MOTT MACDONALD

Thames to Southern Transfer (T2ST)

Environmental Assessment Report

28 June 2021

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Glossary

Acronym	Definition
AA	Appropriate Assessment
ACWG	All Companies Working Group
BEIS	Department for Business, Energy & Industrial Strategy
BNG	Biodiversity Net Gain
BPT	Break Pressure Tanks
CAW	Carbon Accounting Workbook
CEMP	Construction Environmental Management Plan
CRT	Canal and Rivers Trust
EA	Environment Agency
EAR	Environment Assessment Report
GHG	Green House Gas
HGV	Heavy Goods Vehicle
HRA	Habitats Regulations Assessment
INNS	Invasive Non-Native Species
NC	Natural Capital
PCC	Per Capita Consumption
PIC	Public Interest Commitments
PPA	Power Purchase Agreement
PS	Pumping Station
RAPID	Regulators' Alliance for Progressing Infrastructure Development
REGO	Renewable Energy Guarantees of Origin
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
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 Treatment Works

Executive summary

The Environment Assessment Report (EAR) accompanies the Gate 1 submission to the Regulators' Alliance for Progressing Infrastructure Development (RAPID) for the Thames to Southern Transfer (T2ST) Strategic Resource Option (SRO).

Six unconstrained options are being considered for transferring water from the Thames Water region to the Southern Water region. These options include raw water and potable water options, transferring available water from either the Severn Thames Transfer (STT) or the South East Strategic Reservoir Option (SESRO) at Culham, or the River Thames at Reading from the Thames Water supply zone to either Otterbourne North Water Treatment Works (WTW) or Testwood in Southern Water's Hampshire area.

Three regulatory assessments have been completed for the T2ST options: a Habitats Regulations Assessment (HRA); a Water Framework Directive (WFD) Assessment; and a Strategic Environmental Assessment (SEA). The regulatory assessments are summarised in the EAR and the full assessments are presented as separate annexes (Annex B.2, B.3 and B.4 respectively).

Water Resources South East (WRSE) undertook an initial stage assessment of these three regulatory assessments in January 2021 (with an update in March 2021) using data from the T2ST Options Appraisal (ref: Thames to Southern Transfer (T2ST) SRO, Option Appraisal, 3 November 2020, 5201578/9.1/DG/004). These assessments have been taken further at this Gate 1 stage, to include local data and confirm likely effects for components of the transfer which were not included in the WRSE assessment.

The Habitats Regulations Assessment reports the findings of the full HRA Stage 2 / Appropriate Assessment (AA). WRSE undertook the initial HRA screening and identified a number of potential 'likely significant effects', and a number of 'uncertain effects' for each of the options. The AA concluded that all six options were identified as having 'no likely significant effects' (alone), after mitigation is implemented. This was dependant on the route for Options 5 and 6 being altered to avoid intersecting the Solent and Southampton Water Ramsar and Special Protection Area (SPA) sites, so as to avoid any likely significant effects on these sites. In addition, the HRA specified that directional drilling would be required for all options to cross the River Lambourn Special Area of Conservation (SAC), and for Options 5 and 6 to cross the River Test, so as to avoid likely significant effects on these sites.

The Water Framework Directive Assessment reports the findings of the WFD. The Level 1 WFD assessment undertaken by WRSE indicated that all options had one waterbody which required further assessment; Thames (Evenlode to Thame) – Option 1, 2 and 5; and Thames (Wallingford to Caversham) – Option 3, 4 and 6. Level 2 WFD assessments were completed for these two waterbodies. The findings indicate that there are potentially precautionary WFD compliance risks associated with the operation of the new abstractions for all options. The potential hydrological effects could conflict with achieving WFD status objectives. This is particularly the case for Options 3, 4 and 6 where hydrology/river flow is an existing limiting factor. The potential biological effects, particularly on fish, would require further assessment. For all options it has been assumed that another SRO would be used in combination with this option to support the water to the River Thames. This will help to reduce the impact on hydrological regime and therefore on the biological elements.

The Strategic Environmental Assessment reports the findings of the options level SEA applied to the options. WRSE undertook the SEA and the outputs for residual effects (post mitigation), showed that the six pipeline options are predicted to result in similar positive, neutral or negative

effects across all the SEA objectives in construction and operation. The results highlighted that Options 1, 2 and 5 are predicted to result in greater negative residual effects on Biodiversity during construction (due to impacts on Sites of Special Scientific Interest (SSSIs)). Options 3, 4 and 6 are predicted to result in greater negative residual effects on Population and Human Health during construction (due to impacts on a small number of community facilities). Some additional assessment was undertaken to consider the impacts of components of the schemes that were not included in the WRSE assessment. The output of this shows that the components would result in some additional negative effects on some of the SEA objectives. The Otterbourne, Reading and Testwood sites each resulted in additional effects for five SEA objectives. The Otterbourne site is required for Options 1, 2, 3 and 4. The Reading site is required for Options 3, 4 and 6, and the Testwood site is required for Options 5 and 6. As such, the SEA concludes that, of the six options, Options 1 and 2 will result in the least negative effects.

The risk of spreading invasive non-native species (INNS) associated with the options has been investigated. The INNS risk assessment concludes that the risk of spreading INNS from one location to another was significantly lower for options which transferred raw water to a WTW, than options that may transfer to a lake receptor site. As such, it was concluded that risk of INNS spread was highest for Options 5 and 6, which may transfer raw water to a lake, but this risk could be reduced considerably as the conceptual design is developed to include mitigation measures such as raw water screening and chlorination.

Biodiversity Net Gain (BNG) and Natural Capital (NC) assessments were completed by WRSE in January 2021. For each option, an assessment of the potential impact of construction and operation of the option on habitats was undertaken, using the BNG metric. The NC metrics were then quantified as ecosystem services in order to provide monetised values for natural capital benefit or loss. The outputs of the BNG assessments concluded that Options 1 and 2 result in the lowest percentage loss of BNG Habitat Units. Option 6 results in the highest percentage loss of BNG Habitat Units. The outputs of the NC assessment concluded a similar loss to the BNG assessments where Options 1 and 2 are likely to result in the least overall loss of NC stocks and Option 6 is likely to show the greatest overall loss of NC stocks. The ecosystem services assessment estimated that all options would result in a loss in value per year, which was smallest for Options 3 and 4 and greatest for Option 6.

The opportunities identified in the BNG/NC assessment have the potential to contribute to Government ambitions for environment net gain[1]. This could take the form of habitat creation and/or species relocation schemes. Any schemes would need to be taken forward based on a comprehensive understanding on the interaction between natural systems and social uses of land.

The wider benefits of T2ST have been reviewed, considering the context of the benefits provided to society of water resource planning, including the benefits to, and views of, customers. A number of best practice mitigation measures which could be implemented during construction to avoid or mitigate potential disruption and disturbance to communities are identified. For all options, there is the potential for enhancements to be applied during operation in relation to reinstating land to achieve potential positive effects and public value.

Contributing to net zero carbon emission objectives is an important aspiration and opportunities covering whole life (capital and operational) carbon has been investigated. The carbon estimates for the options highlight that the majority of the embedded and operational carbon sits within the construction and pumping associated with the transfer pipelines. Some considerations have been identified that the T2ST transfer options could take to decarbonise

[1] Environmental Net Gain can be defined as the wider environmental gains relevant to a local area, such as reduced flood risk, improvements to air or water quality, or increased access to natural greenspace. Source: Environment Agency: Water resources planning guideline, Draft for consultation (2020).

and drive towards net zero. An important part of turning some of the considerations into deliverable opportunities is to have a robust carbon management process embedded into the scheme development.

The combination of these assessments and studies shows that while positive benefits will likely result from operation of the scheme through the scheme improving water transfer, water resource management and resilience of water supply; and the scheme providing protection against future drought scenarios, construction of the scheme will likely result in some negative effects, even with mitigation applied.

Of the six options, it is likely that Options 1 and 2 will result in the fewest negative effects for HRA, SEA, INNS, NC and BNG, but Options 3 and 4 would result in the least loss in value of ecosystem services per year. Options 5 and 6 result in additional impacts on designated sites and therefore have the most negative effects.

The assessments undertaken as part of this SRO have identified a number of mitigations that would be required to be put in place, should the options be taken forward.

Opportunities for directional drilling should be explored, in order to avoid or reduce likely effects on watercourses and designated sites. Further detailed assessments on the construction methods should be carried out to confirm reduced impact.

Pipeline routes should be refined and re-routed in order to avoid entering designated sites (such as the Solent and Southampton Water Ramsar and SPA) and to avoid sensitive community facilities.

Measures to reduce or eliminate risk of INNS spread should be investigated and incorporated into design.

Opportunities for compensatory habitat creation or habitat reinstatement should be explored, as well as opportunities to improve the existing habitats and provide offsetting planting of trees. Opportunities for reinstating land to achieve potential positive community effects should also be explored for example by improving access to recreational and open space, upgrades to outdoor sports facilities and improving access to community resources.

Opportunities to drive down carbon emissions during construction should be investigated, such as reducing the carbon impact of key materials and products, adopting efficient construction techniques, and considering alternative low or zero carbon construction plant. Options to optimise energy efficiency during operation should also be considered, such as those associated with the pumping and treatment of water.

1 Introduction

1.1 Overview

This Annex B.1 accompanies the Gate 1 submission to the Regulators' Alliance for Progressing Infrastructure Development (RAPID) for the Thames to Southern Transfer (T2ST) Strategic Resource Option (SRO).

1.2 Thames to Southern Transfer Options

The outputs of the initial route options appraisal identified six unconstrained options for transferring water from the Thames Water region to the Southern Water region. These options include raw water and potable water options as shown in Table 1.1. Further details on the options are set out in Section 1.5.

Table 1.1: T2ST options

Option ref	Option name
1	Potable water transfer from Culham to Otterbourne North Water Treatment Works (WTW) (50, 80 and 120Ml/d)
2	Raw water transfer from Culham to Otterbourne North WTW (50, 80 and 120Ml/d)
3	Raw water transfer from the River Thames at Reading to Otterbourne North WTW (50, 80 and 120Ml/d)
4	Potable water transfer from the River Thames at Reading to Otterbourne North WTW (50, 80 and 120Ml/d)
5	Raw water transfer from Culham to Testwood
6	Raw water transfer from the River Thames at Reading to Testwood

1.3 Work undertaken to date

An options appraisal was undertaken for the T2ST SRO in November 2020 (ref: Thames to Southern Transfer (T2ST) SRO, Option Appraisal, 3 November 2020, 5201578/9.1/DG/004).

The data from the options appraisal was sent to Water Resources South East (WRSE) who undertook a number of initial stage environmental assessments of the options in January 2021 and updated in March 2021, following the methodology in the WRSE Regional Plan Environmental Assessment Methodology Guidance, July 2020.

Assessments undertaken by WRSE included:

- Stage 1 Habitats Regulations Assessment (HRA);
- Stage 1 Water Framework Directive (WFD) Assessment;
- A Strategic Environmental Assessment (SEA); and
- Biodiversity Net Gain (BNG) and Natural Capital (NC) assessments

At Gate 1, these assessments have been taken further by the SRO teams, in-line with the methodology in the All Companies Working Group (ACWG) water resources management plan (WRMP) environmental assessment guidance and applicability with SROs, October 2020.

Further work is proposed by both WRSE and the SRO team as the T2ST options progress through Gate 2 and beyond. Figure 1.1 below describes the interaction between WRSE and SRO deliverables.

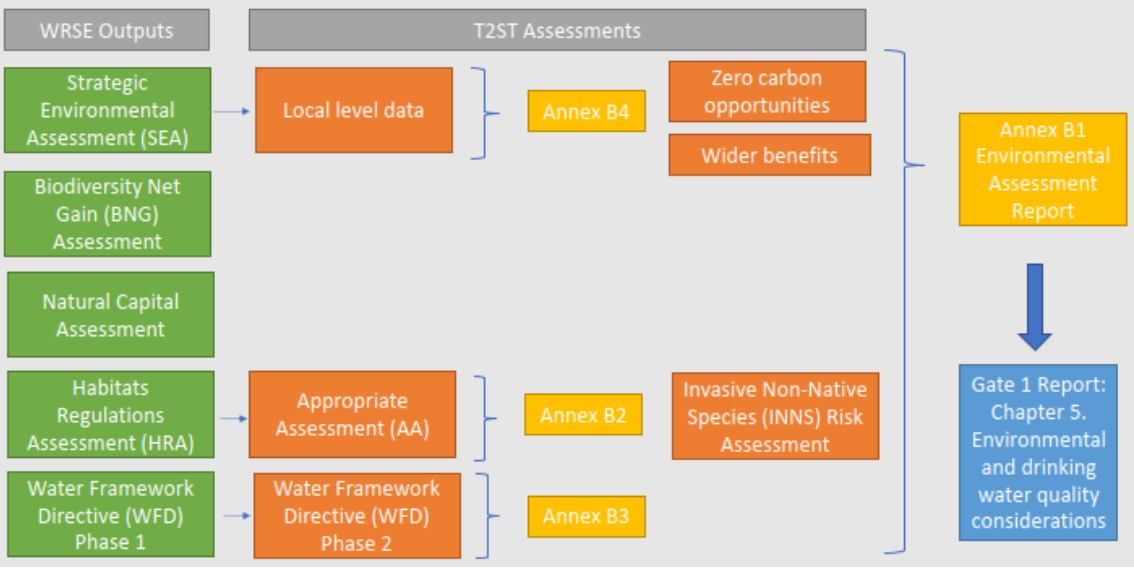
Figure 1.1: WRSE and ACWG SRO Tasks/Deliverables

Environmental Assessment	WRSE Tasks/Outputs	ACWG SRO Tasks/Outputs (Gate 1)	ACWG SRO Tasks/Outputs (Subsequent Gate Stages)
Strategic Environmental Assessment	Option-level SEA based on available SRO option information and using the WRSE SEA objectives SEA cumulative assessment at programme appraisal stage – Not available for SRO Gate 1 submission	Review WRSE SEA output Flag challenges and any additional local level information – written feedback & feedback workshop Use updated WRSE SEA results in Gate 1 submission aligned to ACWG SEA objectives	Review SEA as option design progresses and more information becomes available. Incorporate and update mitigation and enhancement measures.
Habitats Regulations Assessment	Option-level HRA Test of Likely Significance (screening) based on available SRO option information HRA Appropriate Assessment and in-combination effects undertaken at programme appraisal stage – Not available for SRO Gate 1 submission *(SROs HRA AA will feed into WRSE programme appraisal)*	Review WRSE HRA ToLS output Flag challenges – written feedback & feedback workshop Undertake HRA Appropriate Assessment (if required by ToLS outcome) for Gate 1 submission and provide to WRSE	Review HRA as option design progresses and more information becomes available. Incorporate HRA AA identified mitigation into option and liaise with Natural England.
Water Framework Directive Assessment	Option-level WFD Phase 1 screening based on available SRO option information WFD Phase 2 and in-combination effects undertaken at programme appraisal stage – Not available for SRO Gate 1 submission *(SROs WFD Phase 2 assessments will feed into WRSE programme appraisal)*	Review WRSE WFD Phase 1 screening output Flag challenges – written feedback & feedback workshop Undertake WFD Phase 2 assessment (if required by Phase 1 screening outcome) in line with ACWG methodology for Gate 1 submission and provide to WRSE	Review WFD assessment as option design progresses and more information becomes available. Incorporate WFD Phase 2 identified mitigation into option and liaise with Environment Agency.
Biodiversity Net Gain Assessment	Option-level BNG assessment based on available SRO option information BNG cumulative assessment at programme appraisal stage – Not available for SRO Gate 1 submission	Review WRSE BNG assessment output Flag challenges and any additional local level information – written feedback & feedback workshop Use updated WRSE BNG results in Gate 1 submission	Review BNG assessment as option design progresses and more information becomes available. Investigate further opportunities for BNG within the design.
Natural Capital Assessment	Option-level NC assessment based on available SRO option information NC cumulative assessment at programme appraisal stage – Not available for SRO Gate 1 submission	Review WRSE NC assessment output Flag challenges and any additional local level information – written feedback & feedback workshop Use updated WRSE SEA results in Gate 1 submission	Review NC assessment as option design progresses and more information becomes available. Investigate further opportunities for increasing/improving natural capital stocks within the design.
Invasive Non-Native Species Assessment	Option type INNS risk assessment Programme appraisal INNS risk assessment – Not available for SRO Gate 1 submission *(SROs INNS risk assessments will feed into WRSE programme appraisal)*	Undertake INNS risk assessment in line with Atkins methodology for Gate 1 submission and provide to WRSE	Review INNS risk assessment and incorporate any identified mitigation as option design progresses and more information becomes available.

Source: WRSE 14 February 2021

The interaction between the WRSE outputs and the T2ST further assessment is depicted in Figure 1.2.

Figure 1.2: T2ST Gate 1 Report components



1.4 Structure of the report

This document presents:

- Section 1.5 Scheme Description: An overview of each of the T2ST options.

- Section 3 Regulatory Assessment Report: Information on the regulatory assessments undertaken as part of the Gate 1 submission.
- Section 4 Invasive non-native species (INNS) Risk Assessment: INNS risk assessment undertaken on the options.
- Section 5 Natural Capital (NC) and Biodiversity Net Gain (BNG): NC and BNG assessment undertaken on the options.
- Section 6 Wider benefits: High level socio-economic assessment undertaken on the options.
- Section 7 Assessment of opportunities for net zero carbon contributions: High level carbon assessment undertaken for the T2ST scheme.
- Section 8 Comparison between options and summary conclusions.

1.5 Assumptions and limitations

The WRSE outputs for the HRA, WFD, SEA and BNG & NC assessments do not include an assessment for the additional components described in Section 2.3.

For assumptions and limitations for the regulatory assessments, see the full assessments in Annex B.2 HRA, Annex B.3 WFD and Annex B.4 SEA.

For constraints and limitations of the INNS assessment, see Section 4.2.7.

For assumptions and limitations of the NC and BNG assessment, see Section 5.3.

2 Scheme Description

2.1 Overview

The aim of the T2ST SRO is to investigate options for transferring available water from either the Severn Thames Transfer (STT) or the South East Strategic Reservoir Option (SESRO) at Culham from the Thames Water supply zone to Southern Water's Hampshire area.

It should be noted that the SESRO is a proposed reservoir and therefore is not shown on existing baseline maps.

A full scheme description can be found in the RAPID Gate 1 Report for T2ST, however a summary of the main aspects of the options is included below.

2.2 Option descriptions

For Gate 1, there are six unconstrained options for T2ST as described in Table 2.1. A map of the options is shown in Figure 2.1.

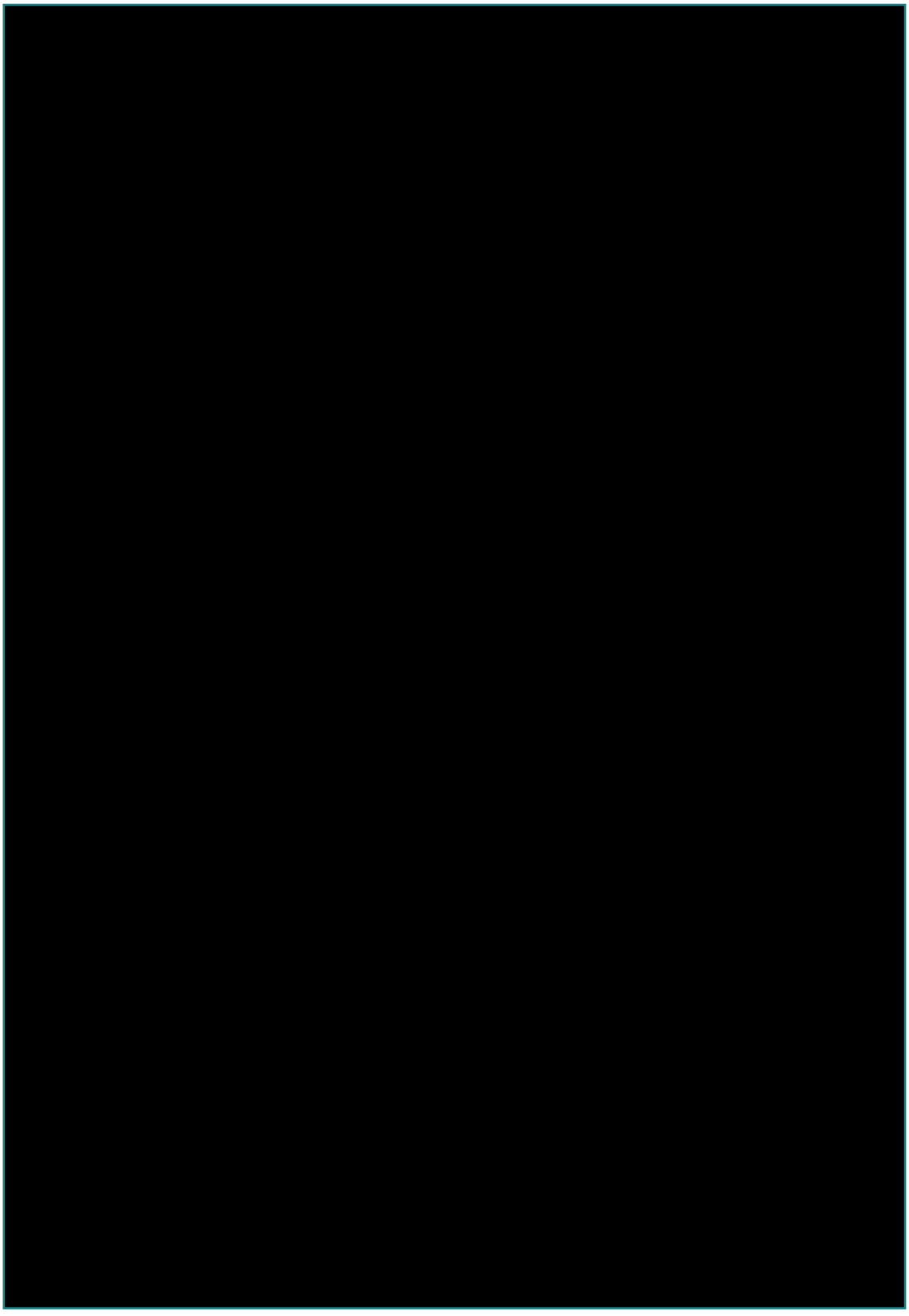
Table 2.1: T2ST Gate 1 unconstrained options description

Option ref	Option name	Option description
1	Potable water transfer from Culham to Otterbourne North WTW (50, 80 and 120Ml/d)	Transfer of potable water from the River Thames at Culham near Abingdon to Otterbourne. Water provided from either STT or SESRO. Water treatment will be required at Culham and potable water will be transferred to Otterbourne North WTW, a new WTW which will be located between South Winchester and Otterbourne North. This option includes offtakes for delivery of potable water as follows: • 10Ml/d offtake to Kingsclere Water supply reservoir (WSR) • 10Ml/d offtake to Micheldever WSR • 10-20Ml/d offtake to the South East Water (SEW) Basingstoke supply zone at Northgate WSR • 50 – 120 Ml/d to a new WTW at Otterbourne North – treated water will be delivered to a new storage tank for distribution into the supply network. A new WTW will be required at Culham. A new WTW will be required at Otterbourne North. Service reservoir extensions will be required at Kingsclere WSR and Micheldever WSR. New pumping stations (PS) will be required at: • Culham WTW • Newton Common New break pressure tanks (BPT) will be required at: [redacted] An alternative option for the Andover connection is being considered where potable water is received at Upper Enham WSR rather than Micheldever WSR.
2	Raw water transfer from Culham to Otterbourne North WTW (50, 80 and 120Ml/d)	Transfer of raw water from the River Thames at Culham near Abingdon to Otterbourne. Water provided from either STT or SESRO. The transferred raw water will require treatment at new WTW sites at Otterbourne, Kingsclere and Andover. This option includes offtakes for delivery of raw water as follows: • 10Ml/d offtake to a new WTW at Kingsclere • 10Ml/d offtake to a new WTW at Andover • 10-20Ml/d offtake to SEW at Northgate WTW • 50 – 120 Ml/d to a new WTW at Otterbourne North

Option ref	Option name	Option description
		New WTW will be required at: • Kingsclere • Andover • Otterbourne North New PS will be required at: • Culham WTW [redacted] New BPT will be required at: • [redacted]
3	Raw water transfer from the River Thames at Reading to Otterbourne North WTW (50, 80 and 120Ml/d)	Transfer of raw water from the River Thames at Reading [redacted] to Otterbourne. Water provided from either STT or SESRO. The transferred raw water will require treatment at new WTW sites at Otterbourne, Kingsclere and Andover . This option includes offtakes for delivery of raw water as follows: • 10Ml/d offtake to a new WTW at Kingsclere • 10Ml/d offtake to a new WTW at Andover • 10-20Ml/d offtake to SEW at Northgate WTW • 50 – 120 Ml/d to a new WTW at Otterbourne North A new river abstraction intake and pumping station will be required at Reading at the abstraction point. New WTW will be required at: • Kingsclere • Andover • Otterbourne North A new PS will be required at [redacted] A new BPT will be required at: • [redacted]
4	Potable water transfer from the River Thames at Reading to Otterbourne North WTW (50, 80 and 120Ml/d)	Transfer of potable water from [redacted] Reading to Otterbourne. Water provided from either the Severn to Thames Transfer or SESRO. Water treatment will be required [redacted] and potable water will be transferred to Otterbourne WTW. This option includes offtakes for delivery of potable water as follows: • 10Ml/d offtake to Kingsclere WSR • 10Ml/d offtake to Micheldever WSR • 10-20Ml/d offtake to SEW at Northgate WSR • 50 – 120 Ml/d to a new WTW at Otterbourne North –treated water will be delivered to a new storage tank for distribution into the supply network A new river abstraction intake and pumping station will be required at Reading at the abstraction point. Service reservoir extensions will be required at Kingsclere WSR and Micheldever WSR. New WTW will be required at: • Otterbourne North A new PS will be required at [redacted] A new BPT will be required at: [redacted] An alternative option for the Andover connection is being considered where potable water is received at Upper Enham WSR rather than Micheldever WSR.
5	Raw water transfer from Culham to Testwood	As Option 2, except raw water is treated at Testwood not Otterbourne. Transfer of raw water from the River Thames at Culham near Abingdon to Testwood. Water provided from either STT or SESRO. The transferred raw water will require treatment at new WTW sites at Testwood, Kingsclere and Andover.

Option ref	Option name	Option description
		This option includes offtakes for delivery of raw water as follows: • 10Ml/d offtake to a new WTW at Kingsclere • 10Ml/d offtake to a new WTW at Andover • 10-20Ml/d offtake to SEW at Northgate WTW • 50 – 120 Ml/d to a new WTW as an extension to the existing Testwood WTW. New WTW will be required at: • Kingsclere • Andover • Testwood New PS will be required at: • Culham WTW • [redacted] New BPT will be required at: [redacted] • [redacted]
6	Raw water transfer from the River Thames at Reading to Testwood	As Option 3, except raw water is treated at Testwood not Otterbourne. Transfer of raw water from the River Thames at Reading [redacted] to Testwood. Water provided from either STT or SESRO. The transferred raw water will require treatment at new WTW sites at Testwood, Kingsclere and Andover. This option includes offtakes for delivery of raw water as follows: • 10Ml/d offtake to a WTW works at Kingsclere • 10Ml/d offtake to a new WTW at Andover • 10-20Ml/d offtake to SEW at Northgate WTW • 50 – 120 Ml/d to a new WTW as an extension to the existing Testwood WTW. A new river abstraction intake and pumping station will be required at Reading at the abstraction point. New WTW will be required at: • Kingsclere • Andover • Testwood A new PS will be required at [redacted] A new BPT will be required at [redacted]

Figure 2.1: Map of the T2ST options



2.3 Updates to the scheme since WRSE undertook their review

The WRSE review was undertaken in January 2021 and updated in March 2021, using data from the T2ST Options Appraisal (ref: Thames to Southern Transfer (T2ST) SRO, Option Appraisal, 3 November 2020, 5201578/9.1/DG/004).

As part of the additional work undertaken in order to produce the RAPID Gate 1 Report, it has been identified that the six options require additional components in order for them to transfer water. The components associated with each option are set out in Table 2.2.

Table 2.2: Additional areas of work since WRSE assessment

Option ref	Changes since WRSE assessment

1	• New start point and section of pipeline route at Culham
	• Possible alternative offtake to Upper Enham
	• Slight modification of the pipeline route to Andover WTW
	• Modification of offtake to Otterbourne North (not Otterbourne WTW)
	• Additional areas for works at:
	  ○ Culham WTW
	  [redacted]
	  ○ Upper Enham Reservoir
	  ○ Andover WTW
	  [redacted]
	  ○ Otterbourne North WTW

2	• New start point and section of pipeline route at Culham
	• Slight modification of the pipeline route to Kingsclere WTW
	• Slight modification of the pipeline route to Andover WTW
	• Modification of offtake to Otterbourne North (not Otterbourne WTW)
	• Additional areas for works at:
	  ○ Culham WTW
	  [redacted]
	  ○ Kingsclere WTW
	  ○ Andover WTW
	  [redacted]
	  ○ Otterbourne North WTW

3	• Modification of the pipeline route to Kingsclere WTW
	• Slight modification of the pipeline route to Northgate WSR
	• Modification of offtake to Otterbourne North (not Otterbourne WTW)
	• Additional areas for works at:
	  [redacted]
	  ○ Kingsclere WTW
	  ○ Andover WTW
	  [redacted]
	  ○ Otterbourne North WTW

4	• Possible alternative offtake to Upper Enham
	• Modification of the pipeline route to Kingsclere WTW
	• Slight modification of the pipeline route to Northgate WSR
	• Modification of offtake to Otterbourne North (not Otterbourne WTW)
	• Additional areas for works at:
	  [redacted]
	  ○ Kingsclere WTW
	  ○ Andover WTW
	  [redacted]
	  ○ Otterbourne North WTW

5	• New start point and section of pipeline route at Culham • Slight modification of the pipeline route to Kingsclere WTW • Slight modification of the pipeline route to Andover WTW

Option ref	Changes since WRSE assessment

	• Slight modification of the pipeline route to Testwood
	• Additional areas for works at:
	  ○ Culham WTW
	  [redacted]
	  ○ Andover WTW
	  [redacted]
	  ○ Testwood

6	• Modification of the pipeline route to Kingsclere WTW
	• Slight modification of the pipeline route to Northgate WSR
	• Additional areas for works at:
	  [redacted]
	  ○ Kingsclere WTW
	  ○ Andover WTW
	  [redacted]
	  ○ Testwood

3 Regulatory Assessment Reports

3.1 Habitats Regulations Assessment

The findings of the HRA Stage 2/ Appropriate Assessment (AA) are presented in Annex B.2. The HRA reports the results of the HRA undertaken at plan level for the six T2ST options and assesses the potential impacts of the options on UK's habitats sites.

The HRA report presents the outputs of the Screening exercise undertaken by WRSE and presents the results of the AA undertaken as part of the T2ST SRO.

The WRSE screening was undertaken in January 2021 and updated in March 2021, using data from the T2ST Options Appraisal (ref: T2ST SRO, Option Appraisal, 3 November 2020, 5201578/9.1/DG/004), and following the methodology in the WRSE Regional Plan Environmental Assessment Methodology Guidance, July 2020. The screening identified a number of potential 'likely significant effects', and a number of 'uncertain effects' for each of the options.

Following the AA, all six options were identified as having 'no likely significant effects' (alone), after mitigation is implemented.

This result depends on the implementation of the proposed mitigation measures including:

- Directional drilling: The current design of all options includes a pipeline route that will cross watercourses that are either designated as a habitats site (River Lambourn Special Area of Conservation (SAC) in Options 1, 2, 3 and 4) or that feed into a habitats sites (River Test, Options 5 and 6). The identified result of 'no likely significant effects' depends on the use of directional drilling in all options, in order to avoid effects on watercourses;
- Review and alteration of the pipeline route: The pipeline route currently proposed for Options 5 and 6 crosses two designated sites (the Solent and Southampton Water Ramsar and Special Protection Area (SPA) sites). It is recommended that the route layout should be revisited to avoid intersecting the designated sites, thus avoiding effects on the habitats sites and features for which they are designated. The identified result of 'no likely significant effects' on these sites depends on the proposed route alteration;
- Standard best practice pollution control measures;
- Standard best practice biosecurity measures;
- Disturbance mitigation measures: including light, noise and visual mitigation measures; and
- A Construction Environmental Management Plan (CEMP) must be in place that will include the proposed mitigation measures in this AA as well as any other specific measures identified following an HRA undertaken at project level.

The AA does not include an in-combination assessment with other plans or projects and therefore must be regarded as provisional. The reason for this, is the lack of knowledge at this stage, of other schemes that might result in in-combination effects with T2ST options. This AA will be updated at Gate 2 stage to include potential in-combination effects with other schemes. Following this a further in-combination AA will be conducted to review external projects and plans.

Aside from the in-combination assessment, following this AA, and provided that all mitigation measures are taken forward and no changes are made to this option, no further assessment is required.

3.2 Water Framework Directive Assessment

The findings of the WFD Assessment for the options for the T2ST pipeline route options are presented in Annex B.3.

The Level 1 WFD assessment completed by WRSE in January 2021 and updated in March 2021, using data from the T2ST Options Appraisal (ref: T2ST SRO, Option Appraisal, 3 November 2020, 5201578/9.1/DG/004), and following the methodology in the WRSE Regional Plan Environmental Assessment Methodology Guidance, July 2020. The Level 1 WFD assessment indicated that all options had one waterbody which required further assessment; Thames (Evenlode to Thame) – Option 1, 2 and 5; and Thames (Wallingford to Caversham) – Option 3, 4 and 6.

Level 2 WFD assessments were completed for these two waterbodies. The findings indicate that there are potentially precautionary WFD compliance risks associated with the operation of the new abstractions for all options. The potential hydrological effects could conflict with achieving WFD status objectives. This is particularly the case for Options 3, 4 and 6 where hydrology/river flow is an existing limiting factor, recorded in WFD baseline data as a 'reason for not achieving good'. The potential biological effects, particularly on fish, would require further assessment.

For all options it has been assumed that another SRO would be used in combination with this option to support the water to the River Thames. This will help to reduce the impact on hydrological regime and therefore on the biological elements.

Further WFD assessment would be required for all options that progress to Gate 2 and beyond, to improve the certainty of the levels of WFD risk outlined in the Gate 1 WFD Level 2 assessments.

3.3 Strategic Environmental Assessment

The findings of an options level SEA applied to the options for the T2ST pipeline route options are presented in Annex B.4.

WRSE undertook an SEA in January 2021, and updated in March 2021, using data from the T2ST Options Appraisal (ref: T2ST SRO, Option Appraisal, 3 November 2020, 5201578/9.1/DG/004), and following the methodology in the WRSE Regional Plan Environmental Assessment Methodology Guidance, July 2020.

The SEA objectives assessed were:

- Biodiversity, flora and fauna
  - Protect and enhance biodiversity, priority species, vulnerable habitats and habitat connectivity (no loss and improve connectivity where possible)
- Soil
  - Protect and enhance the functionality, quantity and quality of soils
- Water
  - Increase resilience and reduce flood risk
  - Protect and enhance the quality of the water environment and water resources
  - Deliver reliable and resilient water supplies
- Air
  - Reduce and minimise air emissions
- Climatic Factors
  - Reduce embodied and operational carbon emissions

  - Reduce vulnerability to climate change risks and hazards
- Landscape
  - Conserve, protect and enhance landscape, townscape and seascape character and visual amenity
- Historic Environment
  - Conserve, protect and enhance the historic environment, including archaeology
- Population and Human Health
  - Maintain and enhance the health and wellbeing of the local community, including economic and social wellbeing
  - Maintain and enhance tourism and recreation
- Material Assets
  - Minimise resource use and waste production
  - Avoid negative effects on built assets and infrastructure

Based on the WRSE SEA outputs for residual effects (post mitigation), the six pipeline options are predicted to result in similar positive, neutral or negative effects across all the SEA objectives in construction and operation, with the following exceptions:

- Biodiversity: All options intersect designated sites (Sites of Special Scientific Interest (SSSI) and SAC). The residual effects on designated sites during construction are likely to be greater for Options 1,2,5 and 6 (moderate negative) than for Options 3 and 4 (minor negative) as these options intersect a greater number of designated sites.
- Population and Human Health: All options have some intersection with community facilities at some point on the route. The residual effects on community facilities during construction are likely to be greater for Options 3, 4 and 6 (moderate negative) than for Options 1, 2 and 5 (minor negative) as these options intersect a greater number of community facilities.

Additional assessment, considering local level data, habitat improvement data and land requirement for additional scheme components, has been undertaken in-line with the methodology in the All Companies Working Group (ACWG) water resources management plan (WRMP) environmental assessment guidance and applicability with SROs, October 2020. The additional assessment:

- Local level data findings show that each of the options intersect or lie within 200m of a number of local wildlife sites and conservation areas. However mitigation can be put in place in order to reduce the potential effects on these areas.
- The habitat improvement data findings show that Options 5 and 6 require land that is located to the south of the Manor House Farm habitat creation area, a scheme which is creating approx. 69ha of grazing marsh.
- All options intersect SSSI and SAC river restoration areas, and construction may cause disturbance effects to these river restoration areas.
- The scheme component data shows that all additional components would result in some additional effects on some of the SEA objectives. The Otterbourne, Reading and Testwood sites show the most additional effects, with effects likely for five SEA topics. The Otterbourne site is required for Options 1, 2, 3 and 4. The Reading site is required for Options 3, 4 and 6, and the Testwood site is required for Options 5 and 6.

As such, it is likely that of the six options, Options 1 and 2 will result in the least negative effects.

This SEA does not include an in-combination assessment with other SROs, water company capital investments or third party development plans or projects. The SEA will be reviewed at Gate 2 stage to include potential in-combination effects.

4 Invasive Non-Native Species Risk Assessment

4.1 Introduction

4.1.1 Background

The transfer of raw water from one location to another may increase the risk of spreading invasive non-native species (INNS). The introduction of INNS to a waterbody can have a significant detrimental effect on ecosystem structure and function, as well as jeopardising compliance with environmental legislation. For example, INNS pose a threat to achieving WFD objectives. Over 70% of WFD waterbodies are at risk of deterioration due to INNS pressures by 2027.[2] Additionally, the presence of INNS in water company assets may compromise the supply of drinking water and the safe return of treated waste water to the environment. It is therefore essential that water companies understand the key pathways of INNS spread between their assets and the wider environment in order to implement appropriate mitigation measures.

4.1.2 Key Legislation

The translocation of INNS is subject to regulation under the following national legislation:

- Under the Wildlife and Countryside Act 1981 (as amended), it may be an offence to release or allow to escape into the wild any animal which ‘is of a kind which is not ordinarily resident in and is not a regular visitor to Great Britain in a wild state’; or is included in Part I of Schedule 9.
- Under the Wildlife and Countryside Act 1981 (as amended), it may be an offence to plant or otherwise cause ‘to grow in the wild any plant which is included in Part II of Schedule 9’.
- The Invasive Non-native Species (Amendment etc.) (EU Exit) Regulations 2019 ensures the continued operability of EU legislation which provides for a set of measures to combat the spread of INNS on the list of EU concern, through prevention, early detection and eradication, and management.
- Under the Invasive Alien Species (Enforcement & Permitting) Order 2019, it may be an offence to release, cause to escape, plant, or grow species of animal or plant ‘not ordinarily resident in’ and ‘not a regular visitor to Great Britain in a wild state’, or otherwise listed in Schedule 2.
- Waterbodies initially classified as ‘High Status’ (representing near-natural conditions) under the Water Environment (Water Framework Directive) (England and Wales) Directive 2017, will be reclassified to the lesser ‘Good Status’ if populations of High Impact INNS are introduced. High Impact INNS are identified on the current aquatic alien species list produced by the Water Framework Directive UK Technical Advisory Group (WFD UKTAG).

4.1.3 Assessment Objectives

The overall aim of this assessment was to undertake a high-level screening and initial assessment of INNS risk for the T2ST raw water transfer options being considered. The overall aim was underpinned by the following objectives:

1. To review potential T2ST options against relevant Environment Agency (EA) guidance.

[2] Hiley and Renals (2017). Price Review 2019 (PR19) Driver Guidance. Driver Name: Invasive Non-Native Species (INNS).

2. To determine whether potential T2ST options are located within areas of high risk of INNS invasion.
3. To identify INNS within an appropriate study area to understand current INNS distribution.
4. To undertake a high-level screening of potential T2ST options against key legislation.
5. To use an INNS risk assessment tool to assess risk for potential T2ST options based on the conceptual design information currently available.

4.2 Methodology

4.2.1 Study Area

The study area was defined as watercourses within the WFD Management Catchment in which the proposed source waterbodies are located, as shown on Figure 4.1 and detailed in Table 4.1.

The source waterbody for Options 1, 2 and 5 is [redacted] to be supplied by raw water from the River Thames. Therefore, the WFD Management Catchment selected as the study area for those options corresponds to the proposed abstraction intake location on the River Thames.

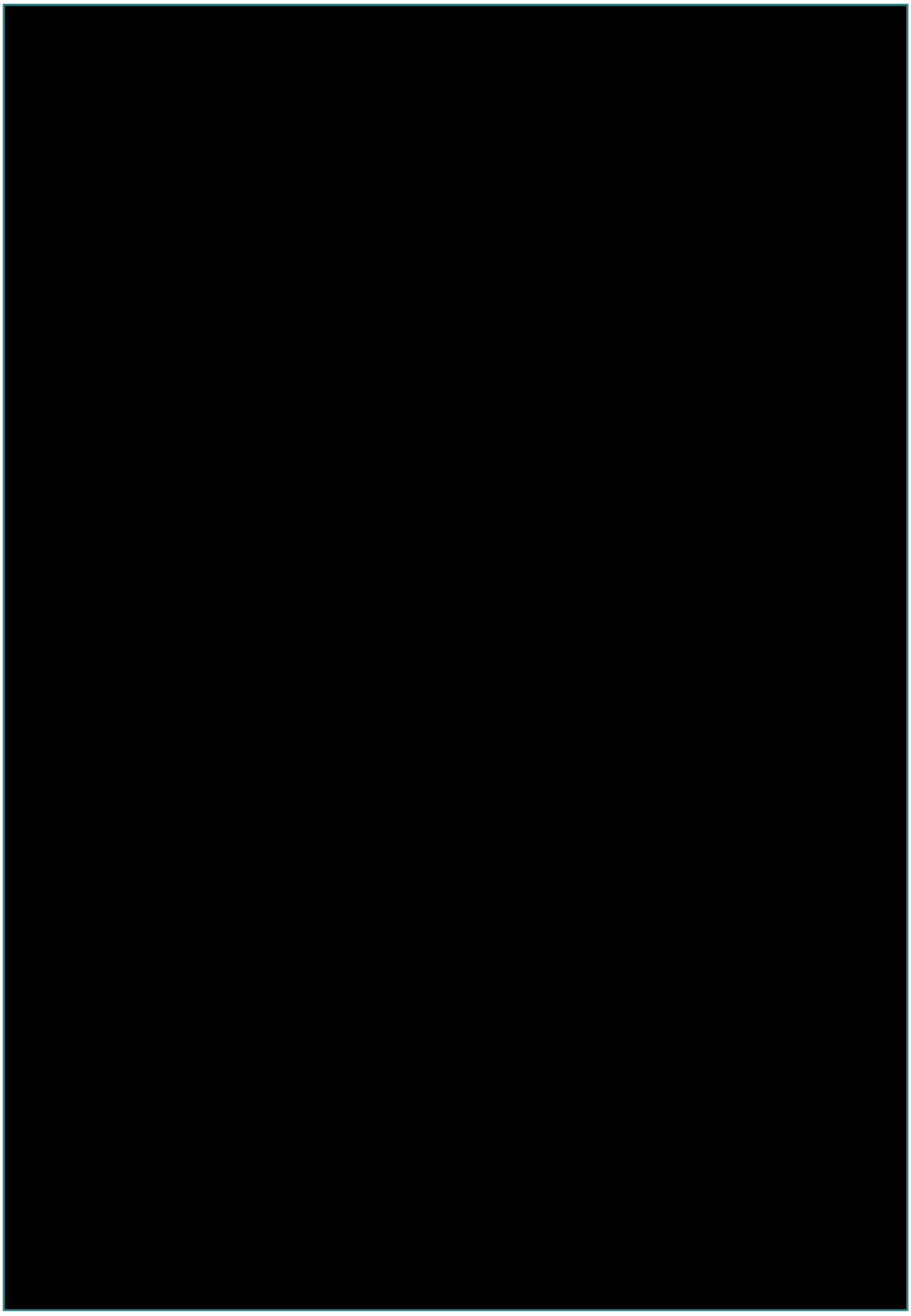
Options 1 to 4 will transfer water to Otterbourne North WTW.

Options 5 and 6 may transfer raw water to Testwood Lakes rather than directly to a WTW. Both scenarios have been considered in this assessment.

Table 4.1: Study area details

Option	Source waterbody	WFD Management Catchment
1	[redacted] Culham, Abingdon ([redacted] supplied by transfer from the River Thames)	Gloucestershire and the Vale
2	[redacted] Culham, Abingdon ([redacted] supplied by transfer from the River Thames)	Gloucestershire and the Vale
3	River Thames at [redacted] Reading	Thames and Chilterns South
4	River Thames at [redacted] Reading	Thames and Chilterns South
5	[redacted] Culham, Abingdon ([redacted] supplied by transfer from the River Thames)	Gloucestershire and the Vale
6	River Thames at [redacted] Reading	Thames and Chilterns South

Figure 4.1: WFD Management Catchment of the Source waterbodies



4.2.2 High-Level Screening Against Environment Agency Guidance

The Environment Agency position statement *Managing the Risk of Spread of Invasive Non-Native Species Through Raw Water Transfers* outlines the organisation's position on how it will manage INNS risks associated with raw water transfers.[3] The key points of relevance to this report are as follows:

- The focus of the Environment Agency's approach is on the pathways that the transfers create, not on current INNS distribution.
- New schemes that create a hydrological connection between isolated catchments must have mitigation measures in place to ensure INNS cannot be spread by the new transfer.
- Where water transfer into another watercourse remains the preferred solution, mitigation will need to be fail safe, resilient, and completely effective for all life stages and forms (e.g. plant propagules, animals, microscopic organisms and larval stages).
- Where catchments are already connected, a risk assessment will be required, which the Environment Agency will use to decide whether subsequent mitigation is required, to ensure the risk of INNS transfer is not significantly increased.

All T2ST options were therefore screened to determine if proposed raw water transfer will create a link between isolated catchments, as mapped in the Environment Agency document *Invasive Non-Native Species Isolated Catchment Mapping*.[4]

4.2.3 High-Level Screening Against INNS Invasion Heatmaps

To determine whether potential source, transfer or receptor sites are located within areas that are at high risk of future INNS invasion, these locations were cross-referenced with the following two INNS heatmaps:

- *Mapping Ponto Caspian Invaders in Great Britain*;[5] and,
- Heatmap of marine non-native species introduction presented in *Introduction of Marine Non-Indigenous Species into Great Britain and Ireland: Hotspots of Introduction and the Merit of Risk Based Monitoring*.[6]

Mapping Ponto Caspian Invaders in Great Britain (Gallardo and Aldridge, 2012) used species distribution models based on climatic factors, water chemistry and altitude to map the probability of presence of 16 Ponto Caspian species based on the match between the environmental conditions in Great Britain and those of the European range of the species. For the purpose of this risk assessment, the predicted number of species present was taken as a proxy for future invasion risk, and translated to low/medium/high Freshwater Invasion Risk categories as shown in Table 4.2. For each T2ST raw water transfer option, a single Freshwater Invasion Risk category was assigned, based upon the risk category of the source and transfer locations. Where these sites encompassed multiple categories, the highest was assigned.

[3] Environment Agency (2017). *Managing the Risk of Spread of Invasive Non-Native Species Through Raw Water Transfers*. Position 1321_16.

[4] Environment Agency (2018). *Invasive Non-Native Species Isolated Catchment Mapping.* v3.

[5] Gallardo and Aldridge (2012). *Mapping Ponto Caspian Invaders in Great Britain*.

[6] Cefas (2014). *Introduction of Marine Non-Indigenous Species into Great Britain and Ireland: Hotspots of Introduction and the Merit of Risk Based Monitoring*.

Table 4.2 Freshwater Invasion Risk categories

Predicted number of species	Freshwater Invasion Risk
0-1	Low
2-3	
4-5	Medium
6-7	
8-9	
10-11	High
12-13	
14-15	

The **heatmap of marine non-native species introduction** presented in *Introduction of Marine Non-Indigenous Species into Great Britain and Ireland: Hotspots of Introduction and the Merit of Risk Based Monitoring* (Cefas, 2014) was created by identifying key introduction pathways (e.g. commercial shipping, recreational boating, aquaculture stock imports, natural dispersal by ocean current, likelihood of offshore structure facilitating introduction), and determining the intensity of these pathways within 50 x 50km coastal grids. The resulting marine pathway intensity categories were translated to low/medium/high Marine Invasion Risk categories as shown in Table 4.3. Each T2ST raw water transfer option was assigned a Marine Invasion Risk category based upon the invasion risk of the source estuary. Where an estuary encompassed multiple risk categories, the highest was assigned.

Table 4.3 Marine Invasion Risk categories

Marine pathway intensity	Marine Invasion Risk
>0 – 1.99	Low
2 – 9.99	
10 – 24.99	Medium
25 – 49.99	
50 – 74.99	High
75 – 100	

4.2.4 INNS Records

Open source macroinvertebrate, macrophyte, and fish data for the period 1965 to 2020 were obtained for the study area (see Section 4.2.1) from the EA Ecology and Fish Data Explorer app[7]. Non-native species are flagged within these datasets, enabling these records to be filtered for non-native species. The resulting non-native species records were then cross-referenced against Schedule 9 of the Wildlife and Countryside Act, the WFD UK Technical Advisory Group INNS guidance[8], and the EU List of Invasive Alien Species of Union concern.[9]

4.2.5 High-Level Screening Against INNS Legislation

Field and desk study INNS data were screened against key legislation to provide an indicative risk of contravention. For the purpose of this assessment, it was assumed that a risk of an offence is caused where a transfer option would risk the movement of a species either specifically named, or implied by description in the legislation, to another waterbody. However, this is precautionary, and it should not be interpreted that an offence would definitely occur.

[7] Available at https://environment.data.gov.uk/ecology-fish/

[8] UK Technical Advisory Group on the Water Framework Directive (WFD-UKTAG) (2015). *Revised classification of aquatic alien species according to their level of impact*. Public working draft.

[9] Available at List of Invasive Alien Species of Union concern - Environment - European Commission (europa.eu) (Accessed 19/02/2021)

Furthermore, it does not take account the impact of potential mitigation measures on either the transfer or reservoir.

The high/medium/low risk categories relating to the WFD are based solely on the reclassification of High Status waterbodies in the presence of High Impact INNS, and not on the risk of deterioration which may result from ecological interactions such as predation and competition.

Risk categories were assigned as shown in Table 4.4.

Table 4.4 Assignment of legislative risk categories

Legislation	Risk Category	Justification
Wildlife and Countryside Act (as amended) 1981 Schedule 9	Low	• As a result of the transfer option, no identified risk of spread to a new waterbody of either a Schedule 9 species, or any species 'of a kind which is not ordinarily resident in' and 'not a regular visitor to Great Britain in a wild state.'
	Medium	• As a result of the transfer option, unclear* risk of any species listed in Schedule 9 being spread to a new waterbody; or, • As a result of the transfer option, unclear* risk any species 'of a kind which is not ordinarily resident in' and 'not a regular visitor to Great Britain in a wild state' being spread to a new waterbody. * May be 'unclear' if such species are present in source waterbody, but pathway risk is uncertain; or if there is doubt concerning the definition of species as described.
	High	• As a result of the transfer option, clear risk of spread of any species listed in Schedule 9 being spread to new a waterbody; or, • As a result of the transfer option, clear risk of spread of any species 'of a kind which is not ordinarily resident in' and 'not a regular visitor to Great Britain in a wild state' being spread to a new waterbody.'
Invasive Non-native Species (Amendment etc.) (EU Exit) Regulations 2019	Low	• As a result of the transfer option, no identified risk of spread of INNS of EU concern to a new waterbody.
	Medium	• As a result of the transfer option, unclear whether a pathway will be created which would allow the spread of INNS of EU concern to a new waterbody.
	High	• As a result of the transfer option, clear risk of INNS of EU concern being spread to a new waterbody.
Invasive Alien Species (Enforcement & Permitting) Order 2019	Low	• As a result of the transfer option, no identified risk of either a Schedule 2 species, or any species 'of a kind which is not ordinarily resident in' and 'not a regular visitor to Great Britain in a wild state' being released into, caused to escape into, or to grow in the wild.
	Medium	• As a result of the transfer option, unclear* risk of a species listed in Schedule 2 being released into, caused to escape into, or to grow in the wild; or, • As a result of the transfer option, unclear* risk any species 'of a kind which is not ordinarily resident in' and 'not a regular visitor to Great Britain in a wild state' being released into, caused to escape into, or to grow in the wild. * May be 'unclear' if such species are present in source waterbody, but pathway risk is uncertain; or if there is doubt concerning the definition of species as described.
	High	• As a result of the transfer option, clear risk of a species listed in Schedule 2 being released into, caused to escape into, or to grow in the wild; or, • As a result of the transfer option, a clear risk of any species 'of a kind which is not ordinarily resident in' and 'not a regular visitor to Great Britain in a wild state' being released into, caused to escape into, or to grow in the wild.
Water Environment (Water Framework Directive) (England and Wales) Directive 2017	Low	• As a result of the transfer option, no identified risk of High Impact INNS being introduced to a High Status WFD waterbody.
	Medium	• As a result of the transfer option, it is unclear whether a pathway will be created which would allow the transfer of High Impact INNS in the study area to a High Status WFD waterbody.

Legislation	Risk Category	Justification
(only refers to re-classification of High Status waterbodies in the presence of High Impact INNS)	High	• As a result of the transfer option, clear risk of High Impact INNS being introduced to a High Status WFD waterbody.
Overall	**Low**	• All legislative risks categorised as Low.
	Medium	• One or two legislative risks categorised as Medium, and no legislative risks classed as High.
	High	• Three or more legislative risks classed as Medium; or any legislative risks categorised as High.

4.2.6 Risk Assessment

4.2.6.1 Tool Overview

The risk assessment tool used here was developed by Northumbrian Water Group to meet the requirements of the Environment Agency's Price Review 2019 (PR19) guidance on the assessment of raw water transfers. There have been many revisions of this tool as it has been continually developed, and for this assessment Version 8a was used. It takes a pathway-based approach and is centred around a comprehensive list of functional groups of INNS. The use of functional groups accounts for all potential INNS at risk of spread, rather than just focusing on the species that are currently present within the source waterbody. The functional groups are shown in Table 4.5.

Table 4.5: INNS functional groups

Functional group	Description
1	Aquatic plant spread by fragments
2	Riparian plant spread by seed or fragment
3	Attached invertebrate/fish egg
4	Free swimming fish
5	Freely mobile invertebrates
6	Pathogen

The risk assessment matrix takes the form of a Microsoft Excel spreadsheet, into which data and information about the different T2ST raw water transfer options were entered and used to generate a risk score for each. In common with many health and safety risk assessments, INNS risk scores are a product of probability scores (herein referred to as 'pathway occurrence scores') and severity scores.

Pathway occurrence scores reflect the probability of INNS transfer by a particular transfer pathway, taking into account:

- Pathway volume score - based on the volume of water transferred, in Megalitres/day (Ml/d)
- Pathway frequency score - based on the frequency with which water is transferred, from infrequent to continuous
- Pathway distance score - based on whether water is to be transferred within the same WFD waterbody, or between different WFD waterbodies, WFD Operational Catchments or WFD Management Catchments.

Severity scores reflect the potential impact of INNS transfer by a particular transfer pathway. Therefore, different severity scores are assigned to every combination of transfer pathway and

INNS functional group. For example, if a freely mobile aquatic invertebrate were spread in silt to land, it would be unlikely to survive and impact the environment, and this combination would be assigned a low score. Conversely, if an aquatic plant propagule was transferred via a raw water connection, it would be free to invade the receptor waterbody, and this combination would be assigned a high severity score.

The tool calculates three type of INNS risk score:

- **Inherent Risk Score**, designed to reflect the inherent risk associated with a raw water transfer option, irrespective of exacerbating factors, mitigation options, or the presence of INNS, protected species or protected habitats.
- **Adjusted Risk Score**, whereby the **Inherent Risk Score** is adjusted according to factors that may reduce or increase the impact of INNS functional groups being transferred by a given transfer pathway. It is calculated by applying multiplier scores according to the relevant exacerbating factors or mitigation options.
  - Exacerbating factors are those which may increase risk, for example, whether a pathway is open or closed, navigation within the pathway route, use of the pathway and/or receptor waterbody for recreational activities and nature of water storage at the receptor site.
  - Mitigation options may reduce risk, for example, physical screening at source, water transfer direct to a WTW, chemical treatment at source or within the pathway, and specific biosecurity measures.
- **Weighted Risk Score,** whereby **Adjusted Risk Scores** are weighted to account for known INNS in source waters. A multiplier score is allocated to each INNS functional group based on their WFD UKTAG impact category (UKTAG, 2015). Protected sites and species of conservation importance near the receptor site are also accounted for at this stage.

4.2.6.2 Test Scenarios

The requirement to conduct an INNS risk assessment relates only to raw water transfers. Of the six options detailed in Section 1, two options (Options 1 and 4) involve the treatment of water at source and subsequent transfer of potable water to Southern Water's Hampshire area. As such, the risk assessment was only applied to Options 2, 3, 5 and 6, all of which involve the transfer of untreated raw water from Thames Water to Southern Water supply areas.

Test scenarios were developed for each of the four raw water transfer options based on the current conceptual design (see Section 1). Details of the test scenarios are shown in Table 4.6.

As the conceptual design is still in development, some of the information required to run the INNS risk assessment tool is not yet available. In particular, the incorporation of measures to mitigate INNS risk has not yet been considered, for example the screening and/or chlorination of raw water at source and/or prior to discharge at the receptor waterbody. While it is likely that mitigation measures will be included in the transfer design, for the purposes of this risk assessment it has been assumed that no mitigation measures will be applied, thereby presenting a 'worst-case' scenario.

Table 4.6: INNS risk assessment test scenarios for T2ST raw water transfer options

Risk type	Input variable	Option 2	Option 3	Option 5	Option 6
Inherent	Transfer pathway	New raw water transfer	New raw water transfer	New raw water transfer	New raw water transfer
	Transfer frequency	Year-round - continuous	Year-round - continuous	Year-round - continuous	Year-round - continuous
	Transfer volume	> 100 Ml/d	> 100 Ml/d	> 100 Ml/d	> 100 Ml/d

Risk type	Input variable	Option 2	Option 3	Option 5	Option 6
	Transfer distance	Between WFD Management Catchments and > 50 km	Between WFD Management Catchments and > 50 km	Between WFD Management Catchments and > 50 km	Between WFD Management Catchments and > 50 km
Adjusted	How raw water is conveyed	Whole length – underground pipeline	Whole length – underground pipeline	Whole length – underground pipeline	Whole length – underground pipeline
	Facilitation works	Lay new underground pipeline	Lay new underground pipeline	Lay new underground pipeline	Lay new underground pipeline
	Storage at transfer destination	Not applicable to pathway	Not applicable to pathway	Storage in a reservoir	Storage in a reservoir
	Navigation along transfer route	Not applicable to pathway	Not applicable to pathway	Not applicable to pathway	Not applicable to pathway
	Recreation at transfer destination	Not applicable to pathway	Not applicable to pathway	Boats / equipment being brought to and leaving site regularly	Boats / equipment being brought to and leaving site regularly
	Riparian/land-based recreational access at transfer	Not applicable to pathway	Not applicable to pathway	Equipment being brought to and leaving site regularly	Equipment being brought to and leaving site regularly
	Risk of arrival of new INNS at source	High for functional groups already at source Low for functional groups not currently at source	High for functional groups already at source Low for functional groups not currently at source	High for functional groups already at source Low for functional groups not currently at source	High for functional groups already at source Low for functional groups not currently at source
	Screening at source	No	No	No	No
	Chlorination at source or along route	No	No	No	No
	Transfer of water direct to WTW	Yes	Yes	No	No
	Screening before discharge to receptor waterbody	Not applicable to pathway	Not applicable to pathway	No	No
	Salt water barrier	No	No	No	No
	Specific operational protocol to mitigate risk	No	No	No	No
Weighted	Weighting of known INNS at raw water transfer source	Score assigned to reflect the species with the highest impact level in each of the functional groups present	Score assigned to reflect the species with the highest impact level in each of the functional groups present	Score assigned to reflect the species with the highest impact level in each of the functional groups present	Score assigned to reflect the species with the highest impact level in each of the functional groups present
	Protected species in or near receptor	No	No	No	No
	Protected sites in or near receptor	No	No	No	No

Risk type	Input variable	Option 2	Option 3	Option 5	Option 6
	Presence of existing connections between source and receptor	No	No	No	No

4.2.7 INNS Constraints and Limitations

The INNS risk assessment tool utilised in this study quantifies the risk associated with the operational phase of a raw water transfer, rather than the construction phase. For any one of the test scenarios, the construction phase would likely involve the laying of new underground pipework between the source waterbody and receptor, construction of new pumping stations and the extension of existing WTWs. This work poses the risk of INNS being spread through the movement of personnel, vehicles and equipment to and from construction sites, as well as the excavation and disposal of materials (e.g. sediments and vegetation). The INNS risk associated with the construction phase of this scheme should be considered separately.

The test scenarios outlined in Section 4.2.6.2 were based on the latest available conceptual design. As the conceptual design is still in development, these details may be subject to change. The INNS risk assessment should be revised at a later stage of the design process to capture the effect of changes on the INNS risk scores.

The Northumbrian Water Group INNS risk assessment tool used here is one of several such tools to have been developed in recent years. It is anticipated that the EA will request that a standardised approach is taken to INNS risk assessments across all 17 SROs being considered nationally. It is understood that development and utilisation of the standardised risk assessment approach is an aspiration for Gate 2 submission. Depending on the agreed approach, the T2ST INNS risk assessment may have to be revised at a later stage to account for any updates or changes to the tool that arise through consultation with the Environment Agency.

The potential legal risks of INNS transfer are poorly understood. It must be emphasised that risk categories assigned in this assessment are purely indicative, and should not be used to interpret the probability of an offence being committed.

4.3 Results and Discussion

4.3.1 High-Level Screening Against Environment Agency Guidance

The proposed abstraction intake from the River Thames [redacted] and the proposed abstraction intake from the River Thames at [redacted] Reading are both located within area 73 of the classification map in *Invasive Non-Native Species Isolated Catchment Mapping*. Area 73 is classified as 'Canal – CRT', meaning that hydrological connections to areas beyond the catchment already exist through intersection of the river network with Canal and Rivers Trust (CRT) navigable canals. Connecting watercourses listed include the Kennet and Avon Canal, Wiltshire and Berkshire Canal, Thames and Severn Canal, Oxford Canal and Grand Union Canal.

The receptor sites, Testwood and Otterbourne, are located within areas 42 and 44, respectively. Both areas are classified as 'Isolated', meaning that they do not have existing hydrological connections to any other catchments. Therefore, all T2ST raw water transfers would create a connection between a 'Canal-CRT' catchment and a previously 'Isolated' catchment.

The EA guidance for raw water transfers states: 'new schemes that create a hydrological connection between isolated catchments must have mitigation measures in place to ensure INNS cannot be spread by the new transfer' (EA, 2017). Transfer of raw water to a WTW provides effective and total removal of INNS, therefore Options 2 and 3 meet EA criteria.

However, a risk of INNS spread exists in the transfer of raw water to a lake, as in Options 5 and 6. Mitigation measures would have to be developed to eliminate the INNS risk should either of these options proceed.

4.3.2 High-Level Screening Against INNS Invasion Heatmaps

4.3.2.1 Freshwater Invasion Risk

Both the proposed intake from the Thames near Abingdon [redacted] and the proposed [redacted] Reading intake fall within a 'medium' Freshwater Invasion Risk area, in which between 6 and 9 of the 16 modelled Ponto-Caspian INNS are predicted, according to the predictive distribution heatmaps produced by Gallardo and Aldridge (2012). That this analysis should not differentiate between T2ST options is unsurprising given that the proposed abstraction intakes are all located on the same river, and therefore have a similar climate, altitude, and water chemistry.

As Options 2 and 3 terminate at a WTW, the risk of future freshwater INNS invasion at receptor sites is 'low'. Testwood Lakes, the proposed receptor site for Options 5 and 6, is located within a 'medium' risk area. However, the lakes are freshwater and not in hydrological connectivity with the River Test, therefore the risk of future invasion by marine INNS is 'low'.

In accordance with the methodology (see Section 4.2.3), if source and receptor sites are assigned different risk categories, the overall risk for the option is determined by the higher of the two. Therefore, all T2ST raw water transfer options were categorised as being at 'medium' risk of freshwater INNS invasion.

4.3.2.2 Marine Invasion Risk

The Thames Estuary falls within a grid square of the marine non-native species introduction heatmap (Cefas, 2014) that has an overall pathway activity intensity falling within the 75 to 100 band, which equates to a 'high' risk of future invasion. However, the tidal limit of the Thames is downstream of both the proposed [redacted] intake near Abingdon and the proposed intake at [redacted] Reading. Consequently, the actual risk of marine INNS spreading upstream to T2ST source waters was determined to be 'low'.

As Options 2 and 3 will terminate at a WTW, the risk of future marine INNS invasion at the proposed receptor site was deemed to be 'low'. Testwood Lakes, the proposed receptor site for Options 5 and 6, falls into an area categorised as being at 'high' risk of future marine INNS invasion. However, the lakes are freshwater and not hydrologically connected to the River Test estuary, so the actual risk of marine INNS invasion was considered 'low'.

In accordance with the methodology (see Section 4.2.3), if source and receptor sites are assigned different risk categories, the overall risk for the option is determined by the higher of the two. Therefore, the risk of future marine INNS invasion was found to be 'low' for all T2ST options.

4.3.3 INNS Records

Twenty-seven INNS were identified in the EA records for Gloucestershire and the Vale Management Catchment, including four aquatic plants, three riparian plants, four fish and 16 macroinvertebrates. At least one species within each of the INNS functional groups is classified as High Impact according to WFD UKTAG.

Twenty-five INNS were identified in the EA records for Thames and Chilterns South Management Catchment, including four aquatic plants, four riparian plants, five fish and 13 macroinvertebrates. At least one species within each of the INNS functional groups is classified as High Impact according to WFD UKTAG.

Environment Agency INNS records for the study area are summarised in Table 4.7 (fish), Table 4.8 (macrophytes) and Table 4.9 (macroinvertebrates).

Table 4.7: Invasive non-native species of fish identified in EA records

Common name	Scientific name	Functional group	Non-native status	Gloucester-shire and the Vale	Thames and Chilterns South
Common carp	*Cyprinus carpio*	4	UKTAG – high[10]	✓	✓
Goldfish	*Carassius auratus*	4	UKTAG – high	✓	
Golden orfe	*Leuciscus idus*	4	UKTAG – low		✓
Grass carp	*Ctenopharyngodon idella*	4	UKTAG – low		✓
Rainbow trout	*Oncorhynchus mykiss*	4	UKTAG – low	✓	✓
Zander	*Sander lucioperca*	4	UKTAG – moderate	✓	✓

Table 4.8: Invasive non-native species of macrophyte identified in EA records

Common name	Scientific name	Functional group	WFD UKTAG impact cat.	Gloucester-shire and the Vale	Thames and Chilterns South
Canadian pondweed	*Elodea canadensis*	1	UKTAG – high WACA 1981 Sch. 9[11]	✓	✓
Nuttall's pondweed	*Elodea nuttallii*	1	UKTAG – high EU species of special concern[12] WACA 1981 Sch. 9 IAS Order 2019 Sch.2[13]	✓	✓
Water fern	*Azolla filiculoides*	1	UKTAG – high WACA 1981 Sch. 9	✓	✓
Least duckweed	*Lemna minuta*	1	UKTAG – unknown	✓	✓
Indian balsam	*Impatiens glandulifera*	2	UKTAG – high EU species of special concern WACA 1981 Sch. 9	✓	✓
Orange balsam	*Impatiens capensis*	2	UKTAG – low	✓	✓
Sweet flag	*Acorus calamus*	2	UKTAG – low	✓	✓

[10] WFD UKTAG listed INNS, categorised as high / medium / low / unknown impact

[11] Invasive Non-native Species (Amendment etc.) (EU Exit) Regulations 2019 – listed as an 'invasive alien species of union concern'

[12] Listed on Schedule 9 Part 2 of the Wildlife & Countryside Act 1981

[13] Listed on Schedule 2 of the Invasive Alien Species (Enforcement and Permitting) Order 2019

Table 4.9: Invasive non-native species of macroinvertebrate identified in EA records

Common name	Scientific name	Functional group	INNS Status	Gloucester-shire and the Vale	Thames and Chilterns South
Asiatic clam	*Corbicula fluminea*	5	UKTAG – high	✓	✓
Bloody red mysid	*Hemimysis anomala*	5	UKTAG – high	✓	✓
Caspian mud shrimp	*Chelicorophium curvispinum*	5	UKTAG – unknown	✓	✓
Demon shrimp	*Dikerogammarus haemobaphes*	5	UKTAG – high	✓	✓
Freshwater amphipod	*Chelicorophium chelicorne*	5	Non-native	✓	
Bladder snail	*Physa acuta*	5	UKTAG – unknown	✓	✓
Oblong orb mussel	*Musculium transversum*	5	UKTAG – unknown	✓	
Jenkins' spire snail	*Potamopyrgus antipodarum*	5	UKTAG – moderate	✓	✓
Northern river / Florida crangonyctid	*Crangonyx pseudogracilis / floridanus*	5	UKTAG – unknown	✓	✓
Northern river crangonyctid	*Crangonyx pseudogracilis*	5	UKTAG – low	✓	✓
Polychaete worm	*Hypania invalida*	5	Non-native	✓	✓
Quagga mussel	*Dreissena bugensis*	5	UKTAG – high	✓	
Sideswimmer	*Gammarus tigrinus*	5	UKTAG – unknown	✓	✓
Signal crayfish	*Pacifastacus leniusculus*	5	UKTAG – high EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch.2	✓	✓
Wautier's limpet	*Ferrissia wautieri*	5	UKTAG – unknown	✓	✓
Zebra mussel	*Dreissena polymorpha*	5	UKTAG – high	✓	✓

4.3.4 High-Level Screening Against INNS Legislation

None of the T2ST options transfer raw water to a High Status WFD waterbody. As such, no risk of re-classification of a High Status waterbody due to the presence of UKTAG High Impact INNS was identified.

As shown in Tables 4.7, 4.8 and 4.9, species listed under the Wildlife and Countryside Act (as amended) 1981 Schedule 9, Invasive Non-native Species (Amendment etc.) (EU Exit) Regulations 2019 and Invasive Alien Species (Enforcement & Permitting) Order 2019 were identified in both source catchments.

Despite INNS presence in the source waters, raw water transfers to a WTW eliminate the risk of INNS spread. Therefore, the risk of contravening INNS legislation was determined to be 'low' for Options 2 and 3.

There is a clear risk of INNS spread associated with Options 5 and 6 if they discharge to a lake and if the conceptual design is not developed to incorporate mitigation measures. As a result, the overall risk of contravening INNS legislation was determined to be 'high' for Options 5 and 6.

4.3.5 Risk Assessment

The input variables for the Inherent Risk Score calculation were the same for all four of the T2ST raw water transfer scenarios. All four proposed transfers operate at the same frequency (year-round – continuous) and volume (> 100 Ml/d) and involve the transfer of raw water between WFD Management Catchments. These pathway characteristics represent the highest scoring options for their respective input variable. Consequently, an Inherent Risk Score of 1,152 was calculated for all options, which is the highest possible score that can be generated by the tool for a new raw water transfer.

The Adjusted Risk Score is largely based on mitigating and exacerbating factors in transfer design and operation. The main distinguishing factor between the options was the nature of the receptor site. Two of the transfers, Options 5 and 6, discharge to a lake, which introduces an exacerbating multiplier score. Conversely, Options 2 and 3 terminate at a WTW where raw water will be treated prior to transfer into the potable water supply network. Of the mitigation options included in the tool, transfer to a WTW is the most effective and introduces a multiplier score of zero. The Adjusted Risk Score for Options 2 and 3 was therefore zero, compared to a score of 11,120 for Options 5 and 6. This score could be reduced through the inclusion of mitigation measures in the design and operation of the transfers. For example, screening of water at the abstraction intake point or prior to discharge, chlorination of raw water at source or along the route and/or restricted recreational use of Testwood Lakes.

The Adjusted Risk Score is carried forward as a multiplier in the calculation of the Weighted Risk Score, therefore Options 2 and 3 were found to have a Weighted Risk Score of zero. The calculation of Weighted Risk Score accounts for the WFD UKTAG impact level of species present in the source waters, as well as protected sites and/or species within the vicinity of the receptor site. Species from the same four functional groups were identified in the EA monitoring data for both WFD Management Catchments within the study area: (1) aquatic plant spread by fragments; (2) riparian plant spread by seed or fragments; (4) free swimming fish; and (5) freely mobile invertebrate.

UKTAG High Impact INNS were identified for each of the functional groups present in both catchments. In terms of High Impact fish species, common carp *Cyprinus carpio* was recorded in both catchments. Goldfish *Carassius auratus* was also recorded in Gloucestershire and the Vale Management Catchment. The highest impact macrophytes in both catchments were Canadian pondweed *Elodea canadensis*, Nuttall's pondweed *Elodea nuttallii* and water fern *Azolla filiculoides*. Five species of High Impact macroinvertebrates were identified in both catchments, including Asiatic clam *Corbicula fluminea*, bloody red mysid *Hemimysis anomala*, signal crayfish *Pacifastacus leniusculus* and demon shrimp *Dikerogammarus haemobaphes*. Quagga mussel *Dreissena bugensis* have also been recorded in Gloucestershire and the Vale Management Catchment.

Testwood Lakes are not a protected site and in the absence of any biological monitoring data, it was assumed that the lakes do not contain any species of conservation importance. As these input variables were the same for Options 5 and 6, the risk assessment tool generated a Weighted Risk Score of 11,120 for both.

The transfer of raw water to Testwood Lakes rather than directly to a WTW has not been confirmed. It may be that the transfer pathway for Options 5 and 6 will terminate at a WTW instead, in which case the Adjusted Risk Score, and consequently the Weighted Risk Score, will be zero.

All proposed transfer options include three offtakes for delivery of raw water to Kingsclere, Andover and Northgate WTWs. These offtakes were not accounted for in the risk assessment but as they terminate at WTWs, they will not present any additional INNS risk.

4.3.6 Results Summary

The results of all components of this assessment are summarised in Table 4.10.

Table 4.10: INNS assessment results summary

Assessment component	Option 2	Option 3	Option 5	Option 6
Transfer between isolated catchments	Yes	Yes	Yes	Yes
Freshwater INNS Invasion Risk	Medium	Medium	Medium	Medium
Marine INNS Invasion Risk	Low	Low	Low	Low
Risk of contravening INNS legislation	Low	Low	High	High
Inherent Risk Score	1,152	1,152	1,152	1,152
Adjusted Risk Score	0	0	11,120	11,120
Weight Risk Score	0	0	24,016	24,016

4.4 Conclusions and Recommendations

The requirement to conduct an INNS risk assessment relates only to raw water transfers. Of the six T2ST options, Options 1 and 4 involve the transfer of potable water. As such, these options have been omitted from the INNS risk assessment.

The results from both the high-level screening and risk assessment tool components of this study suggest that INNS risk associated with raw water transfer to a WTW is significantly lower than the risk associated with transfer to a lake receptor site.

Options 2 and 3 involve the transfer of raw water to a WTW which provides effective and total removal of INNS.

However, Options 5 and 6 may transfer raw water to a lake. A risk of INNS spread exists in these options. Mitigation measures would have to be developed to eliminate the INNS risk should either of these options proceed.

At the time this assessment was conducted, the conceptual design did not include any specific INNS mitigation measures. The INNS risk associated with Options 5 and 6 could be reduced considerably as the conceptual design is developed to include mitigation measures such as raw water screening and chlorination. It is recommended that the INNS risk assessment is repeated as the conceptual design develops.

5 Natural Capital and Biodiversity Net Gain

5.1 Introduction

This section presents the findings from the NC and BNG assessments undertaken by WRSE, following the latest guidance from the EA, Natural England and the ACWG.

Natural capital is defined by the UK Government's recent 25-Year Environment Plan as 'the elements of nature that either directly or indirectly provide value to people'. Natural capital assets are the stocks of renewable and non-renewable natural capital and the natural processes that underpin them, for example, soils, forests, farmland, rivers, minerals and oceans.

Defra have described Net Gain (biodiversity and environmental) as 'an approach to development that aims to leave the natural environment in a measurably better state than beforehand.' A BNG assessment focuses on quantifying impacts on specific types of environmental receptor (often biodiversity) to ensure enhancements are delivered and any negative impacts are compensated.

5.2 Methodology

The NC and BNG assessments were completed by WRSE: These were undertaken in January 2021, and updated in March 2021 using data from the T2ST Options Appraisal (ref: T2ST SRO, Option Appraisal, 3 November 2020, 5201578/9.1/DG/004).

The assessment of impacts on NC and BNG were completed by WRSE following the draft guidance from the Environment Agency: *Water resources planning guideline supplementary guidance – Environment and society in decision-making* (2020)[14]. This guidance has defined the minimum expectations for the assessment as part of the Gate 1 process. In addition methodologies and best practice have been taken from:

- Department for Environment, Food and Rural Affairs (DEFRA) (2020) *Enabling a Natural Capital Approach*;
- HM Treasury and government finance, (2018) *The Green Book: appraisal and evaluation in central government*;
- Natural England, (2019) *The Biodiversity Metric 2.0 auditing and accounting for biodiversity*; and
- Natural England, (2020), *Natural Capital Indicators: for defining and measuring change in NC*.

In addition, the assessment was undertaken following the following WRSE and ACWG guidance documents: All Companies Working Group WRMP environmental assessment guidance and applicability with SROs (Mott MacDonald, 2020)

- WRSE Natural Capital & Biodiversity Net Gain Method Statement (Mott MacDonald, 2020)
- WRSE Regional Plan Environmental Assessment Methodology Guidance (Mott MacDonald, 2020)

Following this guidance, WRSE assessed the NC stocks and BNG units within each option's direct footprint. The potential impact of each option on each of the five NC metrics as defined in the supplementary guidance (biodiversity and habitat, climate regulation, natural hazard

[14] The final guidance published on 24/03/2021 was not available at the time of submission of the draft. No notable changes were made to the guidance between the draft and final versions.

regulation, water purification, water regulation) was reported. In addition, in line with the WRSE regional assessment, three other NC metrics were considered, these were food production, air pollutant removal and recreation and amenity value.

The assessment considered the potential impact of construction and operation of each option. The NC metrics were then quantified as ecosystem services in order to provide monetised values for NC benefit or loss.

No additional assessment took place on the NC and BNG outputs provided by WRSE.

The output tables received from WRSE are contained in Appendix A.

5.3 NC and BNG Assumptions and limitations

The following assumptions and limitations are applicable to the WRSE results.

For NC:

- The cost of the options was not considered within the assessments as it is captured elsewhere within the multi criteria assessment;
- The provision of public water supply has been excluded from all assessments to avoid potential double accounting of benefits within the multi-criteria optimisation;
- Loss of habitat associated with above ground infrastructure was not considered at Gate 1 because the locations of these were not available. Therefore, the potential impacts on natural capital stocks and associated ecosystem services may be underestimated; and
- Natural capital stocks presumed temporarily lost are expected to be reinstated/compensated.

For BNG:

- No enhancement of biodiversity post construction was considered. BNG units were assigned to the pre-construction land use according to the habitats presented in the project boundary. The post construction land use, including agreed mitigation, was used to calculate the post construction biodiversity score;
- This assessment was carried out using only open source data. As such, a precautionary approach was applied, presuming that where not specifically known, habitats were assigned the maximum habitat score. This is recommended as a suitable methodology for Gate 1, and will be supplemented at later gates to increase the accuracy of calculations for each option.

Further information can be found in the methodologies referenced in Section 5.2.

5.4 WRSE Biodiversity Net Gain and Natural Capital Findings

5.4.1 Summary of the results of the Natural Capital Assessment

Table 5.1 presents a summary of the area of NC stocks that would likely be permanently lost as a result of construction of the options.

Only stocks which result in a change in area post construction are included in Table 5.1. Full details of stocks that show no overall change can be found in the WRSE output tables in Appendix A.

Traditional orchards are priority habitat and, if lost, cannot be easily or quickly re-created. Therefore, it is presumed that the options cause the permanent loss of natural capital stock.

Ancient woodland is a high value natural capital stock that will likely be permanently lost due to the options. It cannot be replaced or replicated once lost, therefore, future provision of stock presumed permanently lost.

In each case, the option will likely cause the temporary loss of stocks during construction. However, best practice mitigation (such as directional drilling) and reinstatement/compensation of habitat means that most Natural Capital stocks post construction will have no to little change. No loss of the floodplain is expected as a result of construction of any of the options due to standard mitigation.

Table 5.1: Output of the NC assessment: Change in area (ha) of the stock post construction*

Baseline NC Stock	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Orchards and top fruit	-0.06	-0.06	-0.22	-0.22	-0.06	-0.22
Ancient Woodland	-0.59	-0.59	-0.38	-0.38	-1.62	-1.41

*Note that only stocks which result in a change in area post construction are included in this table.

5.4.2 Summary of the results of the Biodiversity Net Gain metric

Table 5.2 presents the summary of the BNG metrics for the options. The habitat units in Table 5.2 consist of the natural capital stocks listed in Table 5.1.

Table 5.2: Summary of the outputs of the BNG metric calculations

Option	On-Site Baseline (Habitat units)	On-Site Post Intervention (Habitat units)	Total Net Unit Change (Habitat units)	Total Percentage Change (%)	Key habitat types contributing to score*
1	707.83	488.88	-218.96	-30.93	- Grassland - Woodland and forest
2	707.83	488.88	-218.96	-30.93	
3	642.33	425.26	-217.07	-33.79	
4	642.33	425.26	-217.07	-33.79	
5	875.36	552.19	-323.17	-36.92	
6	808.32	486.71	-321.61	-39.79	

* same for all options

Note that ancient woodland is excluded from BNG calculations as this is irreplaceable habitat and outside the BNG metric parameters.

5.4.3 Summary of the results of the ecosystem services screening

Table 5.3 presents the summary of the ecosystem services quantitative assessment which monetises the values for natural capital benefit or loss for all options. The guidance for the monetisation of stocks can be found in Section 4 of the WRSE Natural Capital & Biodiversity Net Gain Method Statement (Mott MacDonald, 2020).

Table 5.3: Outputs of the ecosystem services screening: Quantitative Assessment

Option	Ecosystem Service (change in value £/year)		Estimated total change in value (£ per year)
	Carbon Storage[1]	Natural Hazard Management[2]	
1	-£596.35	-£305.45	-£901.80
2	-£596.35	-£305.45	-£901.80
3	-£579.56	-£307.66	-£887.22

Option	Ecosystem Service (change in value £/year)		Estimated total change in value (£ per year)
	Carbon Storage[1]	Natural Hazard Management[2]	
4	-£579.56	-£307.66	-£887.22
5	-£834.06	-£441.01	-£1,275.06
6	-£903.28	-£443.44	-£1,346.72

Notes: 1. Baseline value provided by each stock calculated using the high short-term traded sector carbon value for policy appraisal for 2020, provided by the standard methods and the Department for Business, Energy and Industrial Strategy (BEIS) Interim Non-Traded Carbon Values which can be found in the WRSE Natural Capital & Biodiversity Net Gain Method Statement (Mott MacDonald, 2020). 2. Scoped out when the option does not cause the loss of associated stocks. 3. GDP discounting has not been applied as part of the monetisation of values.

Quantitative ecosystem services scoped in for the T2ST options are as shown in the columns in Table 5.1, namely:

- Carbon Storage – scoped in as the option causes the temporary loss of associated stock; and
- Natural Hazard Management – scoped in as the option causes the temporary loss of stocks within an active floodplain.

Quantitative ecosystem services that were scoped out for T2ST are as follows:

- Air pollutant removal – scoped out as none of the options are located within an AQMA or a built-up area;
- Recreation & amenity value – scoped out as none of the options permanently impact greenspace; and
- Food production – scoped out as none of the options cause permanent loss of associated stock.

A qualitative assessment for water purification was scoped in as all options cause the temporary loss of associated stock during construction. The stock is expected to be replaced/compensated through inset re-planting schemes. However, broadleaved/coniferous/ urban woodland have a significant maturity time with a delay of 30 years. As a result the potential provision of these stocks will be reduced. Ancient Woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock is presumed permanently lost.

5.5 Conclusions

5.5.1 Natural Capital

In all options the loss of NC will be during construction. Best practice mitigation (such as directional drilling) and reinstatement/compensation of habitat means that most Natural Capital stocks post construction will have no to little permanent long-term change.

The outputs of the methodology show that Options 3, 4 and 6 result in the greatest loss of orchards and top fruit, at a loss of 0.22ha. Options 1, 2 and 5 result in a smaller loss of 0.06ha.

Option 5 results in the greatest loss of ancient woodland at a loss of 1.62ha. Option 6 results in a slightly lower loss at 1.41ha. Options 1 and 2 result in a loss of 0.59ha and Options 3 and 4 result in the loss of 0.38ha.

5.5.2 Biodiversity Net Gain

Applying the methodology, all options are likely to result in a loss of BNG habitat units due to the removal of habitats during construction and the time taken for compensatory habitat to reach maturity.

Option 5 is likely to result in the greatest loss of Habitat Units (-323.17 units) which translates to a loss of 36.92% of the units present at baseline.

Option 6 is likely to result in the loss of slightly lower number of Habitat Units (-321.61 units), but this translates to a greater percentage loss of the units present at baseline (loss of 39.79%).

Options 1 and 2 are likely to result in a slightly higher loss of Habitat Units than Options 3 and 4 (-218.96 for Options 1 and 2, -217.07 for Options 3 and 4), but this translates to a greater percentage loss for Options 3 and 4 than Options 1 and 2 (loss of 33.79% for Options 3 and 4, loss of 30.93% for Options 1 and 2).

5.5.3 Ecosystem services

All of the options are likely to generate the permanent loss of natural capital stocks associated with the provision of several ecosystem services. Option 6 results in the highest loss in value of ecosystem services per year (at -£1,346.72). Options 3 and 4 result in the least loss in value of ecosystem services per year (at -£887.22).

Major construction impacts include the release of CO_2, loss of natural hazard management and water purification due to habitat clearance. The options are also likely to generate a loss of some natural capital stocks during construction, however, if the site is returned to pre construction condition following best practice techniques then there should be no permanent impact on ecosystem services provision.

The options present an opportunity to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats. The options also cross several Natural England Habitat Network Enhancement Zones[15] and are therefore suitable for the planting of new high value habitats.

5.6 Comparison

For NC, Options 3 and 4 result in the greatest loss of orchards and top fruit, but the smallest loss of ancient woodland. Option 6 results in the same greatest loss of orchards and top fruit but also results in a high loss of ancient woodland. Option 5 results in the highest loss of ancient woodland, but a low loss of orchards and top fruit. Options 1 and 2 result in a low loss of orchards and top fruit, and a moderate loss of ancient woodland. As such, Option 6 is likely to show the greatest overall loss of NC stocks, and Options 1 and 2 are likely to show in the least overall loss of NC stocks.

Options 1 and 2 result in the lowest percentage loss of BNG (30.93%). Option 6 results in the highest percentage loss of BNG (39.79%). Key habitat types contributing to this loss are grasslands and woodlands.

Option 6 results in the highest loss in value of ecosystem services per year (at -£1,346.72). Options 3 and 4 result in the least loss in value of ecosystem services per year (at -£887.22).

[15] This is a spatial dataset that describes the geographic extent and location of Habitat Networks for 18 priority habitats based primarily, but not exclusively, on the priority habitat inventory with additional data added in relation to habitat restoration-creation, restorable habitat, plus fragmentation action, and network enhancement and expansion zones. Source: Natural England (2020) https://naturalengland-defra.opendata.arcgis.com/datasets/habitat-networks-combined-habitats-england

While the NC and BNG assessments undertaken provide an indication of the impact of the options, it is important to note the following limitations:

- The calculations do not consider the implementation of mitigation measures; and
- The assessments exclude the updates to the scheme discussed in Section 2.3 (rationale as per Section 2.3).

As such, it is recommended that further investigation into the potential NC and BNG effects should be undertaken in Gate 2 in order to assess the latest pipeline routes and include the proposed sites for the new infrastructure such as WTW, PS and BPT. This will include identifying opportunities to deliver biodiversity net gain and decision-making informed by natural capital data and approaches.

6 Wider Benefits

6.1 Introduction

Thames Water and Southern Water place emphasis on the need to provide greater public value in their activities. This is in line with the wider water industry, where public commitment to contribute positively to society and the environment enables companies to increase customer trust and improve reputations for responsible and socially aware business. A trusted relationship between Thames Water and Southern Water and communities is required to take responsibility for the wider impact their business has on the environment, employees, and society as a whole, and consequently deliver public value.

The environmental assessment guidance available to support the RAPID Gate process for the development of SROs does not include guidance on wider benefits assessments to be undertaken at each Gate of the process. Therefore, the scope of the wider benefits work for Gate 1 was limited to preparing commentary aimed at differentiating between the options.

Increasingly, wider benefits of projects are being considered in terms of natural capital, drawing on methodologies such as the Department for Environment, Food and Rural Affairs (DEFRA) (2020) Enabling a Natural Capital Approach, and other publications cited in Section 5.2. The natural capital stocks provide ecosystem services and these services can provide different types of benefits. One of these benefits is welfare effects. Examples of welfare effects relevant to T2ST are:

- Provisioning services, for example, where water resources provide the welfare benefit of a public water supply;
- Cultural services, for example the benefits of enabling recreation, supporting physical and mental health, changes to local environmental amenity and opportunities for environmental volunteering.

These approaches can then use physical metrics to capture the change resulting from the intervention / project, which can then be assigned a value and can be helpful in investment decisions. However, projects also bring benefits that are not related to changes to the natural land and ecosystem. For example, the benefits of direct employment, promoting education and skills development and the benefits of deepening stakeholder relationships.

This section summarises the potential social benefits of the T2ST scheme and suggests potential mitigation and recommendations for Gate 2.

The section also sets out the approach of T2ST to environment net gain.

6.2 Social benefits

6.2.1 Regional benefits of water resource planning

Water resource planning is undertaken at a regional level in order to manage water resources over a long time period (e.g. toward 2100) and to coordinate approaches between water companies. Many of the considerations that inform this process relate to delivering social benefits, including:

- Growth: to serve a growing population, additional properties and to meet per capita consumption (PCC) rates;

- Demand management: to supplement the measures that customers are encouraged to adopt in order to reduce demand, such as reduction in PCC rates, and water efficiency savings, metering, as well as company actions such as leakage reduction;
- Supply: the supply of water can sometimes create pressure on groundwater sources and some water sources can affect local water supply or the local environment;
- Strategic options and regional need: linking together transfer and storage schemes in the region can help move water around (and between water companies) to make sure it is available to customers wherever they are;
- Environment: meeting the objectives of the national environmental improvement programme (WINEP), which will also deliver landscape, habitat and recreational benefits for people to enjoy; and
- Resilience: identifying drought scenarios and the required resilience to withstand future drought conditions, to enable provision of a secure water supply to people's homes.

A unit cost of water is often considered in the review of options for managing water resources. This includes the cost of investment infrastructure and the costs of alternative engineering solutions to deliver a secure water supply. Increasingly, environmental and social costs, such as cost of carbon and natural capital (which includes some social and amenity values) are integrated into decision-making.

A WRSE research project on 'Customer Preferences to Inform Long-term Water Resource Planning'[16] identifies customer preferences and priorities to support water resource and resilience planning. The research involved nearly 100 customers from different water company areas in the south east. Findings from this study include:

- Customers want companies to develop resilient plans for future water supplies and these should avoid damage to the environment and the need for severe water use restrictions.
- There is also a high level of support for a collaborative approach to long-term planning for water resources and resilience to drought and unexpected events. Customers have a good and increasing awareness of climate and population pressures and are reassured that companies are planning for future risks.
- Customers have little patience for companies competing with each other for water resources that are felt to belong to everyone. It is important to customers that their voices are heard on water resource and resilience issues that are fundamental to the long-term security of their water supplies.
- Customer also support the sharing of resources, but more detail needs to be provided on the strategic context (availability of water by location) as well as local level impacts to help customers decide whether specific strategic resource options are the right choice for them.
- Participants in the Southern Water group were pleased strategic resource options were being considered, but expressed that they were only comfortable with other regions transferring water into their area if the supply region wasn't also short of water.

6.2.2 Sub-regional benefits of additional water supply

Water transfer schemes, such as T2ST, are designed to balance the supply and demand of water over large distances. It should be noted that there is not currently a surplus of water within the Thames Water region, and therefore the T2ST scheme is reliant on a new source of water coming into the Thames Water area. The current assumption is that this would be provided from SESRO and/or STT. This cooperative working between Thames Water and Southern Water,

[16] eftec (2021) Customer Preferences to Inform Long-term Water Resource Planning. Part B Deliberative Research'. WRSE. [Only published in draft as at Feb 21 – reference to be updated when final version published]

which enables the sharing of water resources, contributes to the efficient use of water resources across these two supply areas.

Within Southern Water's areas of operation for water supply there are towns and cities which are projected to have population growth, particularly along the south coast in communities such as Southampton, Portsmouth and urban fringes in Hampshire. The provision of a secure water supply to this sub-region will assist in the delivery of other development required to realise these growth aspirations, such as the provision of affordable housing and other infrastructure requirements. The security of water supply is also likely to have a positive impact on local business water users; reducing the risk of decreased water availability to business growth and agriculture.

Avoiding placing additional pressure on local water sources will also benefit the sub-region. The area around urban south Hampshire relies on both groundwater sources and river sources. Increasing pressure on these sources can lead to environmental damage. As well as affecting natural ecosystems, this can also impact the livelihoods of those who depend on these natural resources being available and the recreation and amenity benefits by the local community.

6.2.3 Localised impacts of T2ST

The T2ST Strategic Environmental Assessment (SEA, Annex B4) includes consideration of social effects, principally through the following SEA objectives:

- Maintain and enhance the health and wellbeing of the local community, including economic and social wellbeing (Population and Human Health);
- Maintain and enhance tourism and recreation (Population and Human Health); and
- Avoid negative effects on built assets and infrastructure (Material Assets).

The SEA objectives are applied to the T2ST options. The impacts identified that affect people relate to:

- The route affecting community facilities (or recreation route) through the temporary or permanent requirement for land of the community facility or access to the community facility;
- Predicted impacts from construction activity, specifically noise and visual, affecting amenity of local residents or users of community facilities; and
- Disruption to journeys as a result of construction activity required for the options to cross transport infrastructure (motorways, A-roads, railway line) which may cause traffic congestion.

In addition to the social effects considered within the SEA, temporary job creation during the construction phase of T2ST is likely to generate direct and indirect social benefits.

6.2.4 Mitigation of T2ST social impacts

The design of the T2ST pipeline route options at Gate 1 has been developed with the aim of avoiding impacts on people. Considerations include:

- Avoiding pipelines through existing residential developments;
- Avoiding community facilities where possible; and
- Not prejudicing plans for future residential and commercial development.

To avoid or mitigate potential disruption and disturbance to communities during construction and operation of the T2ST scheme, it is envisaged that best practice mitigation will be implemented during construction, which usually includes:

- Setting out how engagement with local communities will be undertaken during construction;

- Implementation of specific measures in relation to air quality and noise to reduce impacts on neighbouring residents communities, particularly for sensitive community resources such as educational facilities, health facilities and care homes;
- Sensitive layout and siting of potential construction compounds that take into consideration the potential impacts from noise, traffic, air quality and visual effects on communities; and
- Maintenance or diversion of key routes used by the community such as footpaths and pedestrian and cycling routes.

The T2ST SEA in Annex B4 also identifies mitigation measures which can be applied as the T2ST options are refined. This is likely to include re-routing of pipelines to avoid sensitive community facilities, or avoid some of the parts of community facilities that are critical to their function. Temporary or permanent diversion of access routes will also enable recreational routes to continue to function or for people and staff to access specific facilities.

The T2ST SEA in Annex B4 also identified the potential for enhancements to all options during operation in relation to reinstating land to achieve potential positive effects. Examples of enhancements could include improving access to recreational and open space, upgrades to outdoor sports facilities and improving access to community resources, such as increasing parking/cycling parking provision.

Potential programmes and initiatives that could be implemented as part of the T2ST scheme to deliver public value include:

- Thames Water ‘Time to Give’ programme, which encourages employees to undertake volunteering in local communities, including activities such as river restoration and school engagement;
- Southern Water Target 100 programme, which is committing to help underrepresented groups and people from disadvantaged backgrounds to pursue careers in the water sector; and
- Providing educational programmes on water at local educational facilities, placing particular emphasis on the benefits of water transfers and the necessity to implement sustainable water infrastructure solutions.

More widely, socio-economic benefits of T2ST could accrue through:

- Job and training opportunities, particularly in the construction sector. This will occur primarily during the construction period through supply chain benefits generated by the T2ST scheme, together with the spend by construction workers and contractors in local communities; and
- Cascading benefits through procurement, by requiring companies in the supply chain to demonstrate how they will provide social value to local communities in executing construction works or operation and maintenance contracts.

6.2.5 Recommendations

At this stage, these benefits have not been explicitly included in the scheme, but the opportunity is identified for all options and will be investigated further during subsequent project stages. The wider benefits work to support Gate 2 will include:

- The design of the T2ST options should be refined at Gate 2 to further avoid impacting communities along the route.
- The mitigation measures and enhancement suggestions made in the SEA should be implemented to achieve positive effects.
- Programmes and initiatives to deliver public value should be implemented.
- Further detailed assessment on wider benefits to be included at Gate 2.

6.3 Environmental Net Gain

6.3.1 Approach

Environmental Net Gain can be defined as the wider environmental gains relevant to a local area, such as reduced flood risk, improvements to air or water quality, or increased access to natural greenspace.

Building on the UK Government's 25 Year Environment Plan, the Environment Bill (re-introduced to parliament in January 2021) establishes the concept of delivering net gain to the environment. In the first instance the bill will mandate net gain in biodiversity through the planning system, requiring a 10% increase in biodiversity after development, compared to the level of biodiversity prior to the development taking place, as measured by a metric set out by Defra. A wider concept of Environmental Net Gain, including but extending beyond biodiversity metrics to capture wider changes in natural capital and to ensure development results in a net improvement, has been recommended to the UK Government by the Natural Capital Committee.

In accordance with stated RAPID Gate 1 requirements and the expectations of the Environment Agency (itself a member of RAPID) and Natural England, opportunities to deliver Environmental Net Gain have been considered from the outset of T2ST. Given the requirements at Gate 1 to establish scheme feasibility and identify key risks, work to date has focused upon confirming the scope within which Environmental Net Gain could be delivered. This allows further work to be undertaken at Gates 2 and 3 to define specific proposals to deliver biodiversity and wider Environmental Net Gain, with this timing linked to the anticipated programme for undertaking baseline field surveys and confirming the T2ST Preferred Design.

6.3.2 Opportunities for Environmental Net Gain

Whilst achievement of committed sustainability reductions contributes to the needs case for T2ST, opportunities for Environmental Net Gain should now be focused within the scope of the project itself. At Gate 1, two clear opportunities have been identified:

1. Creation of habitat and/or species relocation schemes where required; and
2. Reinstating land to achieve potential positive community effects in regards to social recreation, for example by improving access to recreational and open space, upgrades to outdoor sports facilities and improving access to community resources.

These opportunities should be further explored at Gate 2 with a focus on identification of potential areas and proposals for environmental offsetting, identifying land availability and suitability to undergo environmental improvements.

7 Opportunities for Net Zero Carbon Contributions

7.1 Introduction

This section reviews and summarises net zero considerations for the T2ST options, covering whole life (capital and operational) carbon considerations.

7.1.1 Public Interest Commitments

English water companies have made several Public Interest Commitments[17] (PIC) to demonstrate the broad value they deliver to society. One of these PICs included a commitment to be a net zero operational carbon sector by 2030. In 2020 the sector, through Water UK, released its net zero routemap[18], which laid out a range of decarbonisation options and pathways the sector could look to adopt to move towards net zero emissions and meet the 2030 commitment.

Thames[19] and Southern Water[20] have both signed up to this commitment to achieve Net Zero carbon emissions from their operations by 2030. Thames Water have additionally made a commitment to go beyond net zero by 2040.

Individual companies are preparing their own net zero plans to be ready by July 2021[21]. The sector Net Zero commitment does not include capital carbon or user carbon emissions. Capital carbon will be addressed separately by the companies and Water UK. The scope boundary of the net zero sector level PIC, and that covered in the net zero routemap, is the same as the mandatory scope used in the UKWIR Carbon Accounting Workbook (CAW), which covers:

- Scope 1: Emissions from burning of fossil fuels, process and fugitive emissions (e.g. Nitrous oxide and methane from wastewater/sludge treatment and emissions from owned or leased vehicles);
- Scope 2: Purchased electricity;
- Some scope 3 emissions, e.g. business travel, outsourced activities and Transmission & Distribution losses; and
- Net emissions taking into account export of surplus renewable generation and purchase of Renewable Energy Guarantees of Origin (REGO) backed green tariff electricity.

The scope above covers the minimum scope of the PIC and individual companies have the discretion to broaden their boundary to include further scopes of emissions.

7.1.2 Net Zero ambition – what does it mean and how efficiently can it be achieved?

Net Zero reflects an operating environment where the water sector will have no overall impact on the atmosphere from its carbon emissions within the sector's Net Zero boundary by 2030. This means that any residual emissions are counterbalanced by an equivalent sequestration of carbon from the atmosphere.

[17] Link to Public Interest Commitment | Water UK
[18] Link to Water-UK-Net-Zero-2030-Routemap.pdf
[19] Link to Climate Change | Responsibility | About us | Thames Water
[20] Link to Carbon emissions (southernwater.co.uk)
[21] Link to Net Zero 2030 - Strategies for Success (britishwater.co.uk)

The water sector has not yet clearly defined how the sector's net zero ambition will apply equally at programme, project or company level. Whilst delivering a net zero sector is an important commitment made by the sector, there is also the ongoing duty to deliver this transition efficiently to maintain efficient and affordable services for customers.

Some companies may choose to set net zero targets across their company operations, investment plans and/or individual projects/schemes. The net zero target is currently at sector-level and once the water company net zero plans are finalised, the sector will have a better understanding on whether individual projects, programmes of work or entire company operations are best to have a net zero target. The main consideration for net zero is for the sector to take a view on what is the most cost-effective way to reach net zero – at company level, investment programme or project level. For example, it may not be most economical for an individual project to have a net zero target if there are other assets in a company's region that present greater opportunities to be net zero or carbon negative (e.g. a wastewater asset managing bioresources differently could contribute to a company's net zero target more efficiently instead of purchasing market offsets in a project where carbon reductions are more economical to reach, say 80% reduction). Cost effectiveness is an important consideration for a water company and the water sector to consider when developing their net zero plans.

It is important to note that capital carbon is not currently in the sector's net zero boundary and that individual companies may set a separate capital carbon reduction target or include it in their own net zero company boundary.

7.1.3 What is a net zero scheme?

If a net zero target is applied at project/scheme level, then a net zero scheme can be defined as a scheme where all Green House Gas (GHG) emissions emitted during its construction and operation are balanced by an equivalent level of emissions being offset or removed from the atmosphere.

Therefore, theoretically it is possible for schemes to claim to achieve net zero by purely focussing on offsetting the emissions arising from the construction and operation of an asset without actually taking steps to reduce emissions. These offsets can either be through sequestration activities within their own company boundary (referred to as insets in the Water UK routemap) or purchased offsets outside of company owned land through certified schemes. However, the water sector net zero target follows a decarbonisation hierarchy that is based on good international practice – emissions have to be reduced as much as possible first before any sequestration options are considered. The water sector routemap provides further details on the decarbonisation hierarchy (this is also presented in Figure 7.1).

All schemes will need to reduce their carbon emissions as much as possible to minimise the required level of offsets. The analysis in the Water UK routemap highlighted that whilst sequestration options can play a role in achieving net zero, the scale of the UK water sector emissions are substantially greater than the scale of emissions reductions that could be achieved through the ambitious tree planting and peatland/grassland restoration options assessed. Purchased offsets through the international market will also incur a cost and are subject to market forces linked to demand and available supply, therefore, reducing emissions in an efficient manner can also help reduce future offsetting costs for residual emissions.

7.1.4 Delivering net zero efficiently at scheme level

Companies will need to consider the overall impact of new strategic schemes, such as the T2ST transfer options, and incorporate this into the broader company plans to deliver net zero. This will help companies, and the sector, make the best strategic decisions in relation to infrastructure requirements and identify the most efficient way to deliver net zero as a company/sector.

Section 7.5 sets out considerations that the T2ST transfer options could take to decarbonise and drive towards net zero, but the project team will need to consider what an efficient level of decarbonisation is for the project as it progresses.

7.2 Methodology

7.2.1 Decarbonisation considerations

The decarbonisation considerations suggested take into consideration the minimum scope of the net zero PIC but also align to the carbon consideration requirements under EA Water Resource Planning guidelines. The latest consultation response[22] states that updated guidance will:

- Ask water companies to report their carbon in tonnes alongside the monetised cost (of carbon);
- Include additional guidance around carbon mitigation and the possibility of carbon offsetting; and
- Ensure that water companies meet government expectations for carbon (and accounting for greenhouse emissions) within their plans.

Section 7.5 includes broad considerations the T2ST options could take to mitigate:

- Capital carbon emissions; and
- Operational carbon emissions.

It also provides considerations of how residual emissions could be tackled to get to net zero carbon emissions.

User carbon emissions (i.e. the emissions associated with the heating of water in the home) are not considered.

7.2.2 Net zero considerations

The considerations made in Section 7.5 take on the principles of the emissions reduction hierarchy (Figure 7.1), whereby all efforts to reasonably reduce emissions are prioritised, followed by looking at opportunities for renewable generation and finally considering opportunities to offset residual emissions.

Considerations for reducing capital carbon in the T2ST options are included, however it will be down to the water company to decide whether capital emissions will be part of the company's or the scheme's net zero consideration.

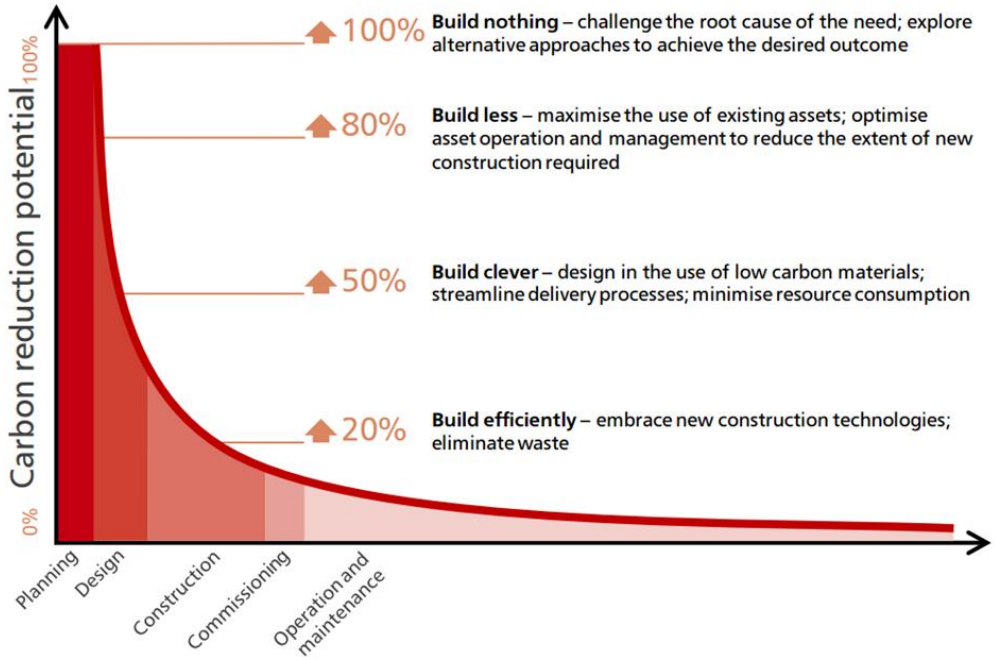
[22] Link toWater resource planning guideline: consultation response summary - GOV.UK (www.gov.uk)

Figure 7.1: Emissions reduction hierarchy

Source: Water UK Net zero 2030 routemap (Figure 4.1)

The carbon reduction hierarchy sets out emissions reduction's opportunities during a project lifecycle into four categories summarised in Figure 7.2.

Figure 7.2: Carbon reduction hierarchy



Source: Infrastructure Carbon Review, 2013

The first category (*build nothing*) is not considered as the options appraisal approach for the individual company WRMPs and the WRSE regional plan will determine the most balanced plan and which combination of supply and demand side schemes to implement. Therefore, the decarbonisation considerations reviewed in Section 7.5 focus on the *build clever* and *build efficiently* categories for the T2ST transfer options.

7.3 Baseline carbon estimates for the T2ST options

Table 7.1 summarises the estimated capital and operational carbon impacts of the T2ST transfer options.

Full details of the carbon values are reported in the RAPID Gate 1 Report for T2ST, Section 10, and in Annex A3: Cost and Carbon Report.

Whilst a detailed whole life carbon breakdown was not reviewed as part of this report, Table 7.1 does highlight that the majority of the embedded and operational carbon sits within the construction and pumping associated with the transfer pipelines.

Table 7.1: Summary of the estimated capital and operational carbon impacts of the T2ST transfer options

Option	Capacity (Ml/d)	Embedded Carbon (teCO2)	Operational Carbon (kgeCO2/Ml)*
1	50	[redacted]	[redacted]
	80	[redacted]	[redacted]
	120	[redacted]	[redacted]
2	50	[redacted]	[redacted]
	80	[redacted]	[redacted]
	120	[redacted]	[redacted]
3	50	[redacted]	[redacted]
	80	[redacted]	[redacted]
	120	[redacted]	[redacted]
4	50	[redacted]	[redacted]
	80	[redacted]	[redacted]
	120	[redacted]	[redacted]
5	50	[redacted]	[redacted]
	80	[redacted]	[redacted]
	120	[redacted]	[redacted]
6	50	[redacted]	[redacted]
	80	[redacted]	[redacted]
	120	[redacted]	[redacted]

*Note: Operational carbon values based on 2021 carbon factor for Commercial/public sector from Green Book Supplementary Guidance: Valuation of energy use and greenhouse gas emissions for appraisal.

The results show that the raw water options (Options 2, 3, 5 and 6) have a higher embedded carbon requirement than the potable options. This is likely due to the additional processing requirements for transferring raw water. Of the four raw water options, Option 5 has the highest embedded carbon requirement, and Option 3 has the lowest.

For the potable water options, the embedded carbon requirement is fairly similar, with Option 4 having a slightly higher requirement than Option 1.

The operational carbon requirement is similar for all options and reduces with the size of the transfer [redacted]. Options 1, 2 and 5 have the highest operational carbon requirement and Option 4 has the lowest.

7.4 Establishing Carbon Hotspots

A key part of delivering an efficient net zero strategy is to focus efforts where largest and most efficient reductions can be made. Therefore, this section looks to identify the major carbon contributors from a capital and operational perspective for the scheme to help focus efforts on areas with the greatest reduction potential.

At this stage only a very top down view of the capital carbon baseline footprint has been reviewed for each of the options based on what was provided in the Concept Design Reports and scheme summaries. It is recommended that as the design progresses a more granular baseline is analysed to provide a more detailed understanding of specific carbon emission sources for the scheme.

Capital Carbon Hotspots

Despite a lack of detailed breakdown of capital carbon emissions, some assumptions can be drawn from experience with similar large water supply schemes about major sources of emissions. A summary of likely hotspots areas is provided below:

- Pipelines (including materials and construction effort associated with excavation and reinstatement);
- Concrete;
- Reinforcement steel;
- Steel within process units;
- Plant fuel emissions associated with excavation and construction activities; and
- Transport of materials to site and disposal of construction waste.

Operational Carbon hotspots

Similarly, a detailed breakdown of operational carbon emissions has not been assessed as part of this report, however, some reasonable judgements can be made about major carbon hotspots areas. Operational hotspots are likely to include:

- Operational power consumption associated with pumping water and also at associated treatment works;
- Chemical consumption[23] at associated treatment works; and
- Maintenance emissions.

7.5 T2ST Decarbonisation considerations

The following sections set out some considerations that the T2ST transfer options could take to decarbonise and drive towards net zero.

7.5.1 Material specification and procurement

The carbon intensity of the materials and products involved in the delivery of the T2ST options will play an important role in the overall carbon footprint of the schemes. The current capital carbon estimates for the options are based on generic or industry standard carbon intensities of materials and products. To drive down emissions on specific schemes it is important to engage and challenge the supply chain to deliver products that meet performance specifications at the lowest carbon intensities possible.

[23] This refers to the embodied carbon associated with the production and transport of chemicals to site.

For example, for large pipeline projects the pipe materials, excavation, and reinstatement activities, along with concrete and steel in any treatment or pumping station assets are going to be key sources of emissions.

For pipes different materials have significantly different capital carbon intensities but also different characteristics that may affect whole life maintenance and operational carbon performance.

Additionally, even with similar materials the carbon intensity of these materials significantly varies dependant on how it has been manufactured, how and where it is transported from and what the carbon intensity of the power source used for manufacturing has been. For example, the recycled scrap content in steel manufacture can have a significant impact on the carbon intensity of steel products and engaging with suppliers to determine and influence the actual carbon intensity of their products is important.

Options to mitigate the carbon impact of key materials and products include:

Specify lower carbon materials and products

Understanding the carbon intensity of products/materials and incorporating the carbon intensity of these into decision making around specification of materials can contribute to driving down the carbon intensity of schemes. Key actions are:

- engaging with the supply chain to understand the carbon intensities of their products
- identifying whether lower carbon alternatives are available
- develop appropriate material carbon intensity specifications based on materials and products available in the market
- ensuring the procurement process for the scheme has steps in place to ensure that materials and products meet carbon intensity specification requirements

Engage with supply chain to develop options to decarbonise major materials and products

As we are at the start of the transition towards a net zero economy many sectors are still planning or starting to implement their decarbonisation strategies. As a major scheme the T2ST options can influence the supply chain to adopt and accelerate their decarbonisation initiatives. As these practices can take a while to adopt and influence the carbon intensity of what is being produced it is important to engage suppliers early. Key actions are:

- communicate carbon reduction ambitions of the scheme
- communicate and share procurement criteria related to carbon and supporting information required
- demonstrate commitment to collaborative working to incorporate low carbon innovations into the scheme

The same approach can be used for significant operational consumables, such as chemicals, which can be a significant part of operational and whole life carbon emissions for water treatment schemes.

7.5.2 Efficient construction approaches and construction waste minimisation

The generation and requirement to dispose of waste during construction can generate significant emissions on construction projects, and significant costs. Adopting efficient construction techniques, e.g. modular or off-site manufacture options, can help reduce the amount of waste associated with construction projects, whilst potentially reducing carbon emissions, improving health and safety and overall operational performance of assets.

Understanding the type, quantity and quality of waste likely to be produced can help identify opportunities to re-use construction waste either within the project site boundary or more locally rather than requiring it to be transported larger distances. Having a robust waste management plan and engaging other potential users of surplus excavations can help reduce emissions associated with construction waste disposal.

7.5.3 Low carbon construction plant

The T2ST scheme will require significant construction plant effort associated with excavation, reinstatement, and disposal of surplus material. These are typically diesel powered and therefore can generate significant carbon emissions. The scheme could consider alternative low or zero carbon construction plant relying on alternatives to diesel fuel, this could include plant powered by:

- Biomethane;
- Hydrogen; and
- Electric.

There is likely to be significant barriers to adopt these technologies immediately due to their relative low penetration into Heavy Goods Vehicle (HGV) fleets. However, as other sectors decarbonise to help support national decarbonisation activities more opportunities to adopt these lower carbon vehicles as part of projects will develop over time. The project team should look to identify what options there are for low carbon vehicles for spoil removal activities and engage appropriate suppliers who may be able to supply these services to better understand how feasible this would be.

7.5.4 Optimising energy efficiency and maintenance activities

The design teams as standard will look to optimise energy efficiency associated with the pumping and treatment of water. This will likely include optimising pump selection and engaging with the supply chain to identify the optimal product to provide the greatest balance between energy efficiency, performance and resilience. The use of Variable Speed Drives (VSDs) on the transfer pumps and pumping through the treatment works are now standard considerations to optimise performance of pumping assets and optimise energy consumption.

Additionally, there should be consideration of what monitoring options are available to incorporate into the design of the options both for the transfers and treatment components. Monitoring should focus on what data needs to be collected to provide insights into how efficiently the assets and the overall transfer option is operating, as well as providing suitable asset condition information to allow targeted proactive maintenance and prevent unnecessary carbon and cost intensive emergency/reactive repairs. Considerations should also be made about what addition external systems may affect the operation of the transfer scheme and affect their operational performance, e.g. rainfall, land-use in the catchment, industry changes that may affect raw water quality etc. This systems level data could potentially help draw understanding of negative and positive impacts of catchment changes on the carbon intensity of the scheme and allow more efficient operational philosophies to be implemented.

7.5.5 Low carbon power generation and decarbonised electricity procurement choices

The power intensity of the pumping requirements and the treatment processes is also a potentially significant source of carbon emissions. There are several factors to consider when considering the carbon impact of power and how to mitigate these emissions, these include:

- **Opportunities for renewable generation:** To mitigate the impact of the significant power consumption the scheme could look to generate all or a proportion of the power demand through renewables onsite. Alternatively, the scheme could look for commercial

arrangements to procure green power through a direct wire Power Purchase Agreement (PPA). This would reduce the carbon impact of the associated power consumption with the site from the grid average value to zero.

- **Procurement of green tariff electricity:** A more immediate decision could be made to procure all power associated with the site through REGO backed green energy tariffs. This would reduce the generation impact of grid power from the grid average to zero but would still incur the associated transmission and distribution losses associated with grid supply. There are currently plenty of green tariffs available on the market and the price premium for these is relatively small currently, however, this may change over time as the competition for REGO backed green electricity increases.

Additionally, consideration of grid carbon intensity at the point the scheme is due to come on-line should also be considered. The recent trend of UK grid carbon intensity shows significant reduction in the carbon intensity of power generation. The Department for Business, Energy & Industrial Strategy (BEIS) grid carbon intensity forecasts[24] show an expectation for the UK grid to continue to significantly decarbonise over the coming years (up to 70% by 2030). This will reduce the carbon impact of the power demand associated with the treatment plant and also potential carbon/cost benefit assessments associated with renewable generation schemes. However, self-generation schemes can support this national decarbonisation and also potentially boost the resilience of schemes too.

As self-generation or PPAs are unlikely to be able to provide all the power required by the transfer options and associated treatment works, a longer term consideration for these large transfer options could be to consider battery storage to help maximise use of any self-generated renewables. However, currently the size and costs of batteries required for the size of the T2ST options are prohibitively large, however, the technology is developing rapidly, and there may be further advancements by the time the scheme reaches construction/commissioning stages.

7.5.6 Residual emissions

The majority of infrastructure construction projects will not be able to reduce emissions to absolute zero through decarbonisation activities alone, particularly when considering capital carbon and other emissions which rely on other sectors to decarbonise. Therefore, it is likely that even after reducing emissions as much as possible within the scheme there will be residual emissions that could be offset. Possibilities to offset emissions could come from:

Natural sequestration improvements

The scheme could look to offset emissions as part of an individual scheme through investments in improving natural sequestration around the scheme. This could include tree planting or promoting alternative land use around the sites and pipeline routes. Consideration would need to be given to land availability around the treatment sites and the pipeline route, including potential requirements for providing ongoing access for maintenance. It is also important to consider the significant non-carbon associated benefits associated with nature-based options, such as biodiversity net gain and plan land-use around the scheme to maximise overall benefits rather than just focus on carbon benefits.

The greatest benefits from natural sequestration schemes are likely to come from large regional or national improvement schemes that have been planned and developed to maximise co-benefits and are at a sufficient scale to sequester significant emissions. Therefore, it is recommended if the scheme were considering natural sequestration improvements these are planned through a multi-stakeholder approach at a regional level.

[24] Table 1 (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/793632/data-tables-1-19.xlsx)

Export of renewable energy

The other opportunity to offset emissions from the scheme is to export excess renewable energy to other end-users. This requires surplus energy to be generated by the scheme and given the relatively high-power demand of the transfer options this is unlikely to be possible for the T2ST options.

7.6 Recommendations and next steps

This report has set out some considerations for how the T2ST options could drive towards net zero. These ideas need to be developed further and emissions sources interrogated in more detail to help provide further insights into the specific sources of emissions in the different options and who needs to be engaged with in order to start to decarbonise these.

An important part of turning some of these considerations into deliverable opportunities is to understand the scheme carbon emissions sources, challenge these through value engineering sessions and engage into the broader supply chain to identify and implement lower carbon opportunities/technologies.

The key recommendations therefore are:

- A clear carbon management process be embedded into the option development process to identify low carbon opportunities and track them through to implementation.
- A detailed capital and whole life carbon baseline should be interrogated for asset and material level hotspots for the scheme to inform focus areas for decarbonisation activities.
- A low carbon workshop be held to review the hotspots and prioritise the low carbon opportunities that need to be investigated further. This should include specific actions on who will be responsible for driving these emissions reductions activities and when they need to be undertaken in the design process.
- Design principles be developed incorporating some key activities and requirements to help decarbonise the scheme, this should include requirements to engage the broader supply chain and incorporate carbon into procurement and material specification criteria.
- A regional systems approach taken to understand how the T2ST transfer options fit within other regional activities and projects to help develop a more integrated plan for development of renewables or residual offsetting schemes.

8 Comparison, Conclusion and Recommendations

8.1 Comparison and conclusion

The assessments undertaken by WRSE and as part of this SRO indicate that some environmental and social impacts are likely to result from construction and operation of each of the options, but that mitigation can be applied to lessen and in some cases avoid these impacts.

The HRA concludes that the route for Options 5 and 6 should be altered to avoid intersecting the Solent and Southampton Water Ramsar and SPA sites, so as to avoid any likely significant effects on these sites. In addition, the HRA specified that directional drilling would be required for all options to cross the River Lambourn SAC, and for Options 5 and 6 to cross the River Test, so as to avoid likely significant effects on these sites.

The WFD indicates that there are potentially precautionary WFD compliance risks associated with the operation of the new abstractions for all options. The potential hydrological effects could conflict with achieving WFD status objectives. This is particularly the case for Options 3, 4 and 6 where hydrology/river flow is an existing limiting factor, recorded in WFD baseline data as a 'reason for not achieving good'. The potential biological effects, particularly on fish, would require further assessment.

The SEA concludes that, based on the WRSE SEA outputs, all of the options would have neutral or negative residual effects across the SEA objectives during construction. The effects are similar for all options with the exception of Biodiversity and Population and Human Health. Options 1, 2 and 5 intersect with a greater number of designated sites than Options 3 and 4 and therefore are predicted to result in greater residual effects on Biodiversity during construction. Options 3, 4 and 6 intersect with a greater number of community facilities than Options 1, 2 and 5 and therefore are predicted to result in greater residual effects on Population and Human Health during construction.

During operation, all of the options would have neutral or positive residual effects across the SEA objectives, with the exception of Climatic Factors. Positive residual effects could result from habitat enhancement and enhancing the local areas for the community. In addition, positive residual effects were likely to result due to the scheme improving water transfer across regions, thus improving water resource management and resilience of supply; and the scheme contributing to efficient use of water resources, providing protection against future drought scenarios (and potentially avoiding abstractions in more vulnerable areas). However, Climatic Factors retained a residual major negative effect for embodied and operational carbon emissions due to the likely energy use during operation (e.g. pumping stations).

The additional SEA assessment undertaken on components to the transfers that were not included in the WRSE assessment, shows that the additional components required to transfer the water would result in some additional negative effects across the SEA objectives. The Otterbourne, Reading and Testwood sites each resulted in additional effects for five SEA topics. The Otterbourne site is required for Options 1, 2, 3 and 4. The Reading site is required for Options 3, 4 and 6, and the Testwood site is required for Options 5 and 6.

As such, SEA concludes that it is likely that of the six options, Options 1 and 2 will result in the least negative effects.

The INNS risk assessment concludes that the risk of spreading INNS from one location to another was significantly lower for options which transferred raw water to a WTW, than options

that may transfer to a lake receptor site. As such, it was concluded that risk of INNS spread was highest for Options 5 and 6, but this risk could be reduced considerably as the conceptual design is developed to include mitigation measures such as raw water screening and chlorination.

The outputs of the BNG assessments concluded that Options 1 and 2 result in the lowest percentage loss of BNG Habitat Units. Option 6 results in the highest percentage loss of BNG Habitat Units. Key habitat types contributing to this loss are grasslands and woodlands.

The outputs of the NC assessment concluded that Options 1 and 2 are likely to result in the least overall loss of NC stocks and Option 6 is likely to show the greatest overall loss of NC stocks. The NC stocks included in the assessment were orchards and top fruit and ancient woodland.

The ecosystem services assessment estimated that all options would result in a loss in value per year. Option 6 results in the highest loss in value of ecosystem services per year (at -£1,346.72). Options 3 and 4 result in the least loss in value of ecosystem services per year (at -£887.22). The ecosystem services that contributed to this loss were Carbon Storage and Natural Hazard Management. The ecosystem services assessment did note that the options present an opportunity to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats. The options also present an opportunity to plant new high value habitats within the Natural England Habitat Network Enhancement Zones.

The opportunities identified in the BNG/NC assessment have the potential to contribute to Government ambitions for environment net gain. This could take the form of habitat creation and/or species relocation schemes. Any schemes would need to be taken forward based on a comprehensive understanding on the interaction between natural systems and social uses of land.

The wider benefits of T2ST have been reviewed, considering the context of the benefits provided to society of water resource planning, including the benefits to, and views of, customers. A number of best practice mitigation measures which could be implemented during construction to avoid or mitigate potential disruption and disturbance to communities are identified. For all options, there is the potential for enhancements to be applied during operation in relation to reinstating land to achieve potential positive effects. Examples of positive programmes and initiatives have been highlighted to deliver public value, such as the Thames Water ‘Time to Give’ programme; the Southern Water Target 100 programme; and providing educational programmes on water at local educational facilities. In addition, socio-economic benefits could accrue through job and training opportunities, particularly in the construction sector; and cascading benefits through procurement, by requiring companies in the supply chain to demonstrate how they will provide social value to local communities in executing construction works or operation and maintenance contracts.

Contributing to net zero carbon emission objectives is an important aspiration and opportunities covering whole life (capital and operational) carbon has been investigated. The carbon estimates for the options highlight that the majority of the embedded and operational carbon sits within the construction and pumping associated with the transfer pipelines. Some considerations have been identified that the T2ST transfer options could take to decarbonise and drive towards net zero. An important part of turning some of the considerations into deliverable opportunities is to have a robust carbon management process embedded into the scheme development.

The combination of these assessments and studies shows that while positive benefits will likely result from operation of the scheme through the scheme improving water transfer, water resource management and resilience of water supply; and the scheme providing protection

against future drought scenarios, construction of the scheme will likely result in some negative effects, even with mitigation applied.

Of the six options, it is likely that Options 1 and 2 will result in the fewest negative effects for HRA, SEA, INNS, NC and BNG, but Options 3 and 4 would result in the least loss in value of ecosystem services per year. Options 5 and 6 result in additional impacts on designated sites and therefore have the most negative effects.

A summary of conclusions of comparisons of the options for each of the environmental assessment types has been included in Table 8.1.

8.2 Recommendations

The assessments undertaken as part of this SRO have identified a number of recommendations that would be required to be put in place in Gate 2.

The pipeline routes should be refined and re-routed in order to avoid entering designated sites (such as the Solent and Southampton Water Ramsar and SPA) and to avoid sensitive community facilities.

Opportunities for directional drilling should be explored, in order to avoid or reduce likely effects on watercourses and designated sites (such as the River Lambourn SAC and the River Test SSSI). Further detailed assessments on the construction methods should be carried out to confirm these methods would reduce the impact to be acceptable.

Measures to reduce or eliminate risk of INNS spread should be investigated and incorporated into design.

Opportunities for compensatory habitat creation or habitat reinstatement should be explored, as well as opportunities to improve the existing habitats and provide offsetting planting of trees. Opportunities for reinstating land to achieve potential positive community effects should also be explored, for example by improving access to recreational and open space and improving access to community resources.

Opportunities to drive down carbon emissions during construction should be investigated, such as reducing the carbon impact of key materials and products, adopting efficient construction techniques, and considering alternative low or zero carbon construction plant. Options to optimise energy efficiency during operation should also be considered, such as those associated with the pumping and treatment of water.

The SEA and HRA should be reviewed at Gate 2 stage to include potential in-combination effects with other SROs, water company capital investments or third-party development plans or projects.

Further WFD assessment would be required for all options that progress to Gate 2 and beyond, to improve the certainty of the levels of WFD risk outlined in the Gate 1 WFD Level 2 assessments.

All assessments should be reviewed at Gate 2 stage to support optioneering refinements and the selection of a preferred design for T2ST.

Table 8.1: Comparison of the options against environmental assessments

Option	Habitats Regulations Assessment	Water Framework Directive	Strategic Environmental Assessment	Invasive Non-Native Species risk assessment	Biodiversity Net Gain and Natural Capital	Wider Benefits	High-level Carbon Assessment
1	Directional drilling required to cross River Lambourn SAC	Potential precautionary WFD compliance risks associated with the operation of the new abstractions	Greater residual effects on biodiversity during construction. Additional effects likely from inclusion of the Otterbourne North WTW.	N/A potable water transfer	Lowest total percentage loss of BNG habitat units. Likely to show in the least overall loss of NC stocks.	Same for all options	Potable water options have a lower embedded carbon requirement than the raw options. Higher operational carbon requirement
2	Directional drilling required to cross River Lambourn SAC	Potential precautionary WFD compliance risks associated with the operation of the new abstractions	Greater residual effects on biodiversity during construction Additional effects likely from inclusion of the Otterbourne North WTW.	Lower risk of INNS spread	Lowest total percentage loss of BNG habitat units. Likely to show in the least overall loss of NC stocks	Same for all options	Raw water options have a higher embedded carbon requirement than the potable options. Higher operational carbon requirement
3	Directional drilling required to cross River Lambourn SAC	Potential precautionary WFD compliance risks associated with the operation of the new abstractions - particularly for this option where hydrology/river flow is an existing limiting factor	Greater residual effects on population and health during construction Additional effects likely from inclusion of the Otterbourne North WTW. Additional effects likely from inclusion of [redacted].	Lower risk of INNS spread	Results in the least loss in value of ecosystem services per year.	Same for all options	Raw water options have a higher embedded carbon requirement than the potable options
4	Directional drilling required to cross River Lambourn SAC	Potential precautionary WFD compliance risks associated with the operation of the new abstractions - particularly for this option where hydrology/river flow is	Greater residual effects on population and health during construction Additional effects likely from inclusion of the Otterbourne North WTW.	N/A potable water transfer	Results in the least loss in value of ecosystem services per year.	Same for all options	Potable water options have a lower embedded carbon requirement than the raw options. Lowest operational carbon requirement.

Option	Habitats Regulations Assessment	Water Framework Directive	Strategic Environmental Assessment	Invasive Non-Native Species risk assessment	Biodiversity Net Gain and Natural Capital	Wider Benefits	High-level Carbon Assessment
		an existing limiting factor	Additional effects likely from inclusion of [redacted]				
5	Route to be altered to avoid intersecting the Solent and Southampton Water Ramsar and SPA sites. Directional drilling required to cross River Lambourn SAC and River Test.	Potential precautionary WFD compliance risks associated with the operation of the new abstractions	Greater residual effects on biodiversity during construction. Additional effects likely from inclusion of Testwood site	Higher risk of INNS spread	Shows average loss of NC and BNG stock	Same for all options	Raw water options have a higher embedded carbon requirement than the potable options. Higher operational carbon requirement.
6	Route to be altered to avoid intersecting the Solent and Southampton Water Ramsar and SPA sites Directional drilling required to cross River Lambourn SAC and River Test	Potential precautionary WFD compliance risks associated with the operation of the new abstractions - particularly for this option where hydrology/river flow is an existing limiting factor	Greater residual effects on population and health during construction Additional effects likely from inclusion of [redacted]. Additional effects likely from inclusion of Testwood site.	Higher risk of INNS spread	Highest percentage loss of BNG habitat units. Likely to show the greatest overall loss of NC stocks. Results in the highest loss in value of ecosystem services per year.	Same for all options	Raw water options have a higher embedded carbon requirement than the potable options

8.3 Ongoing monitoring plan

Monitoring at the T2ST intake and discharge point has been undertaken during Gate 1 and will continue through Gate 2 and beyond. Table 8.2 details the monitoring that is being undertaken for T2ST.

Table 8.2: T2ST Ongoing Monitoring Plan

Monitoring type	Undertaken by	Location	Monitoring method
Algal monitoring (Chlorophyll and nutrient analysis)	CEH	River Thames [redacted]	Weekly samples from March to October 2021
Algal monitoring (Chlorophyll and nutrient analysis)	CEH	Testwood Lakes	Weekly samples from March to October 2021
Algal monitoring (quantification and characterisation by flow cytometry)	CEH	River Thames ([redacted])	The weekly samples from the 2 sites will be analysed by flow cytometry analysis to provide cell counts per ml for diatoms, green algae and cyanobacteria
Algal monitoring (quantification and characterisation by flow cytometry)	CEH	Testwood Lakes	The weekly samples from the 2 sites will be analysed by flow cytometry analysis to provide cell counts per ml for diatoms, green algae and cyanobacteria
Algal monitoring (within-river microcosm experiments)	Atkins & CEH	Testwood Lakes	Water samples (and their associated algal and bacterial communities) are taken from the donor waterbody and be transplanted into the recipient waterbody at the planned release point. The microcosms are later removed and the cells counted using flow cytometry, to determine growth rates and community change
Algal monitoring (lab-based microcosm experiments)	Atkins & CEH	Testwood Lakes	Water samples (with associated algae) are taken from downstream of the proposed water transfer locations. In the lab some microcosms would be in placed in a mixture of recipient waterbody and transferred water, to recreate the water quality and temperatures that will be produced below the transfer point. After a few days, each microcosm would be sampled and analysed for chlorophyll concentration and flow cytometry, to determine algal growth rates and changes in community composition
Ecological monitoring (fish*, macrophytes)	Atkins (As part of SESRO SRO)	Culham (same location used for SESRO monitoring)	Monitoring will only occur for points where no surveys are currently carried out (routinely) by the Environment Agency or Thames Water. Macrophyte sampling is recommended between 1 June and 30 September
Ecological monitoring (fish*, macrophytes)	Atkins	River Thames ([redacted])	Monitoring will only occur for points where no surveys are currently carried out (routinely) by the Environment Agency or Thames Water. Macrophyte sampling is recommended between 1 June and 30 September
Ecological monitoring (Invasive Non-Native Species (INNS))	Ricardo Energy & Environment	River Thames ([redacted])	Two INNS surveys will be required in spring (April) and summer (June) 2021
Ecological monitoring (Macroinvertebrates)	Ricardo Energy & Environment	River Thames ([redacted])	Two macroinvertebrate surveys will be required in spring (April) and autumn (October) 2021

Monitoring type	Undertaken by	Location	Monitoring method
Ecological monitoring	Southern Water (as part of ongoing monitoring)	Testwood Lakes	Ongoing ecology sampling programme
Water quality	Atkins (As part of SESRO SRO)	Culham (same location used for SESRO monitoring)	Continuous monitoring (for dissolved oxygen, conductivity, pH and temperature), water quality spot sampling, WFD, Environmental Quality Standards Directive and Drinking Water
Water quality	Atkins	River Thames ([redacted])	Continuous monitoring (for dissolved oxygen, conductivity, pH and temperature), water quality spot sampling, WFD, Environmental Quality Standards Directive and Drinking Water
Water quality	Southern Water (as part of ongoing monitoring)	River Thames ([redacted])	ongoing water quality sampling programme for monthly samples at the agreed locations. Weekly samples from March to October 2021
Water quality	Southern Water (as part of ongoing monitoring)	Testwood Lakes	ongoing water quality sampling programme for monthly samples at the agreed locations. Weekly samples from March to October 2021

*Note that eDNA 'invertebrate' surveys are proposed which will pick up all vertebrate fish species (including eel and lamprey).

8.4 Proposed environmental and social Gate 2 activities

Monitoring for water quality and ecology is expected to continue through Gate 2.

Other activities that are expected to be undertaken in Gate 2 include:

- Route selection assessments to support optioneering;
- Terrestrial ecology surveys (Phase 1 Habitat Survey);
- Further WFD assessment;
- Further HRA and AA assessment;
- Drinking Water update, reflecting new survey data;
- Further NC and BNG assessment;
- SEA update; and
- Other baseline studies such as; biodiversity; soil quality; water resources; air quality; noise and vibration; climate and carbon resilience; landscape and visual; historic environment; population and health; and material assets.

A. NC & BNG WRSE output tables March 2021

A.1 BNG metric output tables

This data has been redacted

A.2 NC, BNG and Ecosystem services output tables

This data has been redacted

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