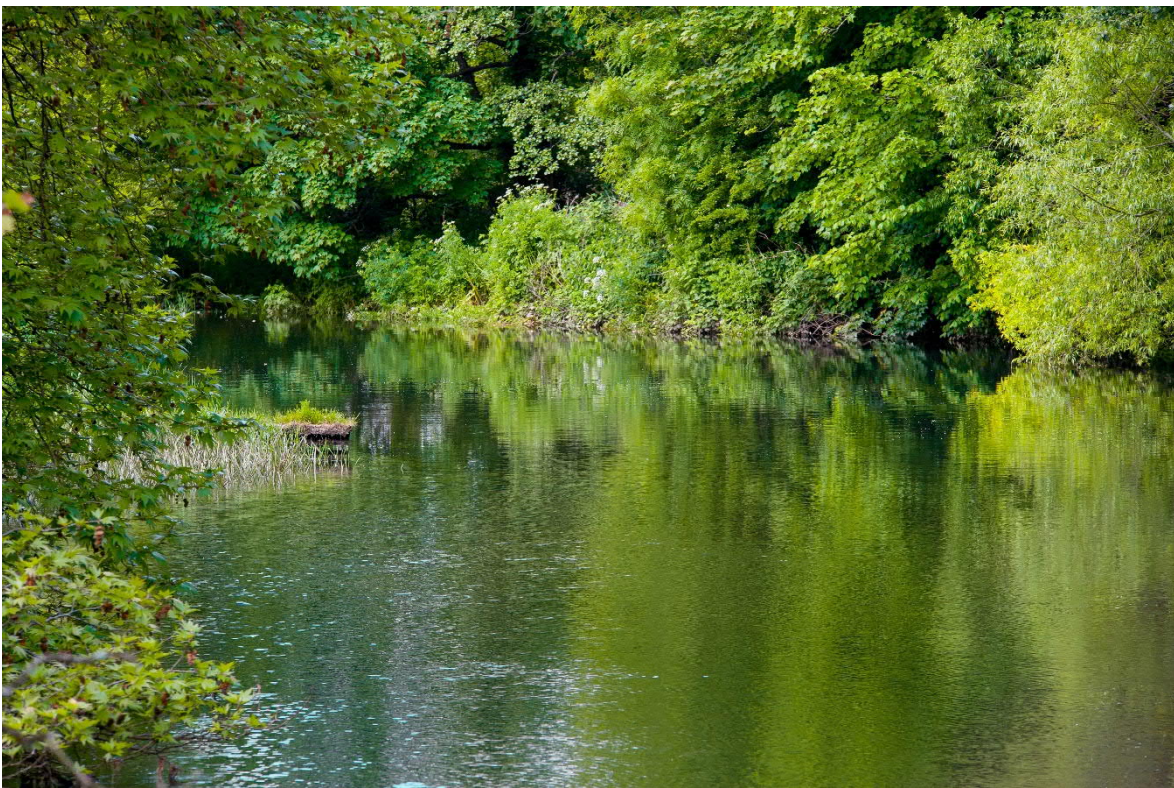


Strategic Regional Water Resource Solutions: Annex A4 Costs and Carbon Report

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.

Thames to Southern Transfer
Costs and Carbon Report
T2ST-G2-REP-11 (Annex A4)

November 2022



THAMES TO SOUTHERN TRANSFER (T2ST)

Annex A4 Costs and Carbon

Mott MacDonald Ref: T2ST-G2-REP-11 (Annex A4)

November 2022

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Executive summary

Following on from the Gateway 1 submission to RAPID in July 2021, Thames Water (TWUL) has undertaken additional work to both rationalise and refine existing and additional options in order to ensure that all feasible solutions have been fully explored for the Thames to Southern Transfer programme of works.

At the 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 TWUL, Southern Water (SWS) 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.

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 two preferred potable water options for T2ST (named as Option B and C) have been identified to take forward to Gate 2 as follows:

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

As detailed in the Preferred Options report, Options B and C have both been developed based on Option 1 from Gate 1 which is now superseded. Option 4 for a potable transfer from Reading to Otterbourne has been held back as a result of the route and site selection process: 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.

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. It has been further agreed with TWUL and SWS for the purposes of the T2ST Gate 2 concept design stage that a range of T2ST option capacities should be assessed at 50, 80 and 120MLD.

This has enabled a suite of six clear options to be shortlisted for outline design and the subsequent production of cost estimates.

The cost estimates produced cover the following options

- Option Route B (50 MLD)
- Option Route B (80 MLD)
- Option Route B (120 MLD)
- Option Route C (50 MLD)
- Option Route C (80 MLD)
- Option Route C (120 MLD)

Costs have been produced against the following criteria:

- Capital Expenditure (CAPEX)
- Risk
- Optimism Bias (OB)
- Operational Expenditure (OPEX)
- Capital Carbon
- Operational Carbon
- Net Present Value (NPV)
- Average Incremental Cost (AIC)

CAPEX calculations have been undertaken using a combination of first principles, estimating using the CCS Candy Platform for Infrastructure elements and a combination of the most appropriate cost models for both SWS and TWULs suites of data for non-Infrastructure elements.

Costed Risk and Optimism Bias have been reviewed through team workshops bringing together views from both design, cost and specialist subject matter experts (SME's) to provide a costed risk register modelled using Monte Carlo analysis, and an Optimism Bias analysis undertaken in accordance with Treasury Green Book recommendations and those of the All Company Working Group (ACWG).

OPEX estimates for each option have been prepared using calculated operating quantities (staffing levels, consumables, etc.) and unit rates. CAPEX & OPEX numbers are summarised in table S.1.

NPV and AIC have been modelled in accordance with current recommendations from the ACWG and are summarised in table S.2.

Carbon – capital (embodied), operational and whole life carbon estimates have been prepared.

Bases of Estimates.

Estimate prices are based on current 2022 market rates adjusted to 2020/21 to align with the WRSE draft Regional Plan as described in section 2.3.

All costs are exclusive of Value Added Tax.

Overall, the Gateway 2 submission provides an increased level of cost confidence to underpin further option selection.

With regard to the capture of costs to progress the project through the gated process, the Southern Water SMART Targets have been applied as a percentage on Costed CAPEX. These are deemed to include for contractor and client indirect costs necessary to deliver a project, over

and above the construction of capital assets. There is a limited risk within the risk register that the SMART Targets do not carry sufficient uplift to undertake all development costs of a project of this complexity. However, this will be prioritised at Gateway 3 once the delivery mechanism is more clearly defined. It should be noted that no actual costs expended by any party prior to the date of this estimate (September 2022) are included within this cost estimate. **Table S.1 provides a summary of the CAPEX and OPEX estimates for each option whilst Table S.2 presents the NPV and AIC estimates.**

Table S.1: Capex and Opex for each option (2020/21 base date)

| Option Name | Units | Option B 50 MLD | Option B 80 MLD | Option B 120 MLD | Option C 50 MLD | Option C 80 MLD | Option C 120 MLD |
|--------------------------|-----------|-----------------|-----------------|------------------|-----------------|-----------------|------------------|
| Option Benefit | MLD | 50 | 80 | 120 | 50 | 80 | 120 |
| CAPEX | | | | | | | |
| Base Capex | £m | 340.6 | 480.4 | 560.7 | 392.6 | 510.2 | 589.5 |
| Costed Risk | £m | 95.1 | 121.8 | 148.4 | 95.6 | 120 | 145.7 |
| Optimism Bias | £m | 82.1 | 115.8 | 135.1 | 94.6 | 122.9 | 142 |
| Total G2 Capex | £m | 517.8 | 718.0 | 844.2 | 582.8 | 753.1 | 877.2 |
| Total G1 Capex | £m | 621.7 | 673.6 | 757.0 | 621.7 | 673.6 | 757.0 |
| Change G1 to G2 | % | -17% | 7% | 12% | -6% | 12% | 16% |
| OPEX | | | | | | | |
| G2 Fixed | £m/ annum | 1.5 | 1.9 | 2.3 | 1.6 | 2.0 | 2.4 |
| G2 Variable | £/ML | 338.4 | 348.9 | 352.7 | 308.4 | 315.0 | 332.1 |
| G2 Total at Maximum Flow | £m/ annum | 7.6 | 12.1 | 17.8 | 7.2 | 11.2 | 16.9 |
| G1 Fixed | £m/ annum | 1.4 | 1.6 | 1.9 | 1.4 | 1.6 | 1.9 |
| G1 Variable | £/ML | 241.0 | 289.0 | 315.0 | 241.0 | 289.0 | 315.0 |
| G1 Total at Maximum Flow | £m/ annum | 5.8 | 10.0 | 15.7 | 5.8 | 10.0 | 15.7 |
| Change (Min Flow) | % | 32% | 21% | 13% | 25% | 12% | 8% |

Table S.2: NPV and AIC costs for each element/option (2020/21 base date)

| Option Name | Units | Option B 50 MLD | Option B 80 MLD | Option B 120 MLD | Option C 50 MLD | Option C 80 MLD | Option C 120 MLD |
|---|------------------|-----------------|-----------------|------------------|-----------------|-----------------|------------------|
| Option Benefit (max flow) | MLD | 50 | 80 | 120 | 50 | 80 | 120 |
| Min Flow (Gate 2) | MLD | 7.5 | 12 | 18 | 7.5 | 12 | 18 |
| Min Flow (Gate 1) | MLD | 15 | 24 | 36 | 15 | 24 | 36 |
| Total planning period option benefit (NPV) | MI | 326,709,676 | 522,735,481 | 784,103,222 | 326,709,676 | 522,735,481 | 784,103,222 |
| Total planning period indicative capital cost of option (CAPEX NPV) | £m | 426.3 | 586.0 | 691.9 | 473.2 | 610.9 | 715.3 |
| Total planning period indicative capital cost of option (FINANCE NPV) | £m | 371.1 | 511.4 | 604.5 | 412.4 | 533.4 | 625.3 |
| Minimum Flow | | | | | | | |
| Total planning period indicative operating cost of option (OPEX NPV) | £m | 42.9 | 62.2 | 83.0 | 43.5 | 60.6 | 81.6 |
| Total planning period indicative option cost (NPV) | £m | 414.0 | 573.5 | 687.4 | 455.9 | 594.0 | 706.9 |
| Average Incremental Cost (AIC) | p/m ³ | 129 | 110 | 88 | 140 | 114 | 90 |
| Gate 1 AIC | p/m ³ | 143 | 103 | 82 | 143 | 103 | 82 |
| Maximum Flow | | | | | | | |
| Total planning period indicative operating cost of option (OPEX NPV) | £m | 136.9 | 217.2 | 318.0 | 129.2 | 200.6 | 303.0 |
| Total planning period indicative option cost (NPV) | £m | 508.0 | 728.6 | 922.5 | 541.6 | 734.0 | 928.3 |
| Average Incremental Cost (AIC) | p/m ³ | 157 | 139 | 118 | 166 | 140 | 118 |
| Gate 1 AIC | p/m ³ | 160 | 123 | 103 | 160 | 123 | 103 |

1 Approach

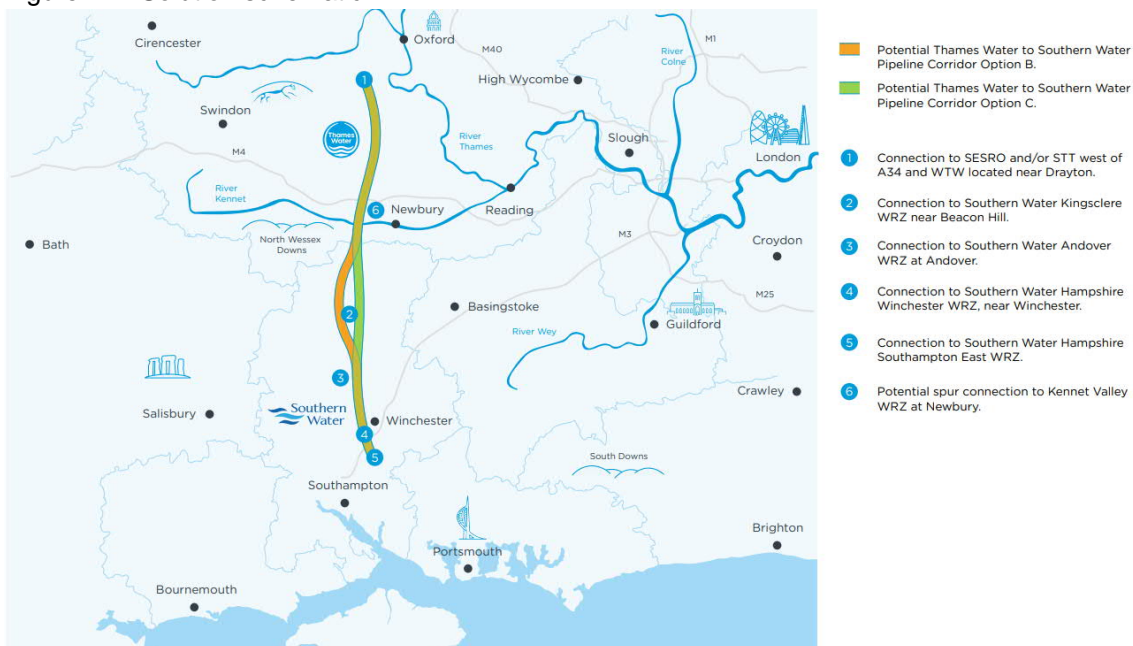
Key solution cost information, building on gate one with reduced uncertainty in costs and benefits

The solutions considered at Gateway 2 are illustrated in Figure 1.1.

The **Option B** pipeline route has a total pipe length of approximately 93.8km. The **Option C** pipeline route has a total pipe length of approximately 94.2km, the pipe routes have been selected as part of the route and site selection process where viable pipeline corridors were identified avoiding environmental designations and other constraints.

Design information has been revised from the option 1 route proposed in the Gateway 1 exercise to two route options (B & C) at Gateway 2. The routes have been optimised to minimise exposure to environmental constraints.

Figure 1.1: Solution schematic



Source: Southern Water Services

In relation to route options B & C, the following exercises have been undertaken:

- Improved design definition for both the proposed works at pumping stations and for pipelines. This was achieved using a GIS web-based tool to map environmental and planning constraints to provide greater certainty in the location of pumping station sites and pipeline alignment.
- Cross sections have been developed for all major crossings for railways, motorways, A road and major rivers where tunnelled solutions are required. This has resulted in greater certainty in the alignment and depth of tunnelled crossings compared to Gate 1.

- More defined locations of pumping station and pipe alignment has provided increased confidence in the hydraulic analysis of the transfer system including pipe diameters and surge vessel requirements.
- Further work has been undertaken on the connectivity of the Thames to Southern transfer with the SWS supply network in Hampshire.
- Additional work has now also been undertaken on the storage requirements for the T2ST and required sweetening flows leading to greater certainty in CAPEX and OPEX estimates
- The assessment of risk sums has been robustly undertaken in the form of costed risk registers for each individual option
- Additional Project Costs (APC) have been reviewed, covering the aspects outlined below. Subject matter experts within both Thames Water and Southern Water and externally from the planning consultancy Adams Hendry and Land Managers Fisher German have provided input into the appropriate costs to be included which are supplemented by a reasoned view of risk and optimism bias:
 - Land
 - Power
 - Planning
 - Public Consultation & Public Engagement
 - Legal
 - Environment

Construction costs have been estimated using a combination of Thames Water and Southern Water parametric cost data and Mott MacDonald held industry data. This has been linked back to the design information and as such the level of granularity of cost and scope has been improved. Gateway 1 was costed using parametric models due to the level of granularity of design information provided.

2 Base CAPEX

Costed CAPEX has been produced from a combination of Southern Water and Thames Water cost models and Mott MacDonald held cost data where model data was not considered available to the project.

Tables 2.1 and 2.2 set out the headline CAPEX costs for Route Option B and Route Option C.

Indirect costs have been aligned to the Southern Water SMART Targets.

Additional Project Costs (Power, Land, Planning, Legal & Environment) were based upon allowances agreed with subject matter experts in host businesses and external consultants where required.

The risk register assesses known external threats and opportunities and assesses a cost and likelihood range for each risk which is then modelled through Monte Carlo analysis.

Optimism bias builds upon this by making allowance in accordance with the methodology set out within the UK Treasury Green Book and the recommendations of the ACWG to assess the level of knowledge of key components that interface with the project. The result of this suggests an allowance to be included to cover “unknown unknowns” which is then revisited at each iteration to assess the increased level of detail available at each gateway.

Table 2.1: Gate 2 Base Capex Value Split Route B (Costs indexed to 2020/21)

| Route B Options | | 50 MLD | 80 MLD | 120 MLD | Comments |
|---------------------------|----|--------|--------|---------|---|
| Option Base Capex 2020/21 | £m | 340.6 | 480.4 | 560.7 | Solution cost indexed at (2020/21) to align with WRSE Regional Plan |

Table 2.2: Gate 2 Base Capex Value Split Route C (Costs indexed to 2020/21)

| Route C Options | | 50 MLD | 80 MLD | 120 MLD | Comments |
|---------------------------|----|--------|--------|---------|---|
| Option Base Capex 2020/21 | £m | 392.6 | 510.2 | 589.5 | Solution cost indexed at (2020/21) to align with WRSE Regional Plan |

2.1 Summary of the process undertaken to prepare the CAPEX estimate

The process undertaken to prepare the CAPEX estimates for the Route Options B & C is as follows:

- Appraisal of the options by the estimating team with the design lead to obtain understanding of scope and known constraints

- Discipline specific estimating leads appointed to enable the collaborative production of estimates covering the infrastructure, non-infrastructure and tunnelling specific elements of scope

- Production by the design team of scope documents aligned to Southern Water’s and Thames Water’s process drivers, to enable the scope to be represented as a cost breakdown structure (CBS) for pricing

Pipeline and tunnelling norms largely conform to practises agreed in collaboration with market engagement for the Water for Life Hampshire (WFLH) Western Grid project undertaken by Southern Water in 2021. However, input from the market in the form of Early Contractor Involvement (ECI) was not undertaken in this exercise.

Estimating of Direct Costs for the Non-Infra elements of each option from a combination of Southern Water and Thames Water data supported by first principals estimating of the infrastructure elements

Estimates combined into comprehensive priced schedule of works in CCS Candy

Estimates reviewed by design leads to ensure that the scope had been correctly interpreted

Estimating Uncertainty applied to direct costs using percentage ranges around the component costs and productivity rates of the defined scope to account for variance inherent in the input values

Contractor indirect cost allowances calculated from Southern Waters percentage uplifts to align with PR19 allowances

Additional project costs reviewed with subject matter experts with assistance from SMEs within Thames Water and Southern Water covering Land, Planning, Legal and Environmental allowances along with external support from Land Managers Fisher German and Planning Consultants Adams Hendry.

Client costs calculated from Southern Waters percentage uplifts to align with PR19 allowances

Costs tested collectively to mitigate against gaps in known data or double counting between base cost, risk, and optimism bias.

2.2 CAPEX Assumptions

2.2.1 Construction General.

Glossary of Terms and Definitions

- **Infrastructure** – Works outside of the boundary on existing or proposed Southern Water sites.
- **Non-Infrastructure** – Works carried out on existing or proposed Southern Water sites.
- **Estimating Uncertainty** – Allowance for specific unit costs to fluctuate, not covered in the Risk Register or Optimism Bias.
- **Indirect Costs** – Costs as defined to enable the contractor and client to adequately administer the project.
- **SMART Targets** – Southern Water percentage uplifts for indirect client and contractor costs.
- **DNO** – Power Supply from statutory undertaker.
- **Third-Party Pass-Through Costs** – Costs undertaken by others outside of Southern Water.
- The design which underpins this estimate remains at an early level of maturity, the estimate is deemed to be of **AACE Class 4 accuracy (+50% / -20%)**. There is a risk that design development may identify alternative solutions and or methodologies which may have significant cost impact both positively and negatively. As such the current accuracy envelope can only cater for fluctuations in cost of the current solution. Any changes to estimated solutions would require a reassessment of the estimate and confidence level.

Figure 2.1: AACE Ranges

| Class of Estimate | Overall Engineering % | Accuracy Range | | Purpose of Estimate |
|-------------------|-----------------------|----------------|---------------|---------------------------|
| | | Low | High | |
| Class 5 | 0% to 2% | -20% to -50% | +30% to +100% | Screening / Conceptual |
| Class 4 | 1% to 15% | -15% to -30% | +20% to +50% | Feasibility / Preliminary |
| Class 3 | 10% to 40% | -10% to -20% | +10% to +30% | Budget, Authorization |
| Class 2 | 30% to 70% | -5% to -15% | +5% to +20% | Control, Bid / Tender |
| Class 1 | 50% to 100% | -3% to -10% | +3% to +15% | Check or Bid / Tender |

- No allowance has been included for piling, specifically for all the proposed buildings and selected process plant base slabs.
- Where ground conditions are as yet unknown, an additional allowance for piling to other structures has been incorporated into the Risk values
- No allowance has been made for any ground stabilisation works.
- No allowance has been made for meeting any planning or environmental costs unless advised within the estimate.
- No allowance has been made for dealing with any impact that the proposed works may have on any existing or proposed assets plant or foundations.
- The SWS provided costs such as the allowances for land purchase, DNO, Public Consultations etc are taken at face value and included within the relevant estimates.
- No allowance has been made for environmental mitigations for invasive or protected species of fauna and flora unless stated.
- No information is available as to the current ground conditions of the proposed plant.
- Process plant and pipework sizing has not been checked and sizes are as per provided.
- Quantum for Bulk Earthworks Allowances for dealing with Cut/Fill/Disposal have been provided by the designers and adopted by estimating. It would be beneficial for a detailed review to be undertaken in the next phase.
- All works are assumed to be carried out during normal day time working hours.
- It is assumed that the working area is not impacted in any way by hazardous working conditions
- It is assumed that there are no restrictions to access.
- With the exception of the Schedule Delay risk that incorporates an element of weather impact, no allowance has been made for any restrictions placed on the works due to adverse weather conditions.
- As the projects are currently at concept stage no quantities have yet been finalised thus all quantities assumed in the preparation of costs are indicative.
- No allowance has been made for 3rd party works such as utility upgrades or diversions & connections unless specifically stated otherwise.
- Specialist Dewatering is excluded from the base cost. An allowance has been included within the risk values.
- No allowance has been made for disconnection, isolation, removal, disposal, or demolition of existing assets
- It is assumed that no works involving asbestos are required.
- It is assumed that there are no restrictions to the works from overhead power lines
- No allowance has been made for the cost of any discharge licenses.

2.2.2 Pipework and Crossings

- Standard working hours - 50 hr week have been assumed (apart from critical TM phases and continuous micro tunnelling)
- Pipe supply data is from Saint Gobain based on current costs and supplying 50% of length with integral anchor joints
- It is assumed that 10% of pipe length includes 55% tape wrap
- It is assumed that Pipe depth is 1.5 - 2.5m to invert of pipe - 70% of route
- It is assumed that Pipe depth is 2.5 - 3.5m to invert of pipe - 20% of route

- It is assumed that Pipe depth is 3.5 - 4.5m to invert of pipe - 10% of route
- All crossings are priced in accordance with the lengths and drive/reception pit dimensions as detailed on the scope sheets
- Reception / drive pits are priced as jacked segmental caissons.
- All crossings to be maximum 1200 diameter sleeve installed within 1800 to 2400mm ID Micro tunnel's (dependent on driven length) using a slurry TBM
- All crossings to be single pipe
- All shafts to be backfilled with imported aggregate
- 150mm bed and haunch in fields with 30% of arisings to tip replaced with imported granular material Spreading surplus spoil across the easement within fields
- 150mm bed in roads with 100% of arisings to tip replaced with imported granular material
- 30-40m easement width in fields depending on pipe diameter
- Assume stock fencing both sides of easement Livestock crossing point every 300m Footpath crossing every 500m
- Assume fluming a ditch required every 500m
- Assume goalposts for overhead lines in fields required every 400m
- Assume land drain crossing in fields every 20m Clay stank in fields every 25m
- Assume allowance for a bend every 167m of route
- Assume no thrust blocks are required - use of anchor gaskets utilised

2.3 Indexation

All costs generated are presented at 2020/21 prices. Costs generated using the various water company costing systems can be at different base dates, but all costs have been presented at 2020/21 for consistency. The deflation factors used have been agreed with the ACWG and are based on the figures used by the WRSE modelling team. Figures used are summarised below in Table 2-2. Inflation will require updating for Gate 3 as current inflation is well above the figures predicted.

Table 2.3: Inflation/ Deflation factors

| F/Yr. | Indices | Factors |
|---------|---------|---------|
| 2017/18 | 275.5 | 1.1002 |
| 2018/19 | 284.8 | 1.0645 |
| 2019/20 | 293.7 | 1.0323 |
| 2020/21 | 303.1 | 1.0000 |
| 2021/22 | 312.9 | 0.9688 |
| 2022/23 | 322.3 | 0.9405 |

2.4 Benchmarking

All infrastructure and non infra MEICA has been priced from both the Thames Water and Southern Water suite of parametric models, with the choice of the most appropriate model being taken, based upon coverage rules, proximity of the driver ranges to the projects requirements and taking advantage of the most up to date data sources present in the models.

Infrastructure civils elements have been costed from 1st principles utilising costs and productivity ranges utilised by current contractor tendering activity and are aligned with both cost and productivity ranges agreed with ECI involvement included within in the previous Southern Water Western Grid Gateway 2 cost estimate.

Whilst market engagement has not taken place with the supply chain at this stage due to sensitivity of information, the process elements have been taken from actual outturn costs indexed to 2020/21. Thus, these costs should be seen to be appropriate at this stage of design maturity when aligned to a relevant inflationary threat in the risk register.

Pipeline and crossing element costs are based upon contractor prices used in previous SRO submissions, again indexed to current day.

3 Costed Risk & Optimism Bias

Following the development of the base CAPEX cost using the detailed scope received from the relevant Design Teams, consideration was given to the overall remaining uncertainty contained within the design assumptions (e.g. assumed ground conditions).

In order to do this, any significant assumptions made during the design and estimating process are interrogated in formal risk workshops to understand the level of variance that remains within these assumptions. Discussion of the assumption between the design team, estimating team and risk team within the workshop enables each assumption to be assigned, as appropriate, to one of costed risk or optimism bias and ensures that these two elements of the estimate are fully integrated and considered in accordance with each other to avoid either cost duplication or cost gaps.

For clarity, and to prevent this cost duplication throughout the cost estimating process, the two elements are defined as follows:

- **Costed Risk:** Discrete and specific events that have the potential to impact (positive or negative) on the successful achievement of the defined and agreed scope
- **OB:** A percentage uplift applied to those elements of the Project Delivery that are not sufficiently defined or understood to enable an agreed scope to be defined and therefore discrete, specific risks to be applied. This approach is ensured through the adjustment of the Optimism Bias percentage utilising the information contained within the quantified risk register.

3.1 Costed Risk

Through the integrated discussions, those items that are considered specific costed risks (threat or opportunity) are captured on a quantified risk register and their current probability of occurrence and range of cost impacts are estimated and agreed. This process is undertaken for both the infrastructure elements and the non-Infrastructure elements of each Option. This ensures that a comprehensive list of discrete costed risks is identified and allows a fully quantified risk register to be developed for each Option based on the assumptions made during the design process.

To estimate the probability for each costed risk, the probability is assessed in a quantitative manner on a scale of 1% to 99% using group consensus during the facilitated cost risk workshop.

When estimating the range of cost impacts for each identified costed risk, Minimum, Most Likely and Maximum cost impacts are considered. However, it should be noted that given the level of uncertainty that remains within the Options, the starting point for each range of cost impacts was to populate only the Minimum and the Maximum costs. Only in the event that the integrated discussions agreed that a Most Likely cost could be identified (i.e. sufficient knowledge exists to specifically suggest a Most Likely cost), enabled a Most Likely cost to be included within the Range of cost impacts. Similar to the probability, these values are estimated using group consensus during a facilitated workshop. All costs are aligned with those values used in the base cost build up.

The risk cost impacts captured incorporate indirect uplifts to reflect the application of indirect cost percentages to ensure that the modelled risk value presented within the estimate is aligned to all the other capital costs, which themselves have been uplifted by indirect costs. Following the estimation of the probability and the range of cost impacts for each costed risk item, and the

application of the indirect cost uplifts, the cost risk inputs have been modelled using Monte Carlo simulation within the @Risk software. This has enabled a range of costed risk output values to be calculated, with the P50 value being selected for inclusion within the cost estimate.

The above risk approach has been applied across all Options, except if the integrated discussions agreed that the level of design maturity for a particular element did not support the use of a quantified risk register. These elements included the design process, location and geotechnical ground conditions aspects of the Treatment Plant (Non-Infrastructure). Under these circumstances, the costed risk approach for these specific elements of the base cost relied on utilising a percentage uplift approach based on the Client Risk element of the Southern Water SMART Targets. However, the values resulting from this percentage uplift were still incorporated within the total risk value for each Option.

Table 3.1: Risk values at Gate 2 (2020/21 base date)

| Option | Gate 2 Base Cost | Gate 2 P50 Risk Value | Gate 2 Risk Percentage |
|------------------|------------------|-----------------------|------------------------|
| Option B 50MI/d | £340.6m | £95m | 28% |
| Option B 80MI/d | £480.4m | £122m | 25% |
| Option B 120MI/d | £560.7m | £148m | 27% |
| Option C 50MI/d | £392.6m | £96m | 24% |
| Option C 80MI/d | £510.2m | £120m | 23% |
| Option C 120MI/d | £589.5m | £146m | 25% |

The P50 risk values for Options B & C at 3 flow sizes are detailed in Table 3.1 above. It should however be noted that the Gate 2 P50 values displayed are indexed and are not the direct outputs of the Monte Carlo analysis. The key costed risk items that comprise the quantified risk values as calculated at Gate 2 for both Options are:

- Uncertainty around future indirect contractor costs, in light of latest market information.
- Summary Risk, with cost impacts calculated using a percentage uplift, expressing uncertainty and risk associated with the design and construction of the Treatment Plant element of the works.
- Construction material cost volatility owing to several factors including tariffs, exchange rates, global supply issues, etc.
- Construction Programme schedule delay owing to several factors including weather, protesters, archaeology, ecology licences, long lead items, discharge of planning, unexploded ordinance, etc.
- Uncertainty over ground conditions including assumptions around groundwater, contaminated land, utilities, pipe depths and archaeology.
- Environmental risks including compensatory habitats, habitat mitigation, environmental net gain, local carbon initiatives and field drainage requirements.

3.2 Optimism Bias

During the integrated discussions, those items that are considered to form part of Optimism Bias (rather than estimating uncertainty or risk) are noted for inclusion within the Optimism Bias process.

In order to undertake the Optimism Bias process, the guidance contained within the HM Treasury Green Book Supplementary Guidance: Optimism Bias has been followed, ensuring that any updated guidance from the All Companies Working Group has also been incorporated.

Optimism Bias has been applied once to each Option and Size, rather than being applied at a more granular level within each Option. In order to determine the level of Optimism Bias to be applied to each Option, the Project Type relating to each Option is first confirmed (Stage 1). Throughout all Options, the Project Type is selected as Standard Civil Engineering as agreed with all attendees of the Optimism Bias workshops.

Following the agreement of the Project Type split, each statement within the OB template is assessed for confidence (Stage 2). The templates used at Gate 1 were updated to ensure alignment with the ACWG guidance and then utilised as the starting point for the Gate 2 assessment, with the previous confidence levels assessed to understand whether there had been an improvement as more information has been made available, or whether there has in fact been a reduction in confidence as previous clarity has diminished. This provided an Adjusted OB percentage, again as detailed in Table 3.2.

Prior to this Adjusted OB percentage being applied to the Base Estimate (excluding risk), Stage 3 of the OB assessment was undertaken. This involved mapping the specific risk items from the cost risk model, where appropriate, to the relevant contributory factors within the OB template. Once completed, the confidence level associated with the contributory factor was further assessed in order that the quantified risk inputs were taken into account and to prevent duplication of costs. This generated a Risk Adjusted OB percentage (see Table 3.2) and this percentage value was then applied to the estimate, excluding the previously calculated total risk value, in order to provide an overall Option Project Cost, subject to Association for the Advancement of Cost Engineering (AACE) range and Indexation adjustments.

Table 3.2: Optimism Bias at Gate 2 (2020/21 base date)

| Option | Gate 2 Combined Upper Bound OB Percentage (Stage 1) | Gate 2 Adjusted OB Percentage (Stage 2) | Gate 2 Risk Adjusted OB Percentage (Stage 3) | Gate 2 Risk Adjusted OB Value |
|---------------------|---|---|--|-------------------------------|
| Option B 50MI/d | 44% | 29% | 24.1% | £82m |
| Option B 80MI/d | 44% | 29% | 24.1% | £116m |
| Option B 120MI/d | 44% | 29% | 24.1% | £135m |
| Option C 50MI/d | 44% | 29% | 24.1% | £95m |
| Option C 80MI/d | 44% | 29% | 24.1% | £123m |
| Option C 120MI/d | 44% | 29% | 24.1% | £142m |

3.3 Risk Register Assumptions

- Financial impact on the contract price resulting from a delay to the planning process is not incorporated within the discrete risks
- The boundary of the project is to the existing service reservoirs as agreed with SWS throughout the Gate 2 cost estimating process. The project does not now include for any upgrade of SWS reservoirs which had previously been considered as part of the Gate 1 Risk Register.
- Twin mains are not required at critical crossings owing to the sleeving of the mains, as agreed with Thames Water and Southern Water on the basis of robust engineering design for sleeved crossings.
- There has been no allowance for the inclusion of private connections within the cost estimate or risk register
- Cost assumptions in relation to contaminated land within the risk register do not include for Hazardous Material rates.
- All costs relating to the Judicial Review process assume that the Judicial Review is ultimately unsuccessful.
- Costs related to additional carbon measures within the risk register include for local carbon reduction initiatives only. They do not include for a wider net zero carbon policy such as sequestration or offsetting concrete use, etc.
- For the purposes of the design process, it is assumed that there is sufficient water available in order to undertake the end-to-end commissioning process.

4 Operational Expenditure

The process undertaken to prepare the **OPEX estimates** for the route B and C options is as follows:

Operating expenditure (OPEX) estimates prepared for each option have been divided into fixed OPEX and variable OPEX to align with WRSE requirements.

Fixed OPEX is made up of operational maintenance (calculated as a percentage of CAPEX) and staffing costs, whereas variable OPEX is made up of electricity and consumables used in treatment and transmission pumping costs.

Two operating regimes were used for deriving variable OPEX for each option. These operating regimes are as follows:

- The maximum operating scenario is the flow each option can deliver in a drought event (deployable output - DO). Three capacities have been modelled: 50, 80 and 120 MLD.
- The minimum operating scenario is the lowest flow the option can operate at and is the usual base case. The minimum operating scenario has been taken as 15% of the DO for each option.

Staff costs for treatment plants and transfer infrastructure have been based on 200 operator hours per week, 52 weeks/year (estimated by the design team) and hourly rates provided by Thames Water.

Chemical costs have been derived using chemical volumes supplied by T2ST design team for the water treatment works for each of the 50, 80 and 120MLD capacity options. Unit costs for chemicals were taken from Southern Water's OPEX tool where available or from industry data.

Power demand estimates for the treatment works and pumping stations for each option and capacity were provided by the T2ST design team and converted to annual power consumption.

Cost of water: based on abstraction costs estimated using the Environment Agency Water resources annual charge indicator tool.

We understand that the WTW sludge would be discharged to a Thames Water sewer and hence sludge transport and disposal costs have not been included.

Annual operational maintenance costs have been estimated based on a percentage of the initial capital costs at the option level. These percentages are based on common assumptions used in the water sector for such infrastructure. Civil maintenance was calculated as 0.30% of the Infra and non-infra civil costs whilst M&E maintenance was calculated as 1.5% of Infra and non-infra-M&E costs.

The variable OPEX cost per ML was derived by dividing the total variable OPEX by the flow estimated for that option.

OPEX values are presented in Table 4.1.

Table 4.1: OPEX values for each option (2020/21 base date)

| Option Name | Units | Option B 50 MLD | Option B 80 MLD | Option B 120 MLD | Option C 50 MLD | Option C 80 MLD | Option C 120 MLD |
|--------------------------|--------------|------------------------|------------------------|-------------------------|------------------------|------------------------|-------------------------|
| Option Benefit | MLD | 50 | 80 | 120 | 50 | 80 | 120 |
| G2 Fixed | £m/ annum | 1.5 | 1.9 | 2.3 | 1.6 | 2.0 | 2.4 |
| G2 Variable | £/ML | 338.4 | 348.9 | 352.7 | 308.4 | 315.0 | 332.1 |
| G2 Total at Maximum Flow | £m/ annum | 7.6 | 12.1 | 17.8 | 7.2 | 11.2 | 16.9 |

5 Net Present Value and Average Incremental Cost

The approach to calculating the Net Present Value (NPV) and Average Incremental Cost (AIC) values has followed guidance from the All Company Working Group (ACWG) to ensure consistency in the calculation of NPVs and AICs across all SROs. The ACWG Cost Consistency report reviewed approaches to calculation of financing costs and recommended a consistent approach which is summarised in Section 6.3 of the Cost Consistency report.

NPV and AIC values are presented in Table 5.1. NPV estimates have been calculated over an 80-year appraisal period, comprising 7 years for planning and development and 5 years for construction followed by 68 years of operation. The 80-year appraisal period has been selected as this is consistent with the ACWG guidelines and the approach taken across all SROs. CAPEX (including maintenance and replacement costs) and OPEX forecasts (both fixed and variable costs) have been profiled over the 80-year appraisal period.

Planning costs are split evenly over the first 7 years, and construction costs are split 25:25:25:15:10 over the following 5 years (years 8 to 12). Spend profiles are indicative only to facilitate multi-solution decision making and will be refined at Gate 3.

The process undertaken to prepare the **Capital Maintenance estimates** for the options is as follows:

- CAPEX estimates have been split by asset type and each asset type has been assigned an asset life from 4 to 100 years, based on the asset lives by asset type provided in the ACWG report '*Cost Consistency Methodology, Technical Note and Methodology*' (ACWG, February 2022).
- This allocation has then been used to allocate future capital maintenance/renewal costs for each asset type over the 80-year appraisal period used in the NPV and AIC analysis. Capital maintenance/renewals cycles have been taken as starting in year 13 (first operating year).

The option Financing costs have then been calculated as a stream of annual costs over the life of the option, using an assumed 2.92% weighted average cost of capital (WACC). The NPV of all costs has then been calculated using the Social Time Preference Rate (STPR) discount rate as set out in The Green Book - Central Government Guidance on Appraisal and Evaluation (HM Treasury 2022). This is 3.5% for years 0-30 of the appraisal periods, 3.0% for years 31-75, and 2.5% for years 76-125.

AIC values have been estimated based on deployable output discounted over the life of the scheme. The AIC provides an estimate of the unit cost for delivering the Deployable Output of the scheme. As the costs will depend upon the level of scheme utilisation, we have estimated maximum and minimum utilisation AIC values. In all cases the denominator (discounted DO over the life of the scheme) is the same - i.e., it is a unit cost for making available a capacity.

It should be noted that these costs enable comparison between options, but do not take account of the holistic costs of the scheme, as they exclude the required raw water source and hence should not be used for decision making in isolation.

The updated Gate 2 RAPID guidance requires the inclusion of WRMP data tables 5a-5b, which are based on the new ACWG AIC template. These tables are presented in Appendix A.

Table 5.1: NPV and AIC costs for each element/option (2020/21 base date)

| Option Name | Units | Option B 50 MLD | Option B 80 MLD | Option B 120 MLD | Option C 50 MLD | Option C 80 MLD | Option C 120 MLD |
|---|------------------|-----------------|-----------------|------------------|-----------------|-----------------|------------------|
| Option Benefit (max flow) | MLD | 50 | 80 | 120 | 50 | 80 | 120 |
| Min Flow (Gate 2) | MLD | 7.5 | 12 | 18 | 7.5 | 12 | 18 |
| Total planning period option benefit (NPV) | MI | 326,709,676 | 522,735,481 | 784,103,222 | 326,709,676 | 522,735,481 | 784,103,222 |
| Total planning period indicative capital cost of option (CAPEX NPV) | £m | 426.3 | 586.0 | 691.9 | 473.2 | 610.9 | 715.3 |
| Total planning period indicative capital cost of option (FINANCE NPV) | £m | 371.1 | 511.4 | 604.5 | 412.4 | 533.4 | 625.3 |
| Minimum Flow | | | | | | | |
| Total planning period indicative operating cost of option (OPEX NPV) | £m | 42.9 | 62.2 | 83.0 | 43.5 | 60.6 | 81.6 |
| Total planning period indicative option cost (NPV) | £m | 414.0 | 573.5 | 687.4 | 455.9 | 594.0 | 706.9 |
| Average Incremental Cost (AIC) | p/m ³ | 129 | 110 | 88 | 140 | 114 | 90 |
| Maximum Flow | | | | | | | |
| Total planning period indicative operating cost of option (OPEX NPV) | £m | 136.9 | 217.2 | 318.0 | 129.2 | 200.6 | 303.0 |
| Total planning period indicative option cost (NPV) | £m | 508.0 | 728.6 | 922.5 | 541.6 | 734.0 | 928.3 |
| Average Incremental Cost (AIC) | p/m ³ | 157 | 139 | 118 | 166 | 140 | 118 |

6 Carbon estimates

The approach used to prepare the Capital Carbon emissions estimates for the Options is as follows:

The capital carbon assessment was based on design scope information from the T2ST design team.

Analogous to cost models, the capital carbon models are based on curves created from data points, relating a driver defining the size of the asset to its carbon emissions. The carbon models are not based on the same underlying information as the cost models, and not all cost models have a directly corresponding carbon model. The size drivers also do not always match. Cost models were mapped to carbon models as closely as possible, with standardised assumptions made where drivers needed converting between units or different estimates of the asset size were required.

The approach used to prepare the Operational Carbon emissions estimates for the options is as follows:

Quantities for power use and chemical use were taken from the OPEX estimates

Power:

- Emissions factors for grid electricity were taken from BEIS Green Book projections and take into account projected grid decarbonization from 2029 to 2100, with the emissions factor assumed to be constant after 2100.
- BEIS Green Book values always appear to lag 2 years behind the Defra reported value in each year. Therefore, the values used for 2049 correspond to the 2047 value in the Green Book etc (though by 2048 the grid is assumed to be largely decarbonised and hence all values after 2048 are the same).

Chemicals:

- Emissions factors were taken from the Carbon Accounting Workbook (CAW). Chemical quantities were taken from the OPEX calculations, converted into the amount of pure chemical used.

Operational maintenance:

- Carbon emissions associated with operational maintenance were assumed to be negligible and primarily associated with labour rather than significant additional materials use

The whole life carbon estimates comprise the capital carbon emissions, annual operational emissions and additional capital emissions associated with capital maintenance. The estimated annual carbon emissions profile was based on the WLC profile developed for the NPV and AIC cost calculations.

- Years 1-7: planning
 - Assumed no carbon emissions associated with planning phase
- Years 8-12: construction
 - Assumes all capital carbon emissions occur in years 8-12 in proportion to the CAPEX breakdown
- Years 13-80: operation and capital maintenance

- Capital maintenance emissions were based on the initial embodied carbon estimate for each asset.
- Annual operational carbon emissions were included and calculated as above. As grid decarbonisation projections are included in the analysis, year 1 is assumed to be 2035 and the first operational year is assumed to be 2049.

The monetised cost of carbon was also calculated using carbon value forecasts from the Green Book Supplementary Guidance: Valuation of energy use and GHG emissions for appraisal (Table 3, Carbon values and sensitivities 2020-2100 for appraisal, 2020 £/tCO₂e, central price). The carbon price was applied to all carbon emissions (capital and operational). The whole life cost of carbon was estimated by discounting the future monetised carbon costs using the recommended Green Book discount rates over the 80-year period.

The current estimate of emissions provides a view of how much the Options would add to SWS's existing emissions once commissioned. Under SWS's net zero operational emissions by 2030 commitment these operational emissions will need to be reduced and potentially offset by 2030. The potential costs of offsets have not been included as this would be considered as part of SWS's overall net zero and offsetting strategy.

Table 6.1 summarises the capital carbon, operational carbon (associated with chemical use, power and transport), whole life carbon (includes capital maintenance as well as capital and operational carbon over the 80-year appraisal period) and the monetised cost of carbon.

Table 6.1: Capital, operational and whole life carbon estimates (monetised costs in 2020/21 prices)

| Operating regime | Flow (MI/d) | Capital carbon (tCO ₂ e) | Operational carbon (tCO ₂ e/y) | Whole life carbon (tCO ₂ e) | Monetised whole life cost of carbon (£m) |
|------------------------|-------------|-------------------------------------|---|--|--|
| Route B Options | | | | | |
| Max (DO) | 50 | 62,400 | 1,083 | 154,100 | 28 |
| Min (15% of DO) | 7.5 | 62,400 | 313 | 104,000 | 21 |
| Max (DO) | 80 | 101,400 | 1,766 | 245,700 | 46 |
| Min (15% of DO) | 12 | 101,400 | 506 | 160,300 | 34 |
| Max (DO) | 120 | 130,800 | 2,635 | 340,500 | 62 |
| Min (15% of DO) | 18 | 130,800 | 756 | 218,300 | 45 |
| Route C Options | | | | | |
| Max (DO) | 50 | 67,000 | 1,049 | 156,200 | 29 |
| Min (15% of DO) | 7.5 | 67,000 | 308 | 107,800 | 22 |
| Max (DO) | 80 | 102,700 | 1,706 | 242,400 | 45 |
| Min (15% of DO) | 12 | 102,700 | 497 | 163,600 | 34 |
| Max (DO) | 120 | 129,500 | 2,580 | 334,700 | 61 |
| Min (15% of DO) | 18 | 129,500 | 748 | 215,400 | 44 |

7 The Journey from Gate 1 to Gate 2:

As the design and solutions have developed between Gateways 1 and 2 the appropriate costs presented to provide insight into the changing values have also altered. Gateway 1 costs were developed entirely from Thames Water's EES models.

Table 7.1: Gate2 Solution Capex Values – Journey from Gate 1 (2020/21) to Gate 2 (2020/21)

| Options | | Route Opt1 – Gate 1 | Route B – Gate 2 | Route C – Gate 2 |
|---------|------------|---------------------|------------------|------------------|
| 50 MLD | CAPEX (£m) | 622 | 518 | 583 |
| 80 MLD | CAPEX (£m) | 674 | 718 | 753 |
| 120 MLD | CAPEX (£m) | 757 | 844 | 877 |

As the T2ST design solution has developed between Gate 1 and Gate 2 there have been changes in the scheme scope that have impacted on both CAPEX and OPEX estimates. These include an increase in the overall pipe length for the 80MLD and 120MLD scheme options due to further development of the pipeline routes between Gate 1 and Gate 2. For Gate 2 the pipeline routes were reviewed in greater detail using a web-based GIS system to map designated sites and key constraints. 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.

For the 50MLD flow case the overall pipe length has been reduced compared to Gate 1 quantities by utilising an existing Southern Water main between Andover and Crabwood, which explains the reduction in CAPEX from Gate 1 to Gate 2 for this flow condition.

The change in pipe alignment from Gate 1 and more detailed assessment of major crossings has also led to increased quantities for tunnelled crossings, for road, rail and river crossings. The total number of tunnelled crossings at Gate 2 is 25 for Option B and 31 for Option C, compared to 11 tunnelled crossings identified at Gate 1. Storage volumes and sweetening flows have reduced from Gate 1, which has also impacted on the CAPEX and OPEX estimates for Gate 2.

Costed Risk & Optimism Bias

Table 7.2: Risk values at Gate 1 versus Gate 2 (2020/21 base date)

| Option | Gate 1 Base Cost | Gate 1 Risk Value | Gate 1 Risk Percentage | Gate 2 Base Cost | Gate 2 P50 Risk Value | Gate 2 Risk Percentage |
|------------------|------------------|-------------------|------------------------|------------------|-----------------------|------------------------|
| Option B 50MI/d | £427m | £30m | 7% | £340.6m | £95m | 28% |
| Option B 80MI/d | £463m | £33m | 7% | £480.4m | £122m | 25% |
| Option B 120MI/d | £520m | £38m | 7% | £560.7m | £148m | 27% |
| Option C 50MI/d | £427m | £30m | 7% | £392.6m | £96m | 24% |
| Option C 80MI/d | £463m | £33m | 7% | £510.2m | £120m | 23% |

| Option | Gate 1 Base Cost | Gate 1 Risk Value | Gate 1 Risk Percentage | Gate 2 Base Cost | Gate 2 P50 Risk Value | Gate 2 Risk Percentage |
|------------------|------------------|-------------------|------------------------|------------------|-----------------------|------------------------|
| Option C 120MI/d | £520m | £38m | 7% | £589.5m | £146m | 25% |

Both the Gate 1 risk values and the Gate 2 P50 risk values for Options B & C at 3 flow sizes are detailed in Table 7.2 above. It should however be noted that the Gate 2 P50 values displayed are indexed and are not the direct outputs of the Monte Carlo analysis.

Since Gate 1, the risk percentages and values associated with the cost risks for all sizes of both Option B and Option C have increased. This is owing to the quantified risk process at Gate 2, where costed values aligned to latest design information and base cost data, superseding the use of qualitative assessment as undertaken at Gate 1. This shift to a quantified risk approach, resulting from a maturing design, has enabled a more realistic view of the cost risk profile at Gate 2 and in this instance has resulted in an increasing risk profile as more information is obtained through the design process and less reliance is placed on the use of optimism bias.

Table 7.3: Optimism Bias at Gate 1 versus Gate 2 (2020/21 base date)

| Option | Gate 1 OB Percentage | Gate 1 OB Value | Gate 2 Risk Adjusted OB Percentage (Stage 3) | Gate 2 Risk Adjusted OB Value |
|------------------|----------------------|-----------------|--|-------------------------------|
| Option B 50MI/d | 35.8% | £164m | 24.1% | £82m |
| Option B 80MI/d | 35.8% | £178m | 24.1% | £116m |
| Option B 120MI/d | 35.8% | £200m | 24.1% | £135m |
| Option C 50MI/d | 35.8% | £164m | 24.1% | £95m |
| Option C 80MI/d | 35.8% | £178m | 24.1% | £123m |
| Option C 120MI/d | 35.8% | £200m | 24.1% | £142m |

Converse to the risk values, and as expected with a maturing design, the risk adjusted optimism bias values calculated at Gate 2 have shown significant decreases compared to the values calculated at Gate 1. This is owing to the ability to identify and more appropriately assess discrete quantified risks at Gate 2.

Therefore, owing to the increasing costed risk values and decreasing OB values at Gate 2, the overall, combined costed risk and OB values have remained similar at Gate 2 when compared with the overall values presented at Gate 1.

Table 7.4: Gate 2 Solution OPEX Values at DO – Journey from Gate 1 (2020/21)

| Option | | | Route Option 1 – Gate 1 | Route B – Gate 2 | Route C – Gate 2 |
|---------|----------|----------|----------------------------|---------------------|---------------------|
| 50 MLD | Fixed | £m/annum | 1.4 | 1.5 | 1.6 |
| | Variable | £/ML | 241.0 | 338.4 | 308.4 |
| | Total | £m/annum | 5.8 | 7.6 | 7.2 |
| 80 MLD | Fixed | £m/annum | 1.6 | 1.9 | 2.0 |
| | Variable | £/ML | 289.0 | 348.9 | 315.0 |
| | Total | £m/annum | 10.0 | 12.1 | 11.2 |
| 120 MLD | Fixed | £m/annum | 1.9 | 2.3 | 2.4 |
| | Variable | £/ML | 315.0 | 352.7 | 332.1 |
| | Total | £m/annum | 15.7 | 17.8 | 16.9 |

Table 7.5: Gate 2 Solution NPV Values at DO – Journey from Gate 1 (2020/21)

| Options | | Route Option 1 – Gate 1 | Route B – Gate 2 | Route C – Gate 2 |
|---------|----------|----------------------------|---------------------|---------------------|
| 50 MLD | NPV (£m) | 692 | 508 | 542 |
| 80 MLD | NPV (£m) | 852 | 729 | 734 |
| 120 MLD | NPV (£m) | 1073 | 922 | 928 |

Opex values are generally higher for Gate 2 due to an increase in pipe length and hence the need for an additional pumping station compared to Gate 1.

NPV values are significantly lower for Gate 2 compared to Gate 1, despite Opex estimates generally being higher for Gate 2. For the 50 Mld option this can be partly attributed to lower capex forecasts for Gate 2. However, another factor affecting the NPVs for all three DO options is the use of a much longer planning and development period (7 years before commencement of construction) for Gate 2, in addition to a 5-year construction period. At Gate 1 the planning and development stage was modelled as 1 year (with 5 years for construction). As discounting of costs starts from the commencement of the planning and design period and the construction capex spend does not occur until years 8 to 12 the effects of discounting are greater, leading to the lower NPV values. The overall NPV appraisal period (80 years), WACC and discount rates (HMT Green Book) were the same at both Gates 1 and 2, however, there was a change in financing approach in the current ACWG guidance to use mid-year (average) NPV rather than year-end as per the original ACWG methodology.

AIC values are similar between gates 1 and 2 as the effect of discounting described above also reduces the NPV of the WAFU, hence NPV cost divided by NPV WAFU is similar.

Table 7.6: Gate 2 Solution AIC Values, at 100% utilisation – Journey from Gate 1 (2020/21)

| Options | | Route Option 1 – Gate 1 | Route B – Gate 2 | Route C – Gate 2 |
|---------|------------|-------------------------|------------------|------------------|
| 50 MLD | AIC (p/m3) | 160 | 157 | 166 |
| 80 MLD | AIC (p/m3) | 123 | 139 | 140 |
| 120 MLD | AIC (p/m3) | 103 | 118 | 118 |

Table 7.7: Gate 2 Solution Whole Life Carbon Values – Journey from Gate 1 (2020/21)

| Options | | Route Option 1 – Gate 1 | Route B – Gate 2 | Route C – Gate 2 |
|---------|----------------|-------------------------|------------------|------------------|
| 50 MLD | Carbon (tCOe2) | 115,900 | 154,100 | 156,200 |
| 80 MLD | Carbon (tCOe2) | 150,500 | 245,700 | 242,400 |
| 120 MLD | Carbon (tCOe2) | 171,200 | 340,500 | 334,700 |

The embodied carbon estimates for gates 1 and 2 are similar. The operational carbon estimates have increased due to the increase in power consumption for Gate 2 (due to increased requirement for intermediate pumping for the transmission mains) and increased emissions from chemical consumption. As a result of the increase in operating carbon, the total whole life carbon has also increased from gates 1 to 2.

8 Changes from WRSE draft regional plan submission

In February 2022 Thames Water submitted updated information to WRSE on the T2ST options to inform the regional plan modelling. Changes in project scope and costing approach between the February 2022 WRSE submission and Gate 2 cost report are set out as follows:

- Only the 2 No. Gate 1 potable water options 1 and 4 were submitted to WRSE in February 2022. The raw water options from Gate 1 were screened out during the Gate 2 option appraisal stage. All CAPEX and OPEX costs submitted to WRSE in February 2022 were the same as the Gate 1 costs for options 1 and 4. All changes made since February 2022 are the same as the changes stated in Section 7 of this report.
- Since submission to WRSE in February 2022 the T2ST preferred options B and C have been developed, which are variants to Gate 1 Option 1, for the transfer of water from SESRO and/or STT to the Southern Water supply network in Hampshire, as set out in Section 1 of this report.
- Changes in costing approach between Gate 1 and Gate 2 are detailed above in Section 7. Gate 1 costs were developed entirely from Thames Waters EES models and while changes have been made to both the costing approach and engineering scope for Gate 2 the option costs remain on average within 10 percent of those proposed at Gate 1.
- The capacity of the T2ST options at 50, 80 and 120MLD as assessed at Gate 2 is consistent with the option capacities submitted to WRSE in February 2022.
- As the T2ST design solution has developed between Gate 1 and Gate 2 there have been changes in the scheme scope that have impacted on both CAPEX and OPEX estimates, as detailed in Section 7.
- OPEX values are generally higher for Gate 2 due to an increase in pipe length and the inclusion of an additional pumping station compared to Gate 1 (Table. 7.2).
- Changes in the approach to costed risk and Optimism Bias between Gate 1 and Gate 2 are set out in Section 7 of this report. Changes in costed risk values are presented in Table 7.2 and changes in Optimism Bias values in Table 7.3.

A. Tables 5a – 5b

Case Profile Worksheet Table

Table with 4 columns: Table Instruction, Option ID, Case Name, Case Metric (EM), Case Sub-metric (EM)

Main data table for Case Profile Worksheet Table. Columns include Case Name, Case Metric (EM), Case Sub-metric (EM), and a grid of values for years 2024-25 to 2054-55. Rows include categories like 'Complete for all options (if both available and preferred)'.

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