days

During times of normal operation in normal weather years when T2ST will not be required by Southern Water to meet customer demand, it will be necessary to minimise the sweetening flow through the pipeline and storage tanks to minimise opex. The sweetening flow received by Southern Water will need to be blended with local sources within the receiving service reservoirs, and abstraction from local resources in Hampshire reduced accordingly. Given the length of the T2ST transfer the operational cost of the T2ST water will be higher than that of local Southern Water sources and hence the sweetening flow will need to be turned down to a minimum level, to maintain the quality of water within the T2ST transmission main and on-line storage tanks.

Table 4-1 shows that for the peak flow rate the time of travel between the water treatment works and Yew Hill service reservoir (the longest transfer length within the T2ST system) is less than 1 day. With sweetening flow at 30% of peak capacity the travel time is increased to around 3 days and with a lower sweetening flow of 15% travel times increase to approximately 6 days, keeping within a 7-day water age limit.

For costing purposes for Gate 2 the lower sweetening flow of 15% has been adopted for Gate 2, to minimise the operating costs of the transfer in a normal operating year, as agreed with Southern Water at this stage of the scheme development. A 15% sweetening flow can be accommodated within the design of the water treatment works but will need to be determined at the outset of outline and detailed design to ensure this is taken into account in the design of treatment processes and pumping and dosing equipment. Further work to confirm the final sweetening flow requirements will be required post Gate 2 once the scheme capacity and utilisation of T2ST has been finalised, in order to minimise the whole life cost.

At 15% sweetening flow with a time of travel of around 6 days there may also be a need for booster chlorination at one of the intermediate pumping stations, which will need to be confirmed through further detailed water quality assessment after Gate 2 once the final scheme capacity and preferred option have been established.

In addition to the sweetening flow requirement to turn over the water stored within the transmission pipeline and storage tanks, conditioning flows will also be required to prevent build-up of sediment within the treated water main, typically by operating the transfer scheme at full flow capacity for 1-2hours per week. The frequency and duration of conditioning flows will be confirmed during detailed design based on the final utilisation of the transfer system and water quality.

5. Economics and Carbon Costs

5.1. Gate 2 cost and carbon estimates

At Gate 1, capital and operational cost estimates for the T2ST options, were derived using Thames Water costs as provided by the Thames Water Engineering Estimating System (EES). Embedded and operational carbon values were also derived using the EES model.

For Gate 2 the cost and carbon estimates for the preferred options (B and C) have been priced by the Southern Water Cost Intelligence Team (CIT) using Southern Water cost and carbon data, in accordance with the ACWG cost consistency methodology. This approach for Southern Water to price the T2ST options for Gate 2 was agreed by Thames Water and Southern Water on the basis that Southern Water will be the recipient of water provided by the T2ST scheme.

The output from this work is documented by the Gate 2 Costs and Carbon Report, Annex A4. Estimates have been provided at 50, 80 and 120Ml/d capacity for both options.

The cost and carbon estimates for Options B and C have been based on quantities for each option, which have been collated and issued to the cost estimating team. These include:

- Pipeline length within roads/field
- Pipe diameter
- Pipe material (ductile iron PN16 pipework for T2ST main, and welded steel sections at major crossings)
- Length and diameter of concrete sleeve for tunnelled sections
- Depth and diameter of launch and reception shafts for tunnelled sections
- Water treatment process type and chemical dosing rates
- Land purchase areas at all surface sites including water treatment works, pumping stations, break pressure tanks, and permanent access roads
- Number of washout and air valve chambers for pipeline transfers
- Number of vertical and horizontal bends for pipeline transfers
- Number of gate valves
- Capacity and plan area of storage tanks
- Number of minor road crossings for pipeline transfers
- Flow monitoring requirements for pipeline transfers
- Temporary working areas and durations for construction compounds, construction access, and pipeline easement
- Pumping station power ratings (kW)
- Water treatment works power rating (kW)
- Maximum flow rate and sweetening flow (15%)

6. Deployable Output Assessment

6.1. T2ST DO assessment

As part of the T2ST Gate 2 submission an assessment of the deployable output (DO) benefits of T2ST has been undertaken by Atkins using a Pywr water resources model. The key focus of this assessment was to establish whether there is likely to be 'conjunctive use' DO benefit through a link between the River Thames and Southern Water's Hampshire supply area. That is, if the DO benefit of the transfer scheme to Southern Water is greater than the loss of DO to Thames Water (the "dis-benefit") from implementing the T2ST scheme. Conjunctive use benefit is dependent on the different characteristics of the Thames Water and Southern Water systems, including potential incoherence of timing or impact of extreme droughts in the geographically separate River Thames and Itchen systems, and differences in the drought vulnerability of the two supply systems.

Modelling assumptions

In order to conduct this investigation, a number of modelling assumptions were made, including:

- Two variants of the T2ST scheme were examined – supplies of 80Ml/d and 120Ml/d capacity. (Subsequent WRSE investment modelling will confirm the required capacity for the T2ST scheme)
- It was assumed, based on the latest WRSE investment modelling outputs available at the time of analysis, that no spur would be required to provide supply to South East Water, or to Thames Water's Kennet Valley WRZ
- No interactions with other options in the Southern Water Western area were considered in this analysis – i.e. it did not allow for potential supplies from Havant Thicket reservoir, or increased bulk supplies from Portsmouth Water).
- It was not critical during this initial analysis to examine the specific source of the abstraction. It was therefore modelled simply as a direct abstraction from the River Thames.
- The use of the transfer is triggered when all other sources in the Hampshire Southampton East WRZ can no longer provide sufficient water to meet demand.

Table 6-1 presents the dry year annual average modelling outputs of the DO assessment of the T2ST impact on Southern Water and Thames Water. This work concludes that the net conjunctive use benefit of T2ST is around 34Ml/d for T2ST scheme capacity of 80Ml/d at a 1:500 return period, increasing to a conjunctive use benefit of 48Ml/d for scheme capacity of 120Ml/d.

Table 6-1 - Summary of conjunctive use assessment of the T2ST scheme

T2ST scheme variant	Return period	T2ST benefit to Southern Water	T2ST disbenefit to Thames Water	Net conjunctive benefit of the T2ST scheme
80Ml/d capacity	100	76	-34	43
	500	77	-43	34
120Ml/d capacity	100	114	-52	62
	500	115	-66	48

7. T2ST Construction

7.1. Construction Methodology

The construction of T2ST would be a major infrastructure project, with an expected capital value of circa £750-800m for the 120Ml/d scheme option, providing significant opportunities for contractors and suppliers. Capex and opex estimates for the T2ST options are presented in the Costs and Carbon Report, Annex D.

As part of the Gate 2 concept design, preliminary assessment of construction methodology and programme for T2ST has been undertaken by the Atkins Construction Management team. This has included the following:

- Review of site access requirements for the pipeline, major crossings and above ground infrastructure sites, including the water treatment works, pumping stations and break pressure tanks
- Review of working areas including pipeline easement, construction compounds and storage areas along the pipeline routes
- Assessment of construction methodology, testing and commissioning approach
- Development of a preliminary construction programme using Primavera P6 software
- Assessment of contract strategy

Quantities for permanent and temporary site access and temporary working areas were provided to the T2ST cost estimating team as part of the Option B and C pricing work, for the 50, 80 and 120Ml/d flow capacities. An average pipeline easement width of 30m has been assumed for pipe diameters up to 800mm diameter and a 40m average working width for pipe diameters 900-1100mm diameter. Subject to future ground investigation during detailed design it may be possible for some limited reduction in working width, but these values are considered appropriate for this stage of design and cost estimating.

7.2. Construction Programme

Given the long length of pipeline for Option B (93.8km) and Option C (94.2km) it is considered that construction of the pipeline would be split into three separate contracts (northern, central and southern sections). For preliminary development of the construction programme the pipe sections were assumed as follows, noting that the actual boundary locations between contracts will change as the scheme design develops and the final preferred T2ST option is selected.

- Northern section: WTW to west Newbury (37.3km), Option B and C
- Central section: West Newbury to Andover (37.8km Option B), (38.3km Option C)
- Southern Section: Andover to Yew Hill (18.7km)

The contractor appointed for each section would be responsible for construction and commissioning of all works within that section including the pipeline and major crossings, and the above ground infrastructure sites including pumping stations and break pressure tanks. Given the length of the pipeline it is considered that letting all works together under one single contract or two contracts would increase project risk given the high levels of construction personnel and equipment required.

A fourth construction contract has been assumed for construction and commissioning of the water treatment works. It is envisaged at this preliminary stage that the contractor for the water treatment works will also have overall responsibility for commissioning the whole scheme to enable water to be pumped and controlled from the treatment works to the receiving water service reservoirs in Hampshire, following construction and testing of the three pipeline sections. Further detailed assessment to identify the preferred contract strategy for T2ST will be undertaken post Gate 2.

The draft programme is based on the largest T2ST capacity (120Ml/d) and assumes that the works within each section of pipeline cannot start until the construction compounds are completed. Following allowance for setting up the pipeline easement, access agreements and ecological works, it is assumed that the pipeline works, major crossings, pumping station sites and break pressure tanks are constructed in parallel to minimise the construction duration. Allowance has also been made for open cut crossings of minor roads and associated traffic diversions. The programme has been developed so that construction of the tunnelled sections beneath major crossings are coordinated with construction and testing of the pipeline works.

At this stage of design it has been assumed that the pipeline would be tested in section lengths of approximately 2km, with water provided from the local distribution network through temporary supply connections. This will require detailed consultation with Thames Water and Southern Water as the scheme developed to agree temporary supply connections depending on the availability of treated water local to the pipeline alignment. Each 2km test section would have a volume of around 1-1.5Ml with multiple fills required for hydrostatic testing and commissioning of the pipeline.

The programme analysis has shown that the pipeline contracts are driving the overall programme with a duration of 4.5years for the two longest pipeline sections (northern and central sections). The construction programme for the water treatment works is estimated as four years for construction and commissioning. With allowance for integration and commissioning of the whole scheme, the total construction programme for T2ST from the start of construction works to final commissioning is estimated as 5 years. Within the scheme delivery programme (Appendix B) a 1 year mobilisation period is also assumed prior to construction following contract award, as shown in Figure 7.1

	Year 0	Year 1		Year 2		Year 3		Year 4		Year 5	
		Q1/2	Q3/4	Q1/2	Q3/4	Q1/2	Q3/4	Q1/2	Q3/4	Q1/2	Q3/4
Mobilisation											
Pipeline contract - Southern											
Pipeline contract - Central											
Pipeline contract - Northern											
Water Treatment Works											
Testing and Commissioning											

Figure 7.1 - T2ST Preliminary Construction Programme: Options B and C

8. Assumptions, Risks and Opportunities

8.1. T2ST Project Need

This report sets out the concept design for the 2No. preferred options for T2ST, Options B and C. Both options are feasible but significant uncertainty remains concerning the required need and timing for the transfer, which is dependent on the outcome of water resource modelling as part of the WRSE draft Regional Plan and WRMP24 strategic planning by Southern Water and Thames Water.

It is important to recognise that there are a number of potential solutions to the long term water supply needs of the Hampshire supply area as set out in Table 8-1, which will directly affect the scheme need case for T2ST. These include potential transfers from Havant Thicket Reservoir, and potential water transfers to Hampshire from the West Country South and West Country North SROs.

As set out in the scheme delivery section of this report, T2ST must be identified as a preferred long term solution for Hampshire supply area, as part of the WRSE Regional Plan and WRMP24, to enable design and planning for the transfer to continue. T2ST is also dependent on the construction and commissioning of either SESRO or STT to provide a reliable source of water for transfer to Hampshire.

Table 8-1 - Inter-related schemes affecting the need and timing of T2ST

Scheme	Description and interaction with T2ST	Earliest potential construction completion	Planning stage
SESRO	South East Strategic Reservoir Option. New reservoir development near Abingdon. Potential water source for T2ST	2038	SRO Gate 2 November 2022
STT	River Severn to River Thames Transfer. Potential water source for T2ST	In 2033	SRO Gate 2 November 2022
Havant Thicket Reservoir	Treated water transfer from Havant Thicket to Gaters Mill. Transfer from Portsmouth Water to Southern that could affect timing and capacity of T2ST	Southern Water's WRMP19 option for potential construction within AMP8 by 2029	Reservoir planning consent implementation commenced in 2022
Southampton Link Main	New 60Ml/d potable water main from Otterbourne (Yew Hill WSR) to Testwood (Rownhams WSR), within Southern Water supply area, and would transfer the T2ST water to the Hampshire Southampton West Water Resource Zone.	Southern Water's WRMP19 option with planned construction by 2027	Non-SRO scheme Currently starting on site surveys (Engineering, Environmental, Archaeological etc) Construction start planned for late 2024
Andover Link Main	15Ml/d potable water main from Otterbourne to Andover (via Yew Hill WSR). Transfer pipeline could be utilised by T2ST scheme. The first section from Otterbourne to Yew Hill WSR would be used in reverse to transfer water from T2ST to the Hampshire Southampton East Water Resource Zone.	Southern Water's WRMP19 option with planned construction by 2027	Non-SRO scheme Implementation to commence in AMP7 Currently starting on site surveys (Engineering, Environmental, Archaeological etc) Construction start planned for late 2024
Hampshire Water Transfer and Water Recycling Project	Raw water transfer to Otterbourne WTW. Transfer from Portsmouth Water to Southern that could affect timing and capacity of T2ST	Southern Water's WRMP19 option with planned construction by 2027	Non-statutory consultation for DCO commenced in July 2022 DCO submission expected 2024

In addition to the number of potential water resource solutions for the Hampshire supply area, there is also uncertainty around the long-term water resource need in terms of future demand growth and water required to meet environmental ambition targets and ensure sustainable abstraction is achieved in the long term to protect the environment.

8.2. Key Risks and Opportunities

Key risks and opportunities for T2ST have been identified during the Gate 2 concept design stage as summarised below. These issues will be kept under constant review as the design continues to develop to Gate 3 and beyond to ensure the optimum design solution for T2ST is delivered to meet the strategic water resource requirements of the region.

Key Risks

- T2ST is not supported by WRSE Regional Plan and WRMP24. Project need cannot be established
- T2ST is dependent on SESRO or STT being commissioned to provide a water source for transfer. Hence the timing of T2ST is tied to SESRO/STT
- Environmental impacts lead to objections from stakeholders, with mitigation to be achieved through careful routeing of pipe corridors away from designated sites and use of trenchless construction
- Local planning opposition to development of above ground assets, including water treatment works, pumping stations and storage tanks
- Construction staff and material availability given scale of scheme
- Maintaining water quality given the long transmission length for T2ST and storage volumes

Key Opportunities

- Provision of a strategic water transfer providing long term resilience of water supplies within the Hampshire region, including Southern Water, South East Water and Portsmouth Water
- Opportunities for utilising existing Southern Water assets for the distribution of T2ST water including the planned Andover Link Main and Southampton Link Main
- Opportunities for improving the resilience of water supplies to Thames Water Kennet Valley
- Opportunities during construction for habitat creation, biodiversity net gain and carbon offsetting initiatives

8.3. T2ST Preferred Option

The concept design of the 2No. preferred options (B and C) for T2ST has been developed and set out within Section 3 of this report. The concept design carried out for Gate 2 has demonstrated that both options are feasible for the bulk transfer of water from Thames Water to the Southern Water network in Hampshire.

It is however too early to confirm the final preferred option and further work will be required following Gate 2 to establish the final preferred T2ST option post Gate 2. Key areas for further option development are set out as follows:

1. T2ST timing and capacity	The required capacity and timing of T2ST is dependent on the outcome of the WRSE Regional Plan. This will confirm any requirements for spur connections to South East Water or Thames Water Kennet Valley. At this stage it is expected that the transfer would only be required in periods of extreme drought but increased utilisation of the transfer may be required to meet the longer term supply demand balance of the Hampshire region depending on the implementation and timing of other schemes and future environmental ambition targets.
2. T2ST utilisation	Utilisation of T2ST during drought events will be confirmed by a Pywr water resources model of the Hampshire supply area that is currently being developed by Southern Water and Portsmouth Water. Model outputs from this model are expected in the autumn of 2022.

3. Site Selection and Route Corridor	The Route and Site Assessment - Preferred Option Report, Annex A2 (doc ref: T2ST-G2-REP-02), has established the 2No. preferred options B and C. Consultation on these two routes has commenced with local planning authorities and other stakeholders including the NAU and North Wessex Downs AONB unit. Post Gate 2 further detailed assessment will be required to assess feedback from this consultation process and to gain full understanding of planning consent risks of the route corridors and above ground infrastructure sites, particularly at pinch points, where options for route deviation are limited. This will include work to further define the locations of water treatment works, break pressure tanks and pumping stations; landowner referencing for above ground sites; statutory utility searches for pipelines and infrastructure sites; and connection details to the abstraction source and the Southern Water supply network. This work will allow an informed decision to be taken on the final preferred option.
4. Receiving Network improvements	Through consultation with Southern Water the destination points for T2ST and interface with the Southern Water network have been agreed. Further work will be required post Gate 2 to assess requirements for distribution of T2ST water within the receiving treated water network, once the final timing and capacity of T2ST is known. This will include water quality assessments to ensure there are no residual risks such as taste/odour or corrosivity issues. Further work will also be required to confirm sweetening flow requirements once the scheme capacity and utilisation has been finalised.

9. Glossary

Acronym	Definition
AA	Appropriate Assessment
ACWG	All Companies Working Group
BNG	Biodiversity Net Gain
BPT	Break Pressure Tanks
CPO	Compulsory Purchase Order
CAP	Competitively Appointed Provider
DCO	Development Consent Order
EA	Environment Agency
EAR	Environment Assessment Report
DAF	Dissolved Air Flotation
DYAA	Dry Year Annual Average
GAC	Granular Activated Carbon
HRA	Habitats Regulations Assessment
INNS	Invasive Non-Native Species
LPA	Local Planning Authority
NAU	National Assessment Unit
NC	Natural Capital
NPS	National Planning Specification
NSIP	Nationally Significant Infrastructure Project
AONB	Area of Outstanding Natural Beauty
PMB	Project Management Board
RAPID	Regulators' Alliance for Progressing Infrastructure Development
RGF	Rapid Gravity Filter
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SESRO	South East Strategic Reservoir Option
SEW	South East Water
SPA	Special Protection Area
SRO	Strategic Resource Option
SSSI	Sites of Special Scientific Interest
STT	Severn Thames Transfer
SWOX	South West Oxfordshire Water Resource Zone
T2ST	Thames to Southern Transfer
WFD	Water Framework Directive
WRMP	Water Resources Management Plan
WRSE	Water Resources South East
WSR	Water Supply Reservoir
WTW	Water Supply Works

Appendices

Appendix A. ACWG Design Principles

A.1. T2ST – ACWG Design principles: Climate

Overarching	Principle	G2 Indicator	Narrative	Where documented in G2 submission?	Target
Climate	Nature knows no boundaries: Water is essential to all life and managing our response to climate change is a collective and urgent activity. Projects must be developed to work across companies and/or legislative boundaries to develop sustainable solutions and environmental enhancement for the wider benefit of society.	1. Evidence of collaborative working across companies. 2. Evidence of working with Regulatory, Statutory (and, where practicable, local) stakeholders including Catchment Partnerships where appropriate. 3. Design Vision and Principles informed by this engagement (Stages 1-6 of design process).	1.1 Collaborative working has been achieved through consultation with water companies, other SROs and engagement with stakeholders, NAU, DWI and RAPID. This has included monthly update calls with the NAU and regular progress calls with DWI and RAPID. 1.2 The WRSE regional plan currently forecasts T2ST being required from 2040 - 2053 depending on the adaptive plan. Timing is under review as the regional plan is finalised. The T2ST project team has kept in close contact with WRSE throughout development of the T2ST solutions including updates to the T2ST WRSE model templates in February 2022. T2ST is unlikely to be required before 2040 and hence will not need to be construction ready until the mid 2030s, and is hence a longer term SRO. 1.3 Full alignment with relevant environmental policy is being achieved as the scheme options are developed through engagement with NAU. Supporting annexes to the T2ST Gate 2 report have been shared with the NAU as the T2ST solutions have been developed including the Options Appraisal Report (A1), Route and Site Selection Report (Annex A2), and Environmental Assessment Report (Annex B1).	*1) Option Appraisal Report (Annex A1)* *2) Route and Site Assessment - Preferred Options Report (Annex A2)* *3) Environmental Assessment Report (Annex B1)* *4) Concept Design Report (Annex A3)* *5) Cost and Carbon report (Annex A4)* *6) Engagement Report (Annex D)*	1.1. Collaborative working across companies and with stakeholders. 1.2. Timely - preparation of proposals ready to construct in 2025-2030 will involve early and rigorous development of design objectives followed by proposals. 1.3. Alignment with other relevant environmental policy, plans and strategies such as Catchment Management and Local Nature Recovery Plans (see also Place 2).

Overarching	Principle	G2 Indicator	Narrative	Where documented in G2 submission?	Target
Climate	Resource and carbon efficient throughout: Projects shall seek to reuse existing assets, eliminate waste (including waste of water) and make efficient use of materials and transport across the whole of the project lifecycle.	1. Submissions to meet expectations of RAPID Gate 2 Guidance. 2. Narrative on the SRO approach to avoiding and reducing the use of carbon and other resources and Inclusion of the approach in the Design Vision and Principles.	2.1/2.3 Carbon values for the T2ST options have been developed in accordance with the ACWG methodology. Embedded carbon will be minimised as the scheme designs are developed by minimising the scheme footprint to meet demand need and through materials selection. 2.2 The scheme options have been developed to integrate with Southern Water assets to minimise carbon impacts. This includes integration with the Southern Water Andover to Crabwood pipeline planned for construction in AMP8. 2.4 T2ST options are being developed to meet the needs of the WRSE regional plan. Sweetening flows will be minimised to reduce operational costs during times of average demand. WTW processes will also be designed to minimise wastewater streams to the environment. During detailed design a testing and commissioning plan will be developed to minimise the use of water during construction.	*1) Option Appraisal Report (Annex A1)* *2) Route and Site Assessment - Preferred Options Report (Annex A2)* *3) Environmental Assessment Report (Annex B1)* *4) Concept Design Report (Annex A3)* *5) Cost and Carbon report (Annex A4)*	2.1. Lifecycle Carbon: Projects shall support the water industry commitment to achieve Net-Zero in terms of operational carbon in accordance with the industry roadmap. Projects must be efficient in embodied carbon in both construction and operation. 2.2. Projects should investigate if existing infrastructure assets could be repurposed and reused. 2.3. Projects should look to avoid unnecessary construction and minimise use of materials 2.4. Projects should seek to minimise the use and waste of water

Overarching	Principle	G2 Indicator	Narrative	Where documented in G2 submission?	Target
Climate	Resilient and adaptable: Design for anticipated future demand at the appropriate scale. Build in the resilience to absorb and recover from the impacts of the extreme events and incremental stresses likely to arise from climate change.	1. Submissions to meet expectations of RAPID Gate 2 Guidance noting the climate change scenario(s) the schemes have been designed to cope with. 2. Review of local plans and strategies that may impact resilience. (G2 or G3 depending on scheme maturity)	3.1 The need for T2ST is being driven by the WRSE plan based on adaptive planning scenarios taking full account of future demand uncertainty and climate change. This process will determine the best value plan for the region including the timing and capacity of T2ST to meet extreme 1:500 drought year events. 3.2 Utilisation of T2ST will be informed by ongoing Pywr resource modelling by Southern Water. The T2ST option design is utilising digital network data from companies as the design solution is progressed, including connectivity to the Southern Water supply network. 3.3 T2ST will provide a key resilience link for Hampshire and the wider region as driven by the WRSE regional plan. 3.4 Site selection for above ground infrastructure sites including break pressure tanks, water treatment and pumping station sites has taken into account local development plans. Development plans will be kept under review as the design solutions develop to identify any potential constraints to proposed infrastructure sites and routeing of the pipeline. 3.5 Environmental impact will be minimised by avoiding disturbance to designated sites and environmental mitigation and enhancement including the use of trenchless technology through consultation with the NAU.	*1) Option Appraisal Report (Annex A1)* *2) Route and Site Assessment - Preferred Options Report (Annex A2)* *3) Environmental Assessment Report (Annex B1)* *4) Concept Design Report (Annex A3)* *5) Cost and Carbon report (Annex A4)*	3.1. Designs should be developed to include proportionate measures to anticipate future extreme events and stresses so that they can resist, absorb, recover and, where necessary, be adapted 3.2. Designs shall support the digitisation of the network at a catchment level using data to inform design, optimise solutions and improve operational efficiency in real time. 3.3. Where proposals add to the resilience of the broader system this should be accounted for in its social value (see Value 3). 3.4. The layout and design of specific elements of infrastructure should be taken in cognisance of planned future development of the immediate area. 3.5. Deploy nature-based approaches to resilience wherever possible (see also Place 2).

A.2. T2ST – ACWG Design principles: People

Overarching	Principle	G2 Indicator	Narrative	Where documented in G2 submission?	Target
People	Understand and respond to your Community's needs: Develop a full understanding of the social context that will be impacted by the project over its lifecycle. Design for how local communities will encounter the infrastructure in their everyday lives during both construction and operation.	1. Indicator for Target 1.1 to be decided by others 2. Initial appraisal of the scheme and its potential to contribute to the UN's Sustainable Development Goals - or other Social Value evaluation process (see also Value 2 and 3). 3. Review of relevant regional/local policy and demographic information and narrative around how it has shaped the draft Vision and Principles for the option	1.1 T2ST is dependent on the prior development and commissioning of either SESRO or STT, depending on the outcome of the WRSE regional plan. Either SESRO or STT will provide a reliable water source for Southern Water and Thames Water customers. Deployable Output modelling of the T2ST options has demonstrated a conjunctive use benefit from the transfer of water between the Thames and Southern region. 1.2 The scheme solution is being developed to maximise wider benefits to society, through the provision of a robust water resource transfer to meet the long term needs of the south east region. Opportunities will also be identified for enhancing the environment as part of the T2ST solution through consultation with the NAU as the design options develop. 1.3 Customer engagement has commenced regarding the T2ST SRO and community views will be addressed through the design development. Information on the T2ST scheme has now been provided on the Thames Water and Southern Water company websites.	*1) Option Appraisal Report (Annex A1)* *2) Route and Site Assessment - Preferred Options Report (Annex A2)* *3) Environmental Assessment Report (Annex B1)* *4) Concept Design Report (Annex A3)* *5) Cost and Carbon report (Annex A4)* *6) Engagement Report (Annex D)*	1.1. Reliable supply of water to customers 1.2. Designs developed to maximise their social value. 1.3. Proposals reflect local community views as to how they interact with and experience the infrastructure as far as possible

Overarching	Principle	G2 Indicator	Narrative	Where documented in G2 submission?	Target
People	Engage widely, early and meaningfully: Work with stakeholders and local communities to develop their understanding of the importance of nature and water conservation. Develop co-design approaches to aspects of the design of infrastructure and associated landscape where practicable.	1. Summary of feedback from stakeholders (either project specific or received to date through the WRMP/Regional Plan process) and narrative around how it has shaped the draft Vision and Principles for the option. 2. Inclusion of engagement activities within the design programme of the project plan for Gate 3 and beyond showing adequate time for community (public) consultation to inform both site selection (where possible) and developed design. 3. The development of tools that will enable successful engagement (e.g. digital models for visualisation/animation, GIS systems, precedent pictures of similar schemes/components) - activity may occur at G2 or G3. 4. Survey information on local needs and preferences in design	2.1 Consultation with stakeholders and customers is progressing to Gate 2. Community engagement will be undertaken post Gate 2 once the final preferred option has been established and site specific layouts developed. 2.2/2.3 The views of customers and communities will be integral to the T2ST design development. The engagement plan for T2ST is set out within the Engagement Report (Annex D). 2.4 Information to the public on the need for the scheme is being provided on the company websites. Further detailed information will be provided through websites and community meetings as the scheme design progresses post Gate 2.	*1) Option Appraisal Report (Annex A1)* *2) Route and Site Assessment - Preferred Options Report (Annex A2)* *3) Environmental Assessment Report (Annex B1)* *4) Concept Design Report (Annex A3)* *5) Cost and Carbon report (Annex A4)* *6) Engagement Report (Annex D)*	2.1. Stakeholders and communities understand the need for the scheme and the nature/appearance of the proposed solution(s). 2.2. The views of local stakeholders have shaped the design, where possible. 2.3. Engagement and consultation with communities has influenced the design (including but not limited to site selection, layout, materials, detailing) making it more acceptable to them. 2.4. The project provides the public with information on the importance of water and/or nature conservation (e.g. through information boards, artwork or digital information)).

Overarching	Principle	G2 Indicator	Narrative	Where documented in G2 submission?	Target
People	Improve access and inclusion: Consider how people move around your works. Maximise opportunities to support active travel and improve recreational access to waterside and green spaces that can improve outcomes for wellbeing, health, local economy, social inclusion and education	1. Mapping of interface with PRoW network* 2. Evidence of engagement with local access groups* 3. Review of Local Cycling and Walking and Infrastructure Plans (LCWIPs) information or similar and note of how the project may impact/enhance it.*	3.1 Opportunities for providing access to open space associated within the T2ST solution will be explored during the development of the scheme design post Gate 2 once the preferred option and pipeline corridor has been established. 3.2 Opportunities for sustainable transport for workers during construction and travel routes will be fully developed as part of the EIA and planning application, to minimise carbon impact and local traffic disruption.	*1) Option Appraisal Report (Annex A1)* *2) Route and Site Assessment - Preferred Options Report (Annex A2)* *3) Environmental Assessment Report (Annex B1)* *4) Concept Design Report (Annex A3)* *5) Cost and Carbon report (Annex A4)* *6) Engagement Report (Annex D)*	3.1. Find opportunities to improve people's health, wellbeing and understanding of the natural environment, through access to waterside and green spaces for recreational and other purposes (see Note 1). 3.2. Maximise opportunities for workers to access sites via sustainable transport during construction and operation. Minimise disruption to travel routes in areas affected by a project during construction and operation. n/a

A.3. T2ST – ACWG Design principles: Place

Overarching	Principle	G2 Indicator	Narrative	Where documented in G2 submission?	Target
Place	Take care: Develop proposals in the spirit of stewardship looking to both the past and future of each context to understand and develop its landscape, cultural heritage, health and sustainability. Work with partners to secure the long-term success of all measures.	1. Evidence of place-based balanced, holistic and long-term decision making in the description of design considerations and development of design vision and principles. 2. Statement on SRO approach to achieving Environmental Net Gain within the Design Vision and Principles. 3. Evidence of review of adopted (or emerging) spatial plans, strategies for the areas impacted by your works (May occur at G2 or G3 depending on scheme maturity). 4. Landscape/townscape character assessments and approach to design specific to context. (May occur at G2 or G3 depending on scheme maturity).	1.1 Environmental net gain will be achieved by the T2ST solution, through provision of compensation habitat. This will be achieved through consultation and agreement with the NAU once the preferred T2ST option has been identified. 1.2 SUDs solutions will be incorporated at all infrastructure sites for the preferred T2ST option to minimise surface water run-off to the local drainage network, including the use of on site retention ponds and permeable surfaces. Opportunities for solar, wind and hydro power as part of the T2ST design will also be explored to reduce power demand on the national grid. 1.3 Local community engagement will be undertaken post Gate 2 once the final preferred T2ST option has been established to maximise benefits to local communities, including access to open space and local environmental enhancements. 1.4 Consultation with English Heritage and LPAs has commenced. This will continue throughout the scheme development to take full account of the natural landscape and heritage. The pipeline route and infrastructure sites will be located to minimise impacts of the scheme on landscape and historic sites.	*1) Option Appraisal Report (Annex A1)* *2) Route and Site Assessment - Preferred Options Report (Annex A2)* *3) Environmental Assessment Report (Annex B1)* *4) Concept Design Report (Annex A3)* *5) Cost and Carbon report (Annex A4)* *6) Engagement Report (Annex D)*	1.1. Achieve Environmental Net Gain (ENG) 1.2. Adopt measures in the design that enhance the environment and help avoid future problems - e.g. adoption of Suds solutions that improve cooling, attenuate surface water run-off and improve infiltration and biodiversity. 1.3. Have clear and realistic long-term strategies for how operational and mitigation proposals will be managed and maintained. Develop partnerships with local communities where this has a mutual benefit. 1.4. Develop proposals in light of a clear understanding of the area's landscape and history.

Overarching	Principle	G2 Indicator	Narrative	Where documented in G2 submission?	Target
Place	Protect and promote the recovery of nature: Focus on the role of landscape, its capacity to accommodate infrastructure and shape places. Work collaboratively and employ holistic, landscape-scale approaches that support and deliver biodiversity net gain as well as multiple other benefits.	1. Statements on your approach to achieving BNG and aspirations to contribute to the recovery of nature within Design Vision and Principles. May include specific reference to local Green-Blue Infrastructure Strategies/ (emerging) Local Nature Recovery Plans, catchment management plans and other measures to improve watercourse quality.	2.1 At least 10% BNG will be achieved through compensation and mitigation measures. This will be established post Gate 2 once the final T2ST option has been identified and environmental site surveys have been undertaken. This will require close liaison with the NAU and local stakeholder groups. 2.2 Nature-based approaches to integrate the scheme into the environment will be followed, including landscaping and habitat creation for the benefit of the natural world and local people. 2.3 Impacts on water courses will be limited as trenchless technology will be utilised for the T2ST solution. Any short term impacts during construction or operation will be mitigated through consultation with the NAU, including the location of tunnel shafts, temporary access roads and working areas.	*1) Option Appraisal Report (Annex A1)* *2) Route and Site Assessment - Preferred Options Report (Annex A2)* *3) Environmental Assessment Report (Annex B1)* *4) Concept Design Report (Annex A3)* *5) Cost and Carbon report (Annex A4)* *6) Engagement Report (Annex D)*	2.1. Achieve at least 10% Biodiversity Net Gain(BNG) 2.2. Deploy nature-based approaches to integration and mitigation as the first-choice solution where possible. 2.3. When looking at options to provide compensation or enhancement prioritise measures that support achieving good ecological condition for affected watercourses and bodies as a whole. When making an intervention, mitigate infrequent impacts by developing proposals that keep them local and short lived. 2.4. Work with landowners and land managers to develop mutually beneficial solutions where practicable.

Overarching	Principle	G2 Indicator	Narrative	Where documented in G2 submission?	Target
Place	Design all features beautifully, with honesty and creativity: Our utility infrastructure can be a source of pride and a positive contribution to its context. Develop proposals that reveal and celebrate its importance, provide visual delight and leave a positive legacy.	1. Set out with opportunities and aspirations for high quality design within Design Vision and Principles. 2. Development of a project plan stating how these aspirations will be developed/achieved. 3. Favourable independent design review outcomes.	3.1 Above ground infrastructure will be sensitively designed to blend in with the local landscape, including water treatment, break pressure tanks and pumping stations. Existing screening will be used wherever possible to reduce any visual impacts, alongside landscape bunding and tree planting as required. 3.2/3.3 Architectural design of buildings will optimise opportunities for adding local interest to the development including artwork and access to green space.	*1) Option Appraisal Report (Annex A1)* *2) Environmental Assessment Report (Annex B1)* *3) Concept Design Report (Annex A3)* *4) Engagement Report (Annex D)*	3.1. Develop a utilities architecture that speaks to its purpose and enhances its context. This applies to buildings, structures and landscape. 3.2. Develop designs and, where appropriate, artworks that bring narrative (meaning), beauty and interest to the proposals. 3.3. Consideration of context in every aspect of design including its location, layout, form, scale, appearance, landscape, materials and detailing.

A.4. T2ST – ACWG Design principles: Value

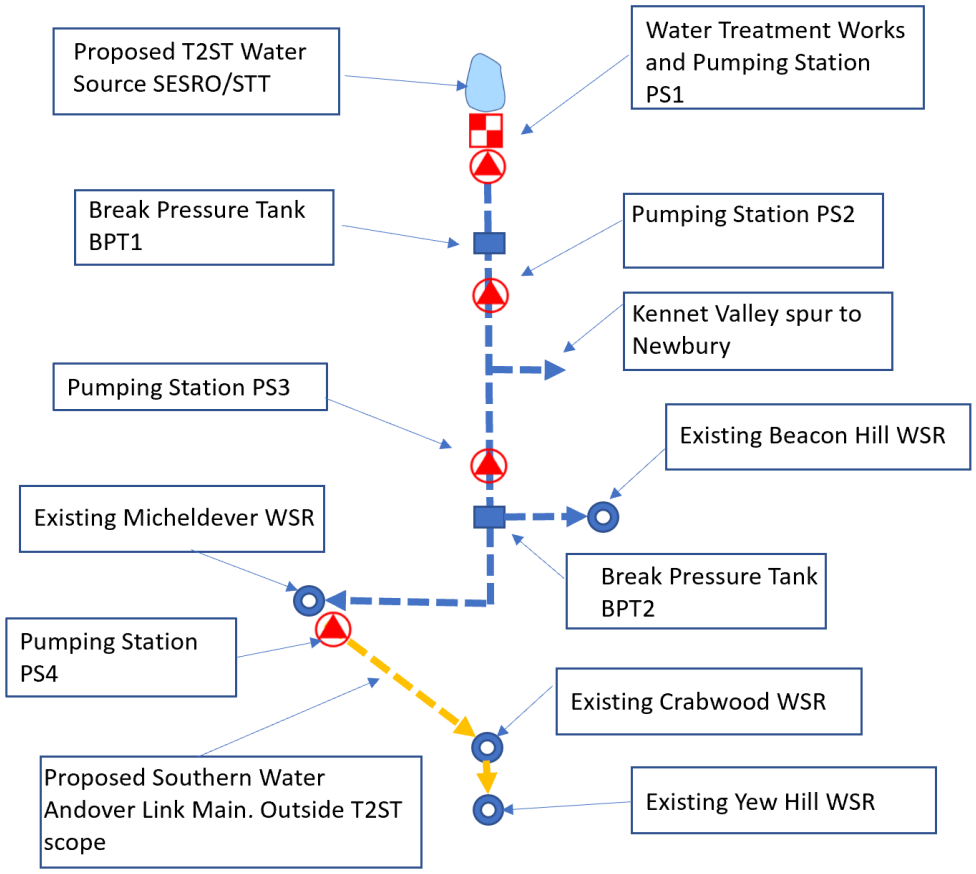
Overarching	Principle	G2 Indicator	Narrative	Where documented in G2 submission?	Target
Value	Maximise embedded value: Work collaboratively across specialisms and with stakeholders to maximise the benefits of the scheme by being smart with the location and arrangement of elements and design of mitigation within the project scope and budget.	1. Evidence of multi-disciplinary input into site selection, this may include architects, ecologists, artists, planning professions etc. 2. Initial project and, where appropriate, site appraisals (including constraints and opportunities) undertaken by a multi-disciplinary team (steps 1-5 in design development process). 3. A statement within the Design Vision on the SRO's aspirations and capability to deliver embedded value which should include Social Value, BNG and ENG.	1.1 A multidisciplinary team has been engaged from the outset of T2ST assessment in Gate 1. Engineering, planning and environmental teams have formed an integrated team to drive best value. 1.2 The need for T2ST is being driven by the WRSE plan based on adaptive planning scenarios taking full account of future demand uncertainty and climate change. 1.3 Robust route and site selection processes have been adopted for Gate 2 to avoid conflict with local development plans. 1.4 Reinstatement, landscape and mitigation will be developed to improve biodiversity, and minimise carbon and surface water run off. 1.5 The T2ST scheme is being developed to achieve multiple benefits to society and the environment, through the provision of a strategic water resource scheme to secure future water supplies and environmental enhancement.	*1) Option Appraisal Report (Annex A1)* *2) Route and Site Assessment - Preferred Options Report (Annex A2)* *3) Environmental Assessment Report (Annex B1)* *4) Habitats Regulatory Assessment Report (Annex B2)* *5) Strategic Environmental Assessment Report (Annex B3)* *6) Water Framework Directive Assessment (Annex B4)* *7) Concept Design Report (Annex A3)* *8) Planning and Consent Strategy Report (Annex G)*	1.1. Early multidisciplinary input informing a design that solves multiple problems at once. 1.2. Design of infrastructure capable of adaptation to reasonable future demands (see also Climate 3). 1.3. Site selection processes and layouts that assist (or as a minimum, do not prevent) local development except where absolutely necessary. 1.4. Reinstatement, landscape and mitigation proposals that improve the existing situation, - e.g. through better biodiversity, carbon sequestration, surface water infiltration and reduced run-off. 1.5. Deliver benefits efficiently by exploiting the two-way relationship between infrastructure and natural capital to enable multiple benefits to be delivered simultaneously.

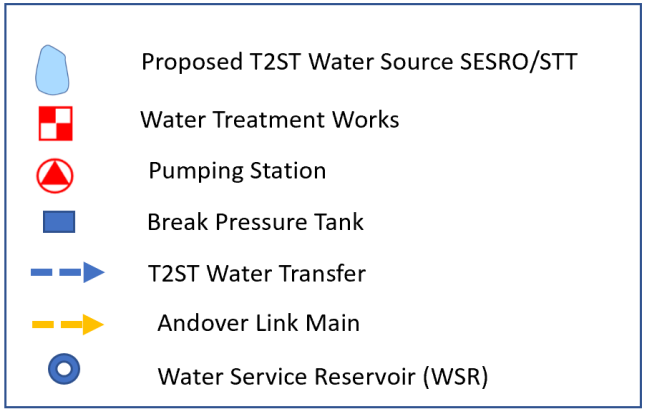
Overarching	Principle	G2 Indicator	Narrative	Where documented in G2 submission?	Target
Value	Understand how you could provide additional value: Identify opportunities to contribute wider regional benefits outside of the project scope. In particular look for synergies with relevant catchment management plans and proposals that support the delivery and enjoyment of a healthy water environment.	1. A description of potential opportunities to work with other projects/partners to achieve wider benefits. 2. A statement within the Design Vision on the SRO's aspirations and capability to deliver additional value.	2.1 As the scheme develops beyond Gate 2 and the preferred option is selected, opportunities for working with other utilities will be explored to maximise social benefits through sharing of pipeline trenches. 2.2 All above ground infrastructure will be developed to blend into the natural environment. Consultation will continue with NAU and other stakeholders as the design is developed. This will include architectural design to match the local historic built environment and landscaping to blend in with the existing environment. 2.3 Early engagement with other partners such as utility companies will be key to maximise opportunities for cost savings and environmental benefits. Consultation and engagement will be actively planned as the T2ST design progresses, as part of the stakeholder engagement plan that is already in place.	*1) Option Appraisal Report (Annex A1)* *2) Route and Site Assessment - Preferred Options Report (Annex A2)* *3) Environmental Assessment Report (Annex B1)* *4) Habitats Regulatory Assessment Report (Annex B2)* *5) Strategic Environmental Assessment Report (Annex B3)* *6) Water Framework Directive Assessment (Annex B4)* *7) Concept Design Report (Annex A3)* *8) Planning and COnsent Strategy Report (Annex G)*	2.1. Strategic project selection is informed by cross-sectoral engagement to maximise social benefit and reduce the use of customers money (this may be engagement with other utilities that may be able to share pipeline trenches or land for renewables). 2.2. Work closely with partners and focus on landscape scale schemes that improve hydrology, aquatic ecology and reduce/sequester carbon and provide opportunities for access to recreation and visual delight. 2.3. Be honest and realistic with partners as to what you might be able to offer as an organisation.

Overarching	Principle	G2 Indicator	Narrative	Where documented in G2 submission?	Target
Value	Capture and measure embedded and additional value: Have clear narratives about how you are contributing to society beyond the core scope of your project. Quantify these benefits so they can be considered meaningfully in conversations on value, financing and risk. Share your experience and knowledge widely.	1. Details of the best-value metrics used in determination of the Regional Plans and WRMPs and a clear narrative on how these have influenced option selection so far. 2. Inclusion of a description within the project plan of how these will be developed and monitored at subsequent gates. 3. Initial narrative (description) of the value of the scheme in plain English.	3.1 T2ST options have been developed in close consultation with WRSE. Data has been provided as required to meet the required WRSE metrics. This consultation will continue into Gate 3 and further stages as the T2ST design progresses. 3.2 Whole life cost analysis has been undertaken for the T2ST preferred options presented at Gate 2, including Net Present Value and average incremental cost values. Further cost assessment will continue to be undertaken as required as the design progresses to support identification of the preferred option and investment case. 3.3 Regular consultation has been undertaken through Gate 1 and Gate 2 with stakeholders including NAU, DWI and RAPID. This consultation will continue post Gate 2 in accordance with the T2ST engagement plan.	*1) Option Appraisal Report (Annex A1)* *2) Route and Site Assessment - Preferred Options Report (Annex A2)* *3) Environmental Assessment Report (Annex B1)* *4) Habitats Regulatory Assessment Report (Annex B2)* *5) Strategic Environmental Assessment Report (Annex B3)* *6) Water Framework Directive Assessment (Annex B4)* *7) Concept Design Report (Annex A3)* *8) Cost and Carbon report (Annex A4)* *9) Engagement Report (Annex D)*	3.1. Gathering of project specific data and improvement in the tools we have to measure and monitor added and additional value across the sector. 3.2. Full consideration of potential benefits in the Cost Benefit analysis and investment case for the SRO. 3.3. Clear communication of value of the scheme to stakeholders, communities and within the industry

Appendix B. Option B and C Schematics

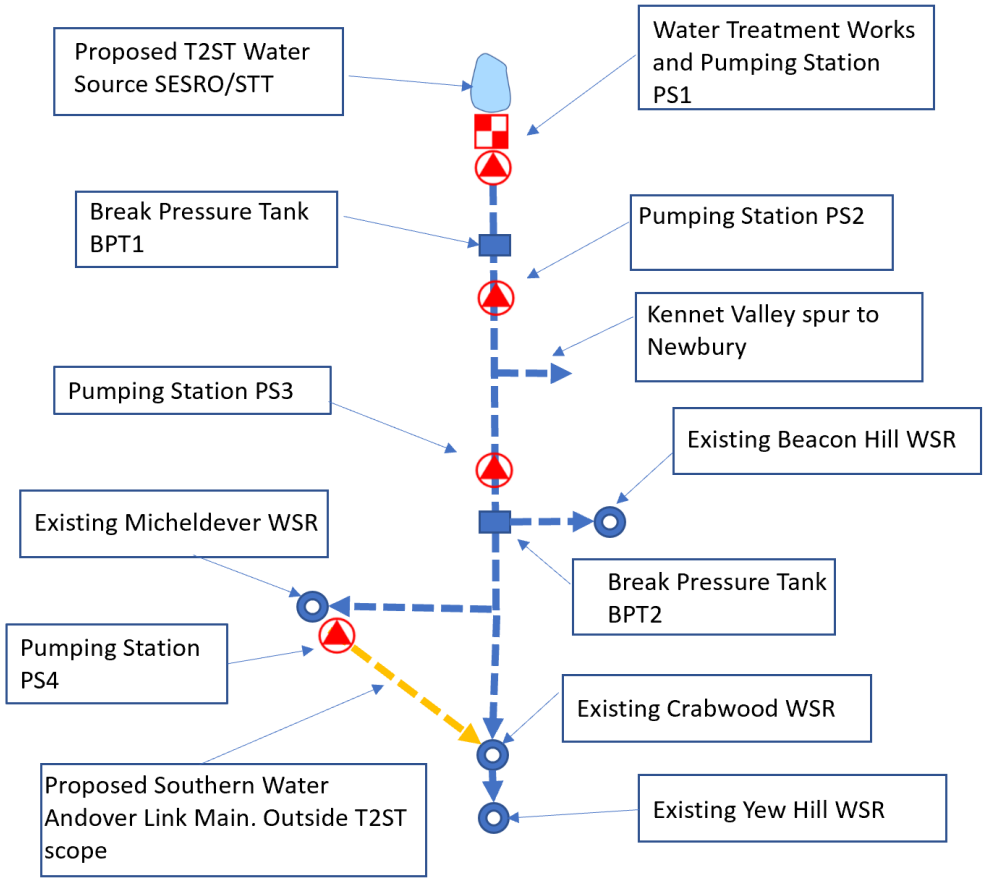
T2ST Option B – 50Ml/d

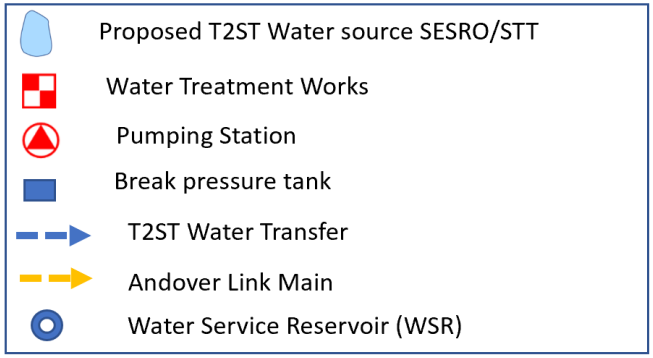




Section	Diameter (mm)	Length (km)	Capacity (Ml/d)
PS1 to BPT1	800	13.7	50
BPT2 to PS2	700	4.3	50
PS2 to PS3	700	25.0	50
PS3 to BPT2	700	5.5	50
BPT2 to Beacon Hill WSR	250	1.8	5
BPT2 to Andover spur connection	700	12.3	45
Andover spur to Micheldever WSR	700	7.0	45

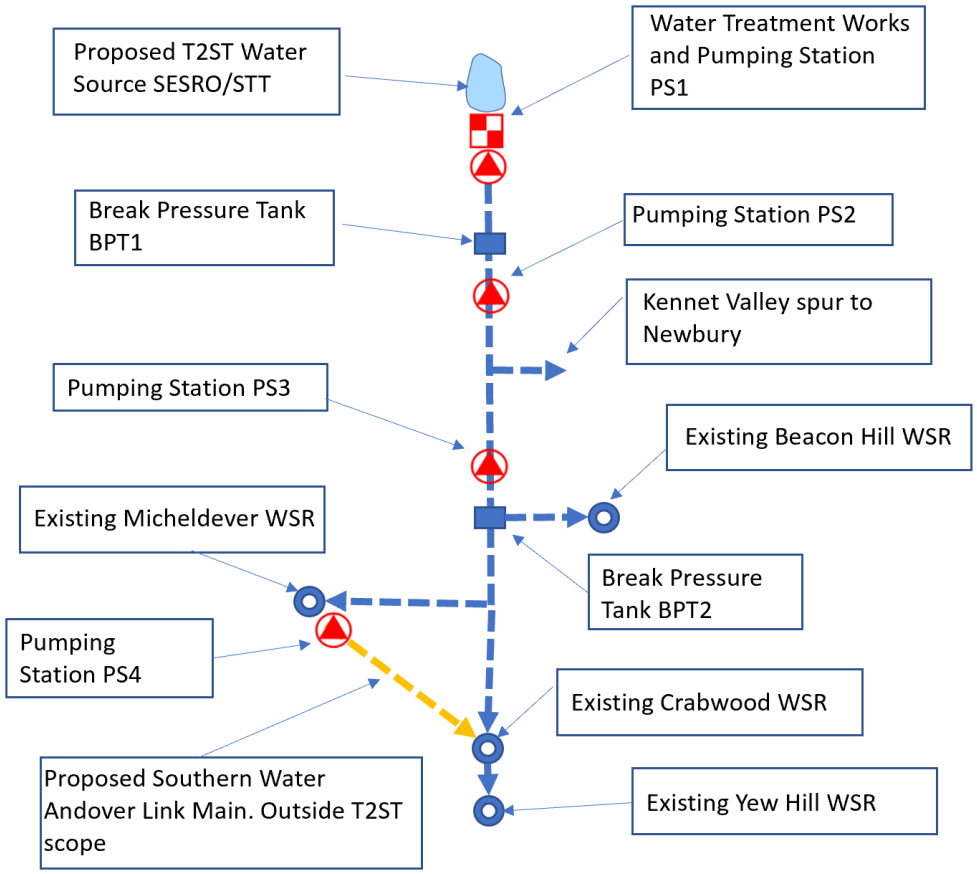
T2ST Option B – 80Ml/d

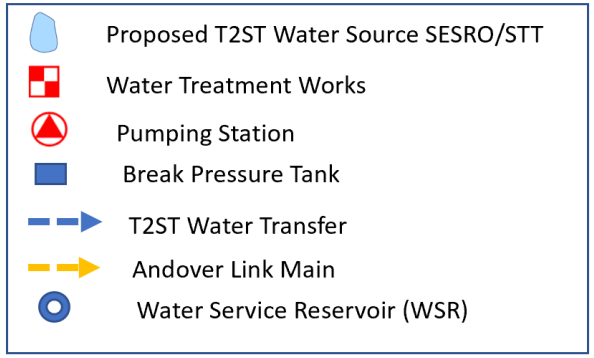




Section	Diameter (mm)	Length (km)	Capacity (Ml/d)
PS1 to BPT1	900	13.7	80
BPT2 to PS2	900	4.3	80
PS2 to PS3	900	25.0	80
PS3 to BPT2	800	5.5	80
BPT2 to Beacon Hill WSR	250	1.8	5
BPT2 to Andover spur connection	800	12.3	75
Andover spur to Micheldever WSR	700	7.0	75
Andover spur to Crabwood WSR	700	20.2	30
Crabwood WSR to Yew Hill WSR	600	3.8	30

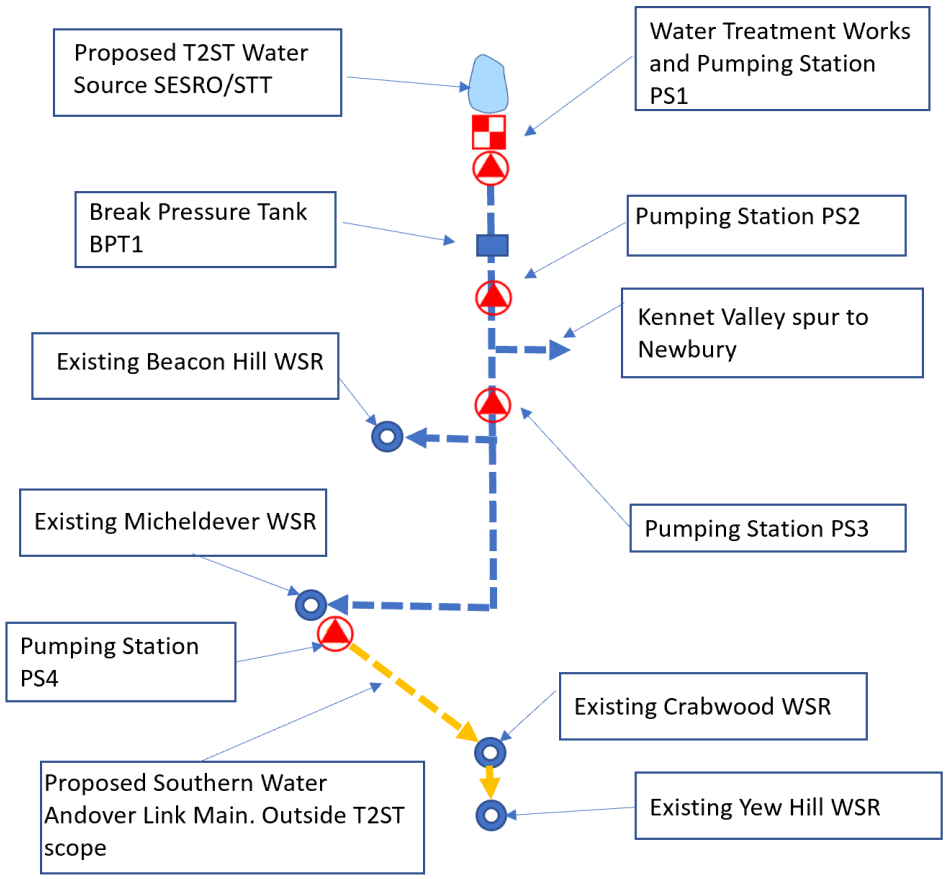
T2ST Option B – 120Ml/d

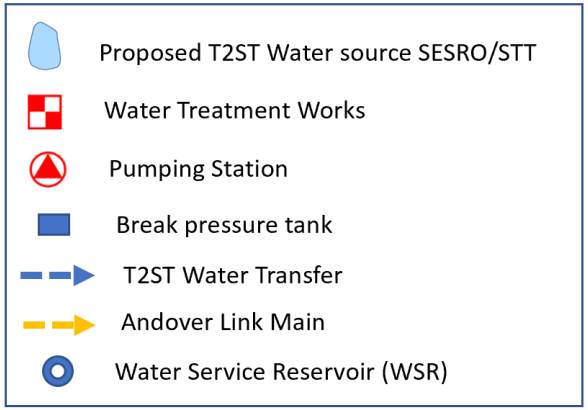




Section	Diameter (mm)	Length (km)	Capacity (Ml/d)
PS1 to BPT1	1100	13.7	120
BPT2 to PS2	1000	4.3	120
PS2 to PS3	1000	25.0	120
PS3 to BPT2	1000	5.5	120
BPT2 to Beacon Hill WSR	250	1.8	5
BPT2 to Andover spur connection	1000	12.3	115
Andover spur to Micheldever WSR	700	7.0	45
Andover spur to Crabwood WSR	800	20.2	70
Crabwood WSR to Yew Hill WSR	800	3.8	70

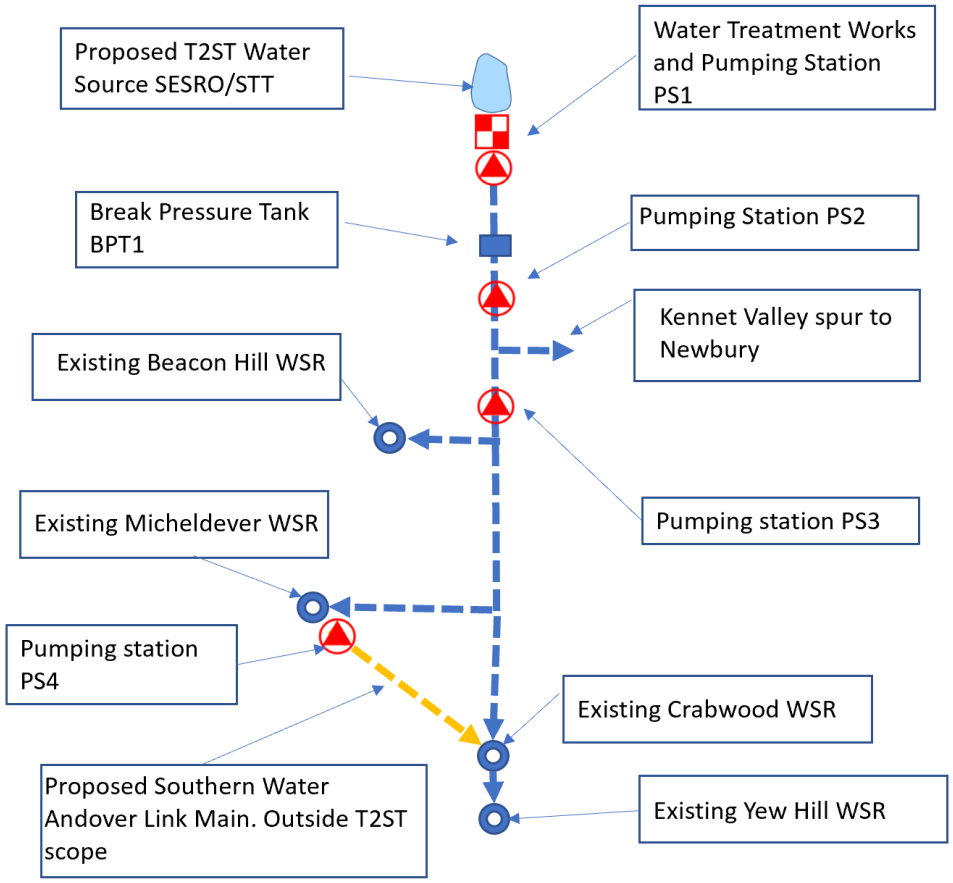
T2ST Option C – 50Ml/d

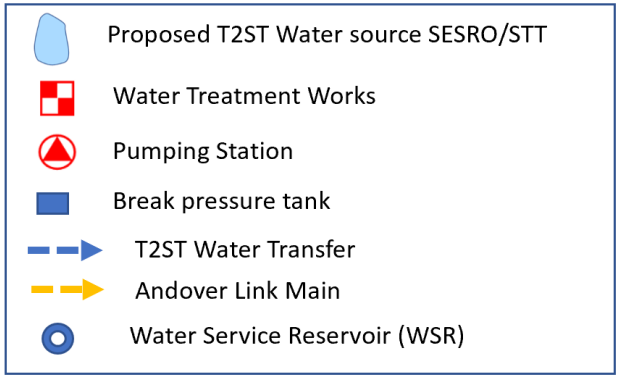




Section	Diameter (mm)	Length (km)	Capacity (Ml/d)
PS1 to BPT1	800	13.7	50
BPT2 to PS2	700	4.3	50
PS2 to PS3	700	25.0	50
PS3 to Beacon Hill WSR	250	4.2	5
PS3 to Andover spur connection	600	18.1	45
Andover spur to Micheldever WSR	700	9.2	45

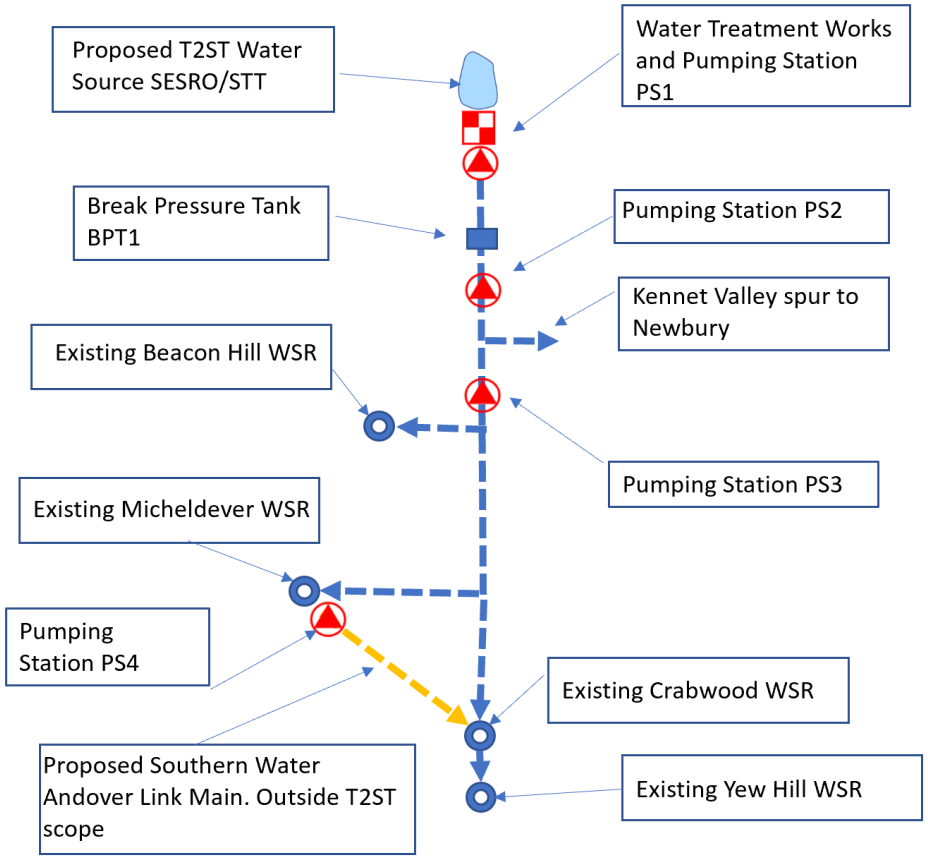
T2ST Option C – 80Ml/d

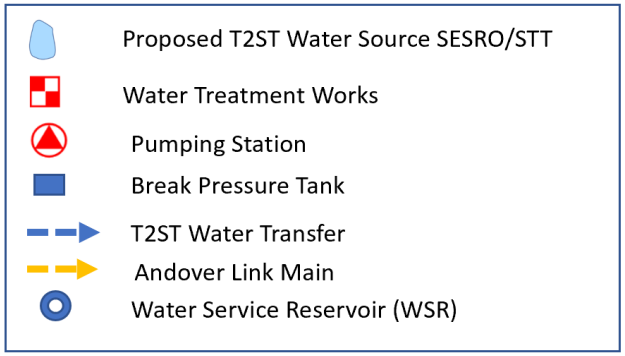




Section	Diameter (mm)	Length (km)	Capacity (Ml/d)
PS1 to BPT1	900	13.7	80
BPT2 to PS2	900	4.3	80
PS2 to PS3	900	25.0	80
PS3 to Beacon Hill WSR	250	4.2	5
PS3 to Andover spur connection	800	18.1	75
Andover spur to Micheldever WSR	700	9.2	45
Andover spur to Crabwood WSR	700	18.1	30
Crabwood WSR to Yew Hill WSR	600	3.8	30

T2ST Option C – 120Ml/d





Section	Diameter (mm)	Length (km)	Capacity (Ml/d)
PS1 to BPT1	1100	13.7	120
BPT2 to PS2	1000	4.3	120
PS2 to PS3	1000	25.0	120
PS3 to Beacon Hill WSR	250	4.2	5
PS3 to Andover spur connection	1000	18.1	115
Andover spur to Micheldever WSR	700	9.2	45
Andover spur to Crabwood WSR	800	18.1	70
Crabwood WSR to Yew Hill WSR	800	3.8	70

Atkins Limited
One St Aldates
Oxford
OX1 1DE