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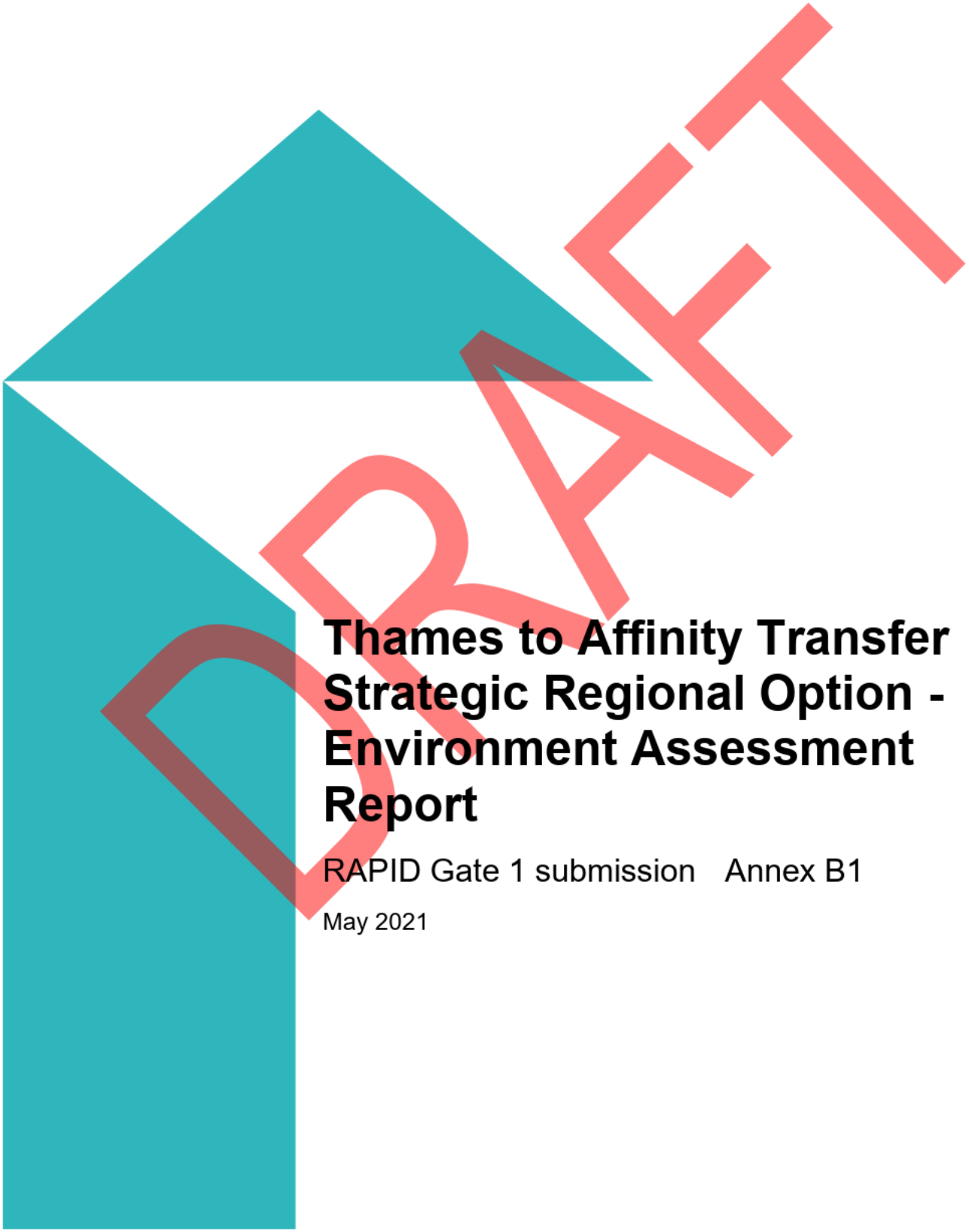

Thames to Affinity Transfer Strategic Regional Option - Environment Assessment Report

RAPID Gate 1 submission Annex B1

May 2021

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Glossary

Acronym	Definition
AA	Appropriate Assessment
ACWG	All Companies Working Group
AFW	Affinity Water
AQMA	Air Quality Management Area
BEIS	Business, Energy, and Industrial Strategy
BNG	Biodiversity Net Gain
CAW	Carbon Accounting Workbook
CRT	Canal and Rivers Trust
DEFRA	Department for Environment, Food and Rural Affairs
DRA	Direct River Abstraction
EA	Environment Agency
EAR	Environment Assessment Report
GEP	Good Ecological Potential
GHG	Green House Gas
HMWB	Heavily Modified Waterbody
HGV	Heavy Goods Vehicle
HRA	Habitats Regulations Assessment
INNS	Invasive Non-Native Species
LWS	Local Wildlife Site
NC	Natural Capital
PCC	Per Capita Consumption
PIC	Public Interest Commitments
PPA	Power Purchase Agreement
PR19	Price Review 2019
RAPID	Regulators' Alliance for Progressing Infrastructure Development
REGO	Renewable Energy Guarantees of Origin
SEA	Strategic Environmental Assessment
SESRO	South East Strategic Reservoir Option
SR	Service Reservoir
SRO	Strategic Regional Option
STT	Severn Thames Transfer
TPO	Tree Preservation Order
T2AT	Thames Water to Affinity Water Transfer
T2ST	Thames Water to Southern Water Transfer
TW	Thames Water

Acronym	Definition
VSD	Variable Speed Drive
WINEP	Water Industry National Environment Programme
WTW	Water Treatment Works
WFD	Water Framework Directive
WFD UKTAG	WFD UK Technical Advisory Group
WRMP	Water Resources Management Plan
WRSE	Water Resources South East
ZOI	Zone of Influence

Executive summary

The Environment Assessment Report (EAR) is an annex prepared to support the Gate 1 submission report to the Regulators' Alliance for Progressing Infrastructure Development (RAPID) for the Thames to Affinity Transfer (T2AT) Strategic Regional Option (SRO).

Seven distinct options have been assessed for the Gate 1 submission. The options are Sunnymeads 1, Maidenhead, Teddington Direct River Abstraction (DRA), Sunnymeads 2a, Walton 2b, Lower Thames Reservoir Transfer 2a and Beckton Reuse Indirect. An eighth option, Mogden Reuse Indirect 3, is identical to Walton 2b in terms of footprint, although the raw water source is different, and so has not been assessed separately These options would enable the transfer water from the Thames Region to either [redacted] (Beckton Reuse Indirect option) or [redacted] (all other options), in the Affinity Region. While the Water Resources South East (WRSE) assessments were undertaken on a previous iteration of the options to the ones that are being submitted for Gate 1, the refinements made to the options since these were assessed by WRSE are not significant.

Three regulatory assessments have been completed for the T2AT options: a Habitats Regulations Assessment (HRA); a Water Framework Directive (WFD) Assessment; and a Strategic Environmental Assessment (SEA) level option The regulatory assessments are summarised in this report and the full assessments are presented as separate annexes (Annex B2, B3 and B4 respectively).

The HRA Stage 1 Screening Assessment undertaken for Maidenhead, Teddington DRA and Lower Thames Reservoir Transfer 2a options identified Uncertain Effects on some Habitats Sites but the Stage 2 Appropriate Assessment did not identify any transmission pathways by which a Likely Significant Effect could reasonably occur Therefore no adverse effects on the integrity of the Habitats Sites are considered likely

The HRA AA undertaken for Sunnymeads 1, Sunnymeads 2a, Walton 2b and Beckton Reuse Indirect options identified transmission pathways, but concluded that no adverse effects on the integrity of the Habitats Sites are foreseeable if the suggested mitigation measures are observed.

The Level 1 WFD assessment completed on all options indicated that Sunnymeads 1, Sunnymeads 2a, Lower Thames Reservoir Transfer 2a and Beckton Reuse Indirect options are anticipated to have very low risks of being non compliant with WFD objectives, therefore a further WFD assessment was not required for these options Level 2 WFD assessments were completed for components of Maidenhead, Teddington DRA and Walton 2b options. For these three options, further WFD assessment will be required; the areas for future focus include consultation with the Environment Agency (EA), data collation and review of Heavily Modified Waterbody measures and baseline data concerning WFD biological, physiochemical and hydromorphological elements, development of a conceptual model, further information on the design and operation of the options, and assessment of the combined effects of multiple options.

Based on the WRSE SEA level option outputs for residual effects (post mitigation), all options are predicted to generally result in the same minor positive, neutral or minor negative effects across all the SEA objectives, with the following exceptions:

- Biodiversity: The assessment outputs vary in the construction phase only The residual effects on biodiversity during construction are likely to be greater for Sunnymeads 1, Sunnymeads 2a, Walton 2b and Lower Thames Reservoir Transfer 2a options as a major

residual effect is likely compared with a moderate effect on Maidenhead, Teddington DRA and Beckton Reuse Indirect options. No operational residual effects are expected on any of the options.

- Soil: There is a potential for the construction and operation of Sunnymeads 1, Maidenhead, Teddington DRA and Beckton Reuse Indirect options to result in residual minor effects on soil. No residual effect on soil is expected from the construction or operation of Sunnymeads 2a, Walton 2b or Lower Thames Reservoir Transfer 2a options
- Water: All options are likely to result in a residual operational effect on the objective of protecting and enhancing the quality of the water environment and water resources. The operation of Sunnymeads 1, Teddington DRA, Sunnymeads 2a, Lower Thames Reservoir Transfer 2a and Beckton Reuse Indirect options would result in a minor residual effect, while the operation of Maidenhead and Walton 2b options would result in a moderate residual effect on water No construction residual effects are expected on any of the options
- Climatic factors: The operation of Sunnymeads 1 and Teddington DRA options would likely result in a major residual effect on carbon emissions, while the operation of all the other options would likely result in a moderate residual effect on carbon emissions

Additional assessment considering local level data has been undertaken in-line with the methodology in the All Companies Working Group (ACWG) Water Resource Management Plan (WRMP) environmental assessment guidance and applicability with SROs, October 2020[1]

In addition to WRSE assessment, an additional assessment was undertaken to consider local data. The local level data findings show that all options intersect or lie within 200m of a number of Local Wildlife Site (LWS) or Tree Preservation Order (TPO). However, mitigation can be put in place in order to reduce the potential effects on these areas.

The WRSE findings and additional assessment show the potential residual impact of all options is similar Overall, Lower Thames Reservoir Transfer 2a and Beckton Reuse Indirect options performed slightly better while Sunnymeads 1 and Walton 2b options performed slightly worse.

An Invasive Non Native Species (INNS) risk assessment was undertaken to screen, at a high level, and conduct an initial assessment of the INNS risk for the T2AT options. As all T2AT options involved the transfer of raw water, the INNS risk assessment was undertaken on all options The results of the high level screening against the freshwater INNS invasion heatmap was the same for all T2AT options, with an indicative 'medium' risk of Ponto-Caspian invasions. The future marine invasion risk of all source waters was classed as 'low', except for the Teddington DRA option, which being close to the tidal limit was precautionarily classed as 'high' risk.

High level Biodiversity Net Gain (BNG) and Natural Capital (NC) assessments were undertaken on the proposed pipeline routes and locations for the Water Treatment Works (WTW) for all options. 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 NC benefit or loss The assessments identified the following:

- NC: The pipelines of all options are likely to generate a permanent loss of high value NC stocks broadleaved mixed woodland, coniferous woodland, and orchards and top fruit, while the WTWs are likely to result in a permanent loss of pastures.
- BNG: The pipelines of 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

[1] Mott MacDonald (2020) All Company Working Group WRMP environmental assessment guidance and applicability with SROs October 2020 51 pages

maturity The construction of the WTWs are expected to result in a loss of BNG units due to habitat clearance.

- Ecosystem services: The pipelines for all options are likely to generate the permanent loss of NC stocks associated with the provision of several ecosystem services However, if the sites are returned to pre-construction condition following best practice techniques then there should be no permanent impact on ecosystem services provision from stocks other than woodland There are opportunities to improve existing habitats along the route through post-construction planting. The construction of the WTW for all options is expected to cause the loss of several ecosystem services namely carbon storage and food production. As the proposed WTWs are located within the Network enhancement zone 1, a suitable opportunity would be to create new woodland as part of these options.

When reviewing the assessments outputs of the pipelines and the proposed WTW locations, the best option overall, from a BNG/NC perspective, would be Maidenhead, while the worst one would be Teddington DRA.

The opportunities identified in the BNG/NC assessment have the potential to contribute to Government ambitions for environmental net gain[2] 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 between natural systems and social uses of land.

Potential social benefits of the T2AT scheme are presented in this report. The section on 'wider benefits' summarises the potential social benefits water transfer schemes as well as scheme options and details potential mitigation While the T2AT options have been developed with the aim of avoiding impacts on people, for all options, there is the potential that even with mitigation, there may be temporary disruption for communities Programmes and initiatives which could be implemented as part of the T2AT scheme to deliver public value are detailed in this section

A high-level carbon assessment was undertaken to review and summarise the net zero considerations for the T2AT options The assessment includes measures which should be considered to mitigate capital carbon emissions and operational carbon emissions, and how residual emissions could be tackled to get to net zero carbon emissions. The embedded carbon footprint of most options is similar with the Lower Thames Reservoir option being significantly lower than other options and the Walton 2b and Teddington options being somewhat higher than the others. Operational carbon footprint, which will be more significant than embedded carbon over time, is broadly similar across the options The ideas provided in the assessment 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 to start to decarbonise these It is recommended a robust carbon management process is embedded into the scheme development to ensure ideas are developed into opportunities

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.

An overview of the assessment results for each option is summarised in Table S 1:

[2] 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)

Table S.1: Summary of the assessments for the T2AT options

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
Sunnymeads 1	Transmission pathways identified, however no significant effects expected if mitigation measures implemented	Only WFD level 1 - very low risks of non-compliance	Potential residual effects similar for all options - but this option performed slightly worse	Same for all options (no risk of INNS spread)	All options similar	Same for all options	Embodied Carbon – similar to most other options. Operational carbon similar across all options
Maidenhead	No transmission pathways - No likely significant effects	Level 2 completed and further assessment needed	Potential residual effects similar for all options	Same for all options (no risk of INNS spread)	All options similar - best overall	Same for all options	Embodied Carbon – similar to most other options. Operational carbon – similar across all options.
Teddington DRA	No transmission pathways - No likely significant effects	Level 2 completed and further assessment needed	Potential residual effects similar for all options	Same for all options (no risk of INNS spread)	All options similar - worst overall	Same for all options	Embodied Carbon higher than other options Operational carbon – similar across all options.
Sunnymeads 2a	Transmission pathways identified, however no significant effects expected if mitigation measures implemented	Only WFD level 1 - very low risks of non-compliance	Potential residual effects similar for all options	Same for all options (no risk of INNS spread)	All options similar	Same for all options	Embodied Carbon – similar to most other options Operational carbon – similar across all options.
Walton 2b	Transmission pathways identified, however no significant effects expected if mitigation measures implemented	Level 2 completed and further assessment needed	Potential residual effects similar for all options - but this option performed slightly worse.	Same for all options (no risk of INNS spread)	All options similar	Same for all options	Embodied Carbon – higher than other options. Operational carbon – similar across all options.
Lower Thames Reservoir Transfer 2a	No transmission pathways - No likely significant effects	Only WFD level 1 - very low risks of non compliance	Potential residual effects similar for all options - but this option performed slightly better	Same for all options (no risk of INNS spread)	All options similar	Same for all options	Embodied Carbon – significantly lower than other options. Operational carbon – similar across all options.
Beckton Reuse Indirect	Transmission pathways identified, however no significant effects expected if mitigation measures implemented	Only WFD level 1 - very low risks of non compliance	Potential residual effects similar for all options - but this option performed slightly better	Same for all options (no risk of INNS spread)	All options similar	Same for all options	Embodied Carbon – similar to most other options. Operational carbon – similar across all options

1 Introduction

1.1 Overview

This annex accompanies the Gate 1 submission to RAPID for the T2AT SRO.

The content of this report is draft and relates to material [or data] which is still in the course of completion in travel to Gate 2 and should not be relied upon at this early stage of development We continue to develop our thinking and our approach to the issues raised in the document in preparation for Gate 2

1.2 T2AT Options

The outputs of the initial route options appraisal identified seven distinct options for transferring water from the Thames Water (TW) region to the Affinity Water (AFW) region. An eighth option, Mogden Reuse Indirect 3, is identical in terms of environmental assessment to Walton 2b and so has not been assessed separately. Throughout this report, the assessment applied to the Walton 2b option applies equally to Mogden Reuse Indirect 3 These options are shown in Table 1.1. Further details on the options are set out in Section 2 Scheme Description.

Table 1.1: T2AT options

Option name	Description overview
Sunnymeads 1	Abstraction of raw water at the existing Affinity Water [redacted] intake and conveyance to a new WTW at the existing [redacted] Service Reservoir (SR) site Available treated water storage capacity at the [redacted] site will be utilised for this option
Maidenhead	Abstraction of raw water at a new [redacted] intake, conveyance to a new WTW at [redacted] SR, and utilisation of available storage capacity at the existing [redacted] SR.
Teddington DRA	Abstraction of raw water at a new intake at [redacted], conveyance to a new WTW at [redacted], and utilisation of the available storage capacity at the existing [redacted] SR.
Sunnymeads 2a	Abstraction of raw water at the existing Affinity Water [redacted] intake and conveyance to a new WTW at [redacted] ([redacted] 2), near to the existing [redacted] WTW. The potable water is then conveyed to the existing [redacted] SR.
Walton 2b (and Mogden Reuse Indirect 3)	Abstraction of raw water at the existing Affinity Water [redacted] intake and conveyance to new [redacted] 2 WTW. The potable water is then conveyed to the existing [redacted] SR.
Lower Thames Reservoir Transfer 2a	Water from Thames Water's [redacted] and [redacted] reservoirs is abstracted via a proposed connection into [redacted] the existing [redacted] WTW site This raw water is then diverted to the proposed [redacted] 2 WTW The potable water is subsequently conveyed to the existing [redacted] SR.
Beckton Reuse Indirect	Indirect transfer of reuse water from [redacted] sewage treatment works to a new WTW near [redacted] The proposed abstraction point would be located on the [redacted], downstream of the outfall from the proposed [redacted] Reuse option of the London Effluent Reuse SRO.

Further details on the options are set out in Section 2 Scheme Description

1.3 Structure of the annex

This document presents:

- Section 2 Scheme Description: An overview of each of the T2AT 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 Risk Assessment: INNS risk assessment undertaken on the options

- Section 5 Natural Capital and Biodiversity Net Gain: 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 T2AT scheme.
- Section 8 Comparison between options and summary conclusions.

2 Scheme Description

2.1 Overview

The T2AT scheme is a prospective project with the objective of abstracting available raw water from the Thames Water catchment in west, south, and east London; treating it to potable water standards; and delivering to Affinity Water customers in the area to the north and north east of London. Potential sources of raw water are the River Thames (supported by the South East Strategic Reservoir Option (SESRO) and Severn Thames Transfer (STT) schemes) and reuse options within the London Reuse SRO scheme. Treated water would be delivered to an existing distribution hub, either the existing [redacted] SR or a new SR near [redacted]

A full scheme description can be found in the Concept Design Report which forms Annex A2 of the Gate 1 submission, however a summary of the main aspects of the options is included below.

2.2 Options descriptions

For Gate 1, seven distinct options for T2AT have been assessed as described in Table 2.1. A map of the options is shown in Figure 2.1.

Table 2 1: T2AT Gate 1 options

Option name	Option description
Sunnymeads 1	Abstraction of raw water at the existing Affinity Water [redacted] intake and conveyance to a new WTW at the existing [redacted] SR site. Available treated water storage capacity at the [redacted] site will be utilised for this option. 50Ml/d and 100Ml/d options Interdependencies of the option with SESRO or STT Downstream network enhancement Indicative intake location: [redacted]. Intake selection by option: Conventional screens.
Maidenhead	Abstraction of raw water at a new [redacted] intake, conveyance to a new WTW at [redacted] SR, and utilisation of available storage capacity at the existing [redacted] SR 50Ml/d and 100Ml/d options. Interdependencies of the option with SESRO or STT. Downstream network enhancement. Indicative intake location: [redacted] Intake selection by option: Passive wedge wire screen intake within the river and a gravity pipe to an offset pumping station
Teddington DRA	Abstraction of raw water at a new intake at [redacted], conveyance to a new WTW at [redacted], and utilisation of the available storage capacity at the existing [redacted] SR 50Ml/d and 100Ml/d options Interdependencies of the option with London Reuse SRO Teddington DRA option Downstream network enhancement. Indicative intake location: [redacted] Intake selection by option: Passive wedge wire screen intake within the river and a gravity pipe to an offset pumping station
Sunnymeads 2a	Abstraction of raw water at the existing Affinity Water [redacted] intake and conveyance to a new WTW at [redacted] near to the [redacted] WTW. The

Option name	Option description
	potable water is then conveyed to the existing [redacted] SR 50Ml/d and 100Ml/d options Interdependencies of the option with SESRO or STT. Downstream network enhancement. Indicative intake location: [redacted]. Intake selection by option: Conventional screens.
Walton 2b (and Mogden Reuse Indirect 3)	Abstraction of raw water at the existing Affinity Water [redacted] intake and conveyance to new [redacted] 2 WTW. The potable water is then conveyed to the existing [redacted] SR. 50Ml/d and 100Ml/d options. Interdependencies of the option with SESRO or STT Downstream network enhancement Another option, referred to as 'Mogden Reuse Indirect 3' comprises the same infrastructure as Walton 2b, but utilises water from the proposed London Reuse SRO (Mogden Reuse option). The environmental assessments for the alternative sources are covered by the source SROs; SESRO and STT for Walton 2b and London Effluent Reuse SRO for the Mogden Reuse Indirect 3 option. In this report, wherever Walton 2b is mentioned as an option, the associated narrative applies equally to the Mogden Reuse Indirect 3 option Indicative intake location: [redacted] Intake selection by option: Conventional screens
Lower Thames Reservoir Transfer 2a	Water from Thames Water's Wraysbury and Queen Mother reservoirs is abstracted via a proposed connection into [redacted] the existing [redacted] WTW site This raw water is then diverted to the proposed [redacted] 2 WTW The potable water is subsequently conveyed to the existing [redacted] SR 50Ml/d and 100Ml/d options. Interdependencies of the option with SESRO. Downstream network enhancement. Indicative intake location: [redacted] Intake selection by option: Proposed [redacted], with supplementary works on the [redacted] intake to enable Thames Water to compensate for lost abstraction at [redacted]
Beckton Reuse Indirect	Indirect transfer of reuse water from [redacted] sewage treatment works to a new WTW near [redacted]. The proposed abstraction point would be located on the [redacted], downstream of the outfall from the proposed Beckton Reuse option of the London Effluent Reuse SRO 50Ml/d and 100Ml/d options Another potential source for this option is water abstracted as part of the London Reuse SRO Teddington DRA option, which abstracts river water upstream of the effluent discharge from [redacted] sewage treatment works, and utilises the existing [redacted] (with an extension), which discharged in a similar location to the proposed Beckton Reuse Scheme. Interdependencies of the option with the London Reuse SRO or London Reuse SRO Teddington DRA option [redacted] to [redacted] extension within the London Reuse SRO Downstream network enhancement Indicative intake location [redacted] Intake selection by option: 1. Passive wedge wire screen and gravity pipe to a pumping station or 2 A channel to an offset conventional screen and pumping station

Figure 2.1: Map of the T2AT options

2.3 Updates of the scheme since WRSE undertook their review

It should be noted that the WRSE assessment (January 2021) was undertaken on an earlier iteration of the options; further beneficial refinements have been made to the options since these were assessed by WRSE in order to optimise the options and to reduce the impact on the environment Although changes were made to the routes, the assessment of the optimised routes would not result in significant differences to the metrics used by WRSE. An overview of the changes made to the routes are presented in Table 2.2.

Table 2 2: Overview of the changes made to the options since WRSE assessment

Option name	Changes since WRSE assessment
Sunnymeads 1	• Optimised route limits the number of crossings of the motorway and adjacent A-roads – as a result of this the total pipeline length was reduced (near the proposed [redacted] 2 WTW). • Pipeline carefully routed closer to field boundaries between the proposed [redacted] 2 and the existing [redacted] SR to minimise the impact on land • The route south of the [redacted] was amended for a slightly longer route which crosses the railway track and requires an additional river crossing While this resulted in a small increase in pipe length, this change in the route means that it no longer routes through the town of [redacted]
Maidenhead	• A longer section of the optimised route goes through the [redacted] • Avoid an area of Grade 2 land (west of the [redacted])
Teddington DRA	• First part of the route has been modified as a result of the change in the proposed abstraction location. This results in a slight increase in the length of the pipeline, and a short section of the optimised route running along [redacted] Sports Ground. • Short sections of the route located between [redacted] have been amended to follow the roads where possible. • Section of the route between [redacted] has also be optimised to follow the roads more closely. • Section of the route between [redacted] and the existing [redacted] SR has moved to the south east therefore no longer adjacent to some ancient woodland
Sunnymeads 2a	• The option follows largely the same route as Sunnymeads 1. The only difference between the routes is that this option diverges east from Sunnymeads 1 near the proposed [redacted] 2 WTW for treatment before joining back. Refer to 'Sunnymeads 1' for the changes made to the route.
Walton 2b (and Mogden Reuse Indirect 3)	• South of the [redacted], the optimised route would follow the [redacted]) While the route would need to cross the [redacted] at that point, the optimised route avoids landfills sites, priority habitats, [redacted], a golf course and green spaces The optimised route also results in fewer motorway crossings. • As the optimised route intercepts the Sunnymeads 1 route [redacted] to the proposed [redacted] 2 WTW and then follows the same route to the existing [redacted] SR, refer to 'Sunnymeads 1' for the changes made to that section of the Walton 2b route.
Lower Thames Reservoir Transfer 2a	• As the option conveys water from the [redacted] 2 WTW and from there follows the same route as the Sunnymeads 1 option, refer to 'Sunnymeads 1' for the changes made to that section of the Lower Thames Reservoir transfer 2a route
Beckton Reuse Indirect	• South of the [redacted], the optimised pipeline runs on the west side of the [redacted] and passes through The [redacted]. • The route crosses the [redacted] (instead of further along the [redacted]) and routes through fields and the north end of the town of [redacted] to end at the proposed [redacted] WTW and Reservoir instead of along the [redacted].

3 Regulatory Assessment Reports

Three regulatory assessments have been undertaken to support the Gate 1 submission and are presented as standalone annexes

3.1 Habitats Regulations Assessment

Annex B2 contains the results of the HRA undertaken for each of the T2AT options. It provides information on the HRA screening (HRA stage 1) and the further, AAs (HRA stage 2) undertaken to assess the potential effects of the options on UK's Habitats Sites

The HRA Stage 1 Screening Assessment undertaken for Maidenhead, Teddington DRA and Lower Thames Reservoir Transfer 2a options identified Uncertain Effects on some Habitats Sites but the Stage 2 Appropriate Assessment did not identify any transmission pathways by which a Likely Significant Effect could reasonably occur. Therefore no adverse effects on the integrity of the Habitats Sites are considered likely.

The Appropriate Assessment undertaken for Sunnymeads 1, Sunnymeads 2a, Walton 2b and Beckton Reuse Indirect options identified transmission pathways, but concluded that no adverse effects on the integrity of the following Habitats Sites are likely if the following suggested mitigation measures are observed:

- Sunnymeads 1 and Sunnymeads 2a: There is a potential for adverse effects on the [redacted] SPA and the [redacted] Ramsar site as a result of their close proximity to the construction pipeline corridor and intake location, the site being located within the same river catchment as the intake location and as a result of disturbance (noise, light, dust pollution) during construction on qualifying species Provided that the proposed mitigation measures are taken forward at the project stage, no residual impacts on the Habitats Sites are likely to occur and therefore no adverse effects on the integrity of the Habitats Sites are foreseeable
- Walton 2b: There is a potential for adverse effects on the [redacted] SPA and the [redacted] Ramsar site as a result of their close proximity to the construction pipeline corridor, the possibility the site may be hydrologically connected as the pipeline runs directly adjacent to a waterbody that forms part of the designation, and as a result of disturbance (noise, light, dust pollution) during construction on qualifying species Provided that the proposed mitigation measures are taken forward at the project stage, no residual impacts on the Habitats Sites are likely to occur and therefore no adverse effects on the integrity of the Habitats Sites are foreseeable.
- Beckton Reuse Indirect: There is a potential for adverse effects on the [redacted] SPA and [redacted] Ramsar site as a result of their close proximity to the construction pipeline corridor and abstraction point on the [redacted] and as a result of disturbance (noise, light, dust pollution) during construction on qualifying species. Provided that the proposed mitigation measures are taken forward at the project stage, no residual impacts on the Habitats Sites are likely to occur and therefore no adverse effects on the integrity of the Habitats Sites are foreseeable.

It should be noted that this report presents the results of the initial HRA assessment and should be considered a high level assessment with respect to the preliminary nature of design details that is available at this early stage of the WRSE regional plan. The HRA will be updated to include a more conclusive HRA assessment at Gate 2. For similar reasons, an in combination assessment to identify potential cumulative effects of T2AT with other non related plans or projects would not be considered proportionate at this stage and has therefore not been

conducted The updated HRA conducted at Gate 2 will include an in combination assessment of the options within T2AT, between different SROs and between any other external plans or projects that may put pressure on the same water resources. As T2AT develops, it is assumed that any potential significant effects on Habitats Sites due to individual options, or in combination effects will be avoided as far as reasonably practicable.

3.2 Water Framework Directive Assessment

Annex B3 contains the results of the WFD assessment undertaken for the T2AT options. It provides information on the WFD screening (Level 1 basic screening) applied to all T2AT options and on the further assessment (Level 2 – detailed impact screening) undertaken for the T2AT options that were screened in at Level 1

The Level 1 WFD assessment completed by WRSE in January 2021 indicated that four of the options are anticipated to have very low risks of being non-compliant with WFD objectives, and do not require further assessment:

- Sunnymeads 1
- Sunnymeads 2a
- Lower Thames Reservoir Transfer 2a
- Beckton Reuse Indirect.

Where waterbodies and option impacts were 'screened in', a further assessment was undertaken Level 2 WFD assessments were completed for components of the below options:

- Maidenhead
- Teddington DRA
- Walton 2b

For these three options the findings indicate that there are potentially precautionary WFD compliance risks associated primarily with the operation of either 50 or 100Ml/d additional/new abstractions The potential hydrological effects could conflict with achieving WFD status objectives. This is particularly the case 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, and physico chemical changes (for example, reduced dilution) would require further assessment.

For new or modified intakes, it is recognised that appropriate fish and eel screening would be required to prevent entrainment At Gate 1, this has been considered as likely mitigation, but moderate/amber risks have been maintained until option designs and assessments are further progressed

Subject to their progression through the approvals process, further WFD assessment would be required for the Maidenhead, Teddington DRA and Walton 2b options, to improve the certainty of the levels of WFD risk outlined in the Gate 1 WFD Level 2 assessments. Areas for future focus for Gate 2 include:

- Consultation with the EA to present and discuss key WFD risks and proposed approach to improving certainty of assessments;
- Collation and review of Heavily Modified Waterbody (HMWB) measures information from the EA for inclusion into the assessment of potential impediment to obtaining Good Ecological Potential (GEP);
- Collation and review of detailed baseline data concerning WFD biological, physicochemical and hydromorphological elements identified as being at yellow, amber, or red risk in the Level 2 assessments This may include existing EA long term WFD and water quality

monitoring data within the relevant waterbodies, and targeted baseline surveys being undertaken specifically for the SRO assessments;

- Development of a conceptual model linking together how potential hydrological changes could influence water quality and the sensitivity of aquatic communities to those changes;
- Further information on the design and operation of the options;
- Assessment of the combined potential WFD effects/risks of inter-reliant multiple options (where T2AT is reliant on other SROs being delivered);
- Update to Level 2 WFD assessments to incorporate additional information;
- Outlining further work or modelling required to demonstrate compliance into Gate 3.

3.3 Strategic Environmental Assessment

Annex B4 presents the findings of a SEA level option applied to the options for the T2AT options.

WRSE undertook an SEA in January 2021, in line with the methodology in the WRSE Regional Plan Environmental Assessment Methodology Guidance, July 2020

Based on the WRSE SEA outputs for residual effects (post mitigation), the options are predicted to generally result in the same minor positive, neutral or minor negative effects across all the SEA objectives, with the following exceptions:

- Biodiversity: The assessment outputs vary in the construction phase only. The residual effects on biodiversity during construction are likely to be greater for Sunnymeads 1, Sunnymeads 2a, Walton 2b and Lower Thames Reservoir Transfer 2a options as a major residual effect is likely compared with a moderate effect on Maidenhead, Teddington DRA and Beckton Reuse Indirect options No operational residual effects are expected on any of the options.
- Soil: There is a potential for the construction and operation of Sunnymeads 1, Maidenhead, Teddington DRA and Beckton Reuse Indirect options to result in residual minor effects on soil. No residual effect on soil is expected from the construction or operation of Sunnymeads 2a, Walton 2b or Lower Thames Reservoir Transfer 2a options.
- Water: All options are likely to result in a residual operational effect on the objective of protecting and enhancing the quality of the water environment and water resources. The operation of Sunnymeads 1, Teddington DRA, Sunnymeads 2a, Lower Thames Reservoir Transfer 2a and Beckton Reuse Indirect options would result in a minor residual effect, while the operation of Maidenhead and Walton 2b options would result in a moderate residual effect on water. No construction residual effects are expected on any of the options.
- Climatic factors: The operation of Sunnymeads 1 and Teddington DRA options would likely result in a major residual effect on carbon emissions, while the operation of all the other options would likely result in a moderate residual effect on carbon emissions.

Additional assessment considering local level data has been undertaken in line with the methodology in the ACWG WRMP environmental assessment guidance and applicability with SROs, October 2020.

The local level data findings show that all options intersect or lie within [redacted] of a number of LWS or TPO. While direct loss may occur, the impact of the route on LWS and TPO will be reviewed at Gate 2 following the refinement of the routes and identification of mitigation to be put in place in order to reduce the potential effects on these areas

The WRSE findings and additional assessment show the potential residual impact of all options is similar Overall, Lower Thames Reservoir Transfer 2a and Beckton Reuse Indirect options performed slightly better while Sunnymeads 1 and Walton 2b options performed slightly worse.

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, with over 70% of WFD waterbodies at risk of deterioration due to INNS pressures by 2027[3]. Additionally, the presence of INNS in water company assets may compromise the supply of drinking water and the safe return of treated wastewater 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 INNS (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 (WFD) (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 WFD 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 T2AT raw water transfer options being considered. The overall aim was underpinned by the following objectives:

1 To review potential T2AT options against relevant EA guidance
2. To determine whether potential T2AT options are located within areas of high risk of INNS invasion

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

3 To identify INNS within an appropriate study area to understand current INNS distribution
4. To undertake a high-level screening of potential T2AT options against key legislation.
5. To use an INNS risk assessment tool to assess risk for potential T2AT options based on the conceptual design information currently available

Section 4 also includes the screening against the marine INNS and Ponto Caspian freshwater INNS invasion heatmaps which is a separate assessment to the INNS risk assessment tool. This additional screening exercise was undertaken on the basis that Ponto-Caspian aquatic species represent a high proportion of recent, and predicted future invasions. It would be unfeasible to conduct this specific assessment at a global scale

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, detailed in Table 4 1 and as shown on Figure 4 1

Table 4.1: Study area details

Option	Source waterbody	WFD Management Catchment
Sunnymeads 1	River Thames	[redacted]
Maidenhead	River Thames	[redacted]
Teddington DRA	River Thames	[redacted]
Sunnymeads 2a	River Thames	[redacted]
Walton 2b	River Thames	[redacted]
Lower Thames Reservoir Transfer 2a	[redacted]	[redacted]
Beckton Reuse Indirect	[redacted]	[redacted]

4.2 2 High Level Screening Related to EA Guidance

The EA 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 [4] The key points of relevance to this report are as follows:

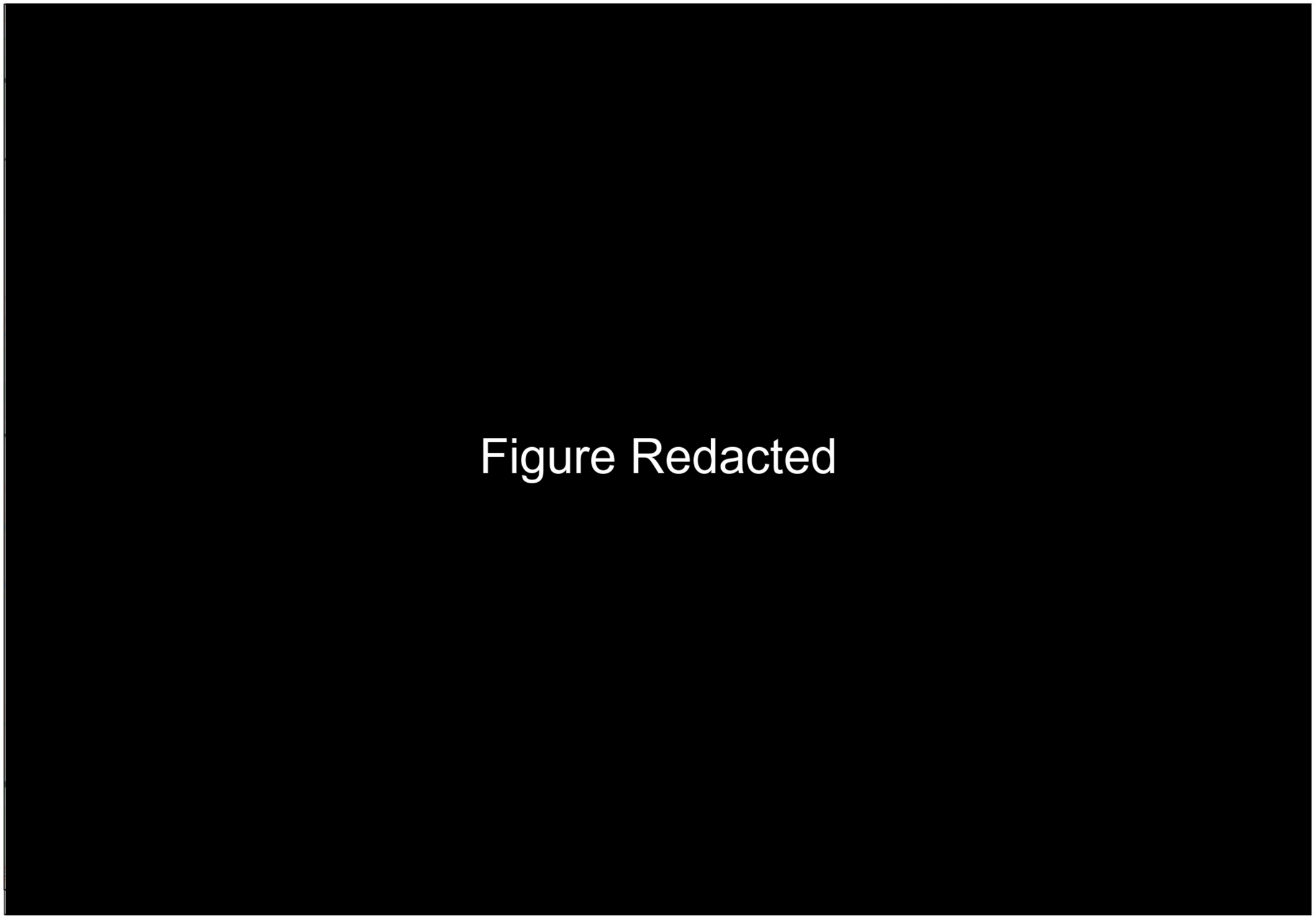
- The focus of the EA's approach is on the pathways that the transfers create, not on current INNS distribution
- New schemes that create a hydrological connection between isolated catchments must have mitigation measures in place to ensure INNS cannot be spread by the new transfer.
- Where water transfer 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 EA will use to decide whether subsequent mitigation is required, to ensure the risk of INNS transfer is not significantly increased.

All T2AT options were screened to determine if proposed raw water transfer will create a link between isolated catchments, as mapped in the EA document *Invasive Non-Native Species Isolated Catchment Mapping*.[5]

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

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

Figure 4.1: INNS risk assessment study area



4.2.3 High-Level Screening Related to 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*;[6] 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*.[7]

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 T2AT 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.

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** (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 T2AT 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

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

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

Table 4.3: 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 Invasive Non-Native Species 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[8] The data were screened against Schedule 9 of the Wildlife and Countryside Act and WFD UK Technical Advisory Group INNS guidance[9] to identify INNS present within the study area [10]

4.2.5 High-Level Screening Related to INNS Legislation

Desk study INNS data were screened against key national legislation to provide an indicative risk of contravention 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 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 * 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 '
INNS (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,

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

[9] 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

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

Legislation	Risk Category	Justification
		• 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 (WFD) (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.
	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 originally developed by Northumbrian Water Group to meet the requirements of the EA'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 list of functional groups of INNS encompassing different life stages 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 T2AT 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

Aspects of transfer design that factor into the INNS risk assessment are the same across all T2AT raw water transfer options For all options, it is proposed that raw water will be transferred between WFD Management Catchments via a new underground pipeline. The proposed frequency of operation and volume of raw water transfer are also the same for all options. Additionally, the mitigation measures already incorporated into the conceptual design are identical across all options. Therefore, a single test scenario was developed based on the current conceptual design (see Section 1) to represent the options.

At the time of this assessment (Gate 1), the conceptual design is still in development and the frequency at which raw water will be transferred is unknown. As the risk assessment tool requires an input for transfer frequency, it was assumed that transfers will be operational on a ‘seasonal continuous’ basis for all options

The test scenario is detailed in Table 4.6.

Table 4.6: INNS risk assessment test scenario for T2AT raw water transfer options

Risk type	Input variable	Option selected
Inherent	Transfer pathway	New raw water transfer
	Transfer frequency	Seasonal - continuous
	Transfer volume	50 100Ml/d
	Transfer distance	Between WFD Management Catchments
Adjusted	How raw water is conveyed	Whole length – underground pipeline
	Facilitation works	Lay new underground pipeline
	Storage at transfer destination	Not applicable to pathway
	Navigation along transfer route	Not applicable to pathway
	Recreation at transfer destination	Not applicable to pathway
	Riparian/land-based recreational access at transfer	Not applicable to pathway
	Risk of arrival of new INNS at source	High for functional groups already at source Low for functional groups not currently at source
	Screening at source	Screens 3 10 mm mesh
	Chlorination at source or along route	No
	Transfer of water direct to WTW	Yes
	Screening before discharge to receptor waterbody	Not applicable to pathway
	Salt water barrier	No
	Specific operational protocol to mitigate risk	Yes
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
	Protected species in or near receptor	No
	Protected sites in or near receptor	No

4.2 7 Constraints and Limitations

The INNS risk assessment tool utilised in this study scores 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 and construction of new pumping stations 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) As the concept design is developed, construction phase risks relating to INNS should also be considered

The test scenario outlined in Section 4.2.6.2 is 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 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 T2AT

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 EA.

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 caused.

4.3 Results

4.3 1 High-Level Screening Related to EA Guidance

Maidenhead, Sunnymeads 1, Sunnymeads 2a, Teddington DRA, Lower Thames Reservoir Transfer 2a and Walton 2b raw water transfer options are all located entirely within [redacted] of the classification map in *Invasive Non Native Species Isolated Catchment Mapping* (EA, 2018). Beckton Reuse Indirect option spans [redacted] Both areas are classified as 'Canal – CRT', meaning that hydrological connections to areas outwith the catchment already exist through intersection of the river network with Canal and Rivers Trust (CRT) navigable canals. Connecting watercourses include the [redacted] Canal, [redacted] Canal, [redacted] Canal, [redacted] Canal and [redacted] Canal. None of the T2AT transfer options will create a link between 'isolated' catchments

The EA guidance for raw water transfers states: 'where catchments are already connected, a risk assessment will be required, which the EA will use to decide whether subsequent mitigation is required, to ensure the risk of INNS transfer is not significantly increased' The INNS risk assessment presented in this report fulfils this requirement at Gate 1. The output suggests that T2AT options will not significantly increase the risk of INNS transfer, and therefore incorporation of further mitigation measures into the transfer design is not necessary However, this conclusion should be taken under advisement from the EA.

4.3.2 High-Level Screening Related to INNS Invasion Heatmaps

4 3 2 1 Freshwater Invasion Risk

The indicative intakes for all options are located 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 T2AT options is unsurprising given that the indicative intake locations are all in proximity to one another within the Thames River Basin District, and therefore have a similar climate, altitude, and water chemistry

As all proposed transfer options terminate at a WTW, the risk of future freshwater INNS invasion at receptor sites was considered to be '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 T2AT 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.

Although the Marine Invasion Risk of the Thames Estuary is 'high', the tidal limit of the Thames is downstream from most of the proposed intake locations. Therefore, the actual risk of marine INNS spreading upstream to T2AT option source waters was determined to be 'low'.

[redacted]

As all proposed transfer options will terminate at a WTW, the risk of future marine INNS invasion at receptor sites was determined to be '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 T2AT options, except for Teddington DRA option, which was considered to be at 'high' risk of future marine INNS invasions

4.3.3 Invasive Non-Native Species Records

Twenty-six INNS were identified in the EA records for [redacted] Management Catchment, including four aquatic plants, four riparian plants, four fish and 14 macroinvertebrates.

Thirty INNS were identified in the EA records for [redacted] Management Catchment, including five aquatic plants, three riparian plants, seven fish and 15 macroinvertebrates

Twenty-five INNS were identified in the EA records for [redacted] Management Catchment, including four aquatic plants, three riparian plants, five fish and 13 macroinvertebrates

Twenty-five INNS were identified in the EA records for [redacted] Management Catchment, including five aquatic plants, four riparian plants, four fish and 12 macroinvertebrates

EA 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: INNS of fish identified in EA records

Common name	Scientific name	Functional group	Non-native status	[redacted]	[redacted]	[redacted]	[redacted]
Common carp	*Cyprinus carpio*	4	UKTAG high[11]	✓	✓	✓	✓
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	✓	✓	✓	✓
Topmouth gudgeon	*Pseudorasbora parva*	4	UKTAG – high WACA 1981 Sch 9[12]		✓		
Zander	*Sander lucioperca*	4	UKTAG moderate	✓	✓	✓	

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

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

Table 4.8: INNS of macrophyte identified in EA records

Common name	Scientific name	Functional group	Non-native status	[redacted]	[redacted]	[redacted]	[redacted]
Broadleaf arrowhead	*Sagittaria latifolia*	2	WACA 1981 Sch. 9	✓			✓
Curly water-thyme	*Lagarosiphon major*	1	UKTAG – high EU species of special concern[13] WACA 1981 Sch. 9				✓
Canadian pondweed	*Elodea canadensis*	1	UKTAG – high WACA 1981 Sch. 9		✓	✓	✓
Floating pennywort	*Hydrocotyle ranunculoides*	1	EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch.2[14]	✓	✓		✓
Nuttall's pondweed	*Elodea nuttallii*	1	UKTAG – high EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch 2	✓	✓	✓	✓
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	✓	✓	✓	✓

Table 4.9: INNS of macroinvertebrate identified in EA records

Common name	Scientific name	Functional group	Non-native status	[redacted]	[redacted]	[redacted]	[redacted]
Asiatic clam	*Corbicula fluminea*	5	UKTAG high	✓	✓	✓	
Bloody red mysid	*Hemimysis anomala*	5	UKTAG – high	✓	✓	✓	✓

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

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

Common name	Scientific name	Functional group	Non-native status	[redacted]	[redacted]	[redacted]	[redacted]
Caspian mud shrimp	*Chelicorophium curvispinum*	5	UKTAG – unknown	✓	✓	✓	
Demon shrimp	*Dikerogammarus haemobaphes*	5	UKTAG – high	✓	✓	✓	✓
Freshwater amphipod	*Chelicorophium chelicorne*	5	UKTAG – unknown				✓
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	UKTAG – unknown	✓	✓	✓	
Quagga mussel	*Dreissena bugensis*	5	UKTAG – high	✓	✓		✓
Side swimmer	*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	✓	✓	✓	✓

High Impact INNS were identified for each of the functional groups present in all catchments In terms of High Impact fish species, common carp *Cyprinus carpio* was recorded in all four catchments, goldfish *Carassius auratus* was recorded in the [redacted] Management Catchments, and topmouth gudgeon *Pseudorasbora parva* was recorded only in [redacted] Management Catchment.

The highest impact macrophytes identified in EA records for all four of the catchments were Nuttall's pondweed *Elodea nuttallii* and Indian balsam *Impatiens glandulifera*. Additionally, water fern *Azolla filiculoides* was identified in [redacted], London and [redacted] Management Catchments; and, Canadian pondweed *Elodea canadensis* was identified in the [redacted], and [redacted] Management Catchments.

Three species of High Impact macroinvertebrates were identified in all four catchments, including bloody red mysid *Hemimysis anomala*, demon shrimp *Dikerogammarus haemobaphes* and zebra mussel *Dreissena polymorpha*. Other High Impact macroinvertebrates were Asiatic

clam *Corbicula fluminea*, identified in [redacted], [redacted], and [redacted] Management Catchments; and quagga mussel *Dreissena bugensis*, identified in [redacted], [redacted], and [redacted] Management Catchments.

4.3 4 High Level Screening Related to INNS Legislation

None of the T2AT 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, INNS (Amendment etc.) (EU Exit) Regulations 2019 and Invasive Alien Species (Enforcement & Permitting) Order 2019 were identified in all three 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 all options.

4.3.5 Risk Assessment

The INNS risk scores generated for each of the raw water transfer options are presented in Table 4.10.

The input variables for the Inherent Risk Score calculation were the same for all of the T2AT raw water transfer options. All proposed transfers operate at the same frequency (seasonal – continuous) and volume (50 – 100Ml/d) and involve the transfer of raw water between WFD Management Catchments Consequently, an Inherent Risk Score of 648 was calculated for all options.

The Adjusted Risk Score is largely based on mitigation options and exacerbating factors in transfer design and operation The same mitigation options have been incorporated into the current conceptual design of all options. They include screening of raw water at source with 3 - 10 mm mesh screens and transfer of raw water directly to a WTW. Of the mitigation options included in the tool, transfer to a WTW is the most effective It recognises that raw water will not be discharged to a watercourse or reservoir, instead it will be treated at the WTW before transfer into the potable water supply network. Transfer to a WTW introduces a multiplier score of zero to the Adjust Risk Score calculation The Adjusted Risk Score for all options was therefore zero.

The Adjusted Risk Score is carried forward as a multiplier in the calculation of the Weighted Risk Score, so all T2AT options were also 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 the four 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 In all three source catchments, High Impact INNS were identified for each of the functional groups present.

It is possible that the infrequent use of pipeline drainage points and occasional WTW overflows will introduce an INNS risk to the T2AT raw water transfer options The overall INNS risk will be reviewed at Gate 2 when further design information is available to account for the risk presented by WTW overflow and pipeline drainage

4.3 6 Results Summary

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

Table 4.10: INNS assessments results summary

Assessment component	Sunnymeads 1	Maidenhead	Teddington DRA	Sunnymeads 2a	Walton 2b	Lower Thames Reservoir Transfer 2a	Beckton Reuse Indirect
Transfer between isolated catchments	No	No	No	No	No	No	No
Freshwater INNS Invasion Risk	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Marine INNS Invasion Risk	Low	Low	High (Precautionary)	Low	Low	Low	Low
Risk of contravening INNS legislation	Low	Low	Low	Low	Low	Low	Low
Inherent Risk Score	648	648	648	648	648	648	648
Adjust Risk Score	0	0	0	0	0	0	0
Weight Risk Score	0	0	0	0	0	0	0

4.4 Conclusions and Recommendations

The following conclusions have been drawn from the environmental assessment of the T2AT raw water transfer options:

- Source and receptor locations for all proposed transfers have existing man made connections to other catchments via Canal and River Trust canals. The development of any of the proposed transfers would not introduce a new connection between previously isolated catchments
- The results of the high-level screening against the freshwater INNS invasion heatmap was the same for all T2AT options, with an indicative 'medium' risk of Ponto-Caspian invasions The future marine invasion risk of all source waters was classed as 'low', except for the Teddington DRA option, which being close to the tidal limit was precautionarily classed as 'high' risk
- As all proposed T2AT raw water transfer options terminate at a WTW, the risks associated with spreading freshwater or marine INNS via the transfer would be effectively eliminated. Within the risk assessment tool, this is reflected in a risk score of zero for all options
- As the Weighted Risk Scores were calculated as zero for each the proposed transfer options, it is considered unlikely that the T2AT scheme will contravene INNS legislation.
- The impact of all options on freshwater inflows, salinity within the Thames estuary, and resulting impacts on the distribution of invasive species, require further consideration

At the time of this assessment, the conceptual design is not finalised. It is recommended that the INNS risk assessment is updated upon finalisation of the conceptual design after Gate 1 to account for any changes that may introduce an INNS risk.

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 Biodiversity Net Gain as 'an approach to development that aims to leave the natural environment in a measurably better state than beforehand.' The 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 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)[15]. 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 All Company Working Group guidance documents:

- All Companies Working Group (ACWG) 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 was assessed 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 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.

[15] 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

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 BNG and NC outputs provided by WRSE

The output tables from WRSE are contained in Appendix A.

5.2.1 Assessment Assumptions and limitations

WRSE undertook the assessments to the required level of detail as stated in the Environment Agency and Natural England Gate 1 Assessment Expectations and utilised the best available information.

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 yet because the locations of these were not available. Therefore, the potential impacts on natural capital stocks and associated ecosystem services may be underestimated
- It was assumed that WTW included in the option boundary generated a permanent loss of all natural capital stock
- 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

As this assessment was carried out using only open source data, 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 the scale of the regional plan and will allow for the individual companies to utilise this work within their own WRMPs and supplement the open source habitat data with local datasets or Phase 1 site data to increase the accuracy of calculations for each option

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

5.3 WRSE Natural Capital and Biodiversity Net Gain Findings

The findings of the NC and BNG assessment undertaken by WRSE, per option, are presented below. As the findings did not differentiate between a 50Ml/d or 100Ml/d transfer capacity, the findings do not refer to the size of the pipe.

Separate assessments were undertaken on the pipelines and on the WTWs The final location and footprint of the WTWs and the pipeline routes remain open at this stage as they will be identified through a process of engagement later in scheme development. Therefore, the assessment has been undertaken using indicative sites and routes which are considered representative of the final design for each option should it be selected. Undertaking separate assessments could result in combined impacts; this was not considered as part of the Gate 1 assessments, however in-combination assessments will be considered at Gate 2

5 3 1 Summary 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.

In each case, the option will likely cause the temporary loss of stocks during construction. Stock temporarily lost is listed in Table 5 1 as no change in area of stock post 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: Summary of the NC assessment: Change in area (ha) of the stock post construction

Option Name	Broadleaved Mixed Woodland	Coniferous Woodland	Orchards and Top Fruit	Pastures
Sunnymeads 1				
Pipeline	-2.47	-1.98	-0.06	0
WTW	N/A	N/A	N/A	-2.07
Maidenhead				
Pipeline	0 52	0 55	0 01	0
WTW	N/A	N/A	N/A	2 07
Teddington DRA				
Pipeline	-5.05	-0.06	N/A	0
WTW	N/A	N/A	N/A	-2.07
Sunnymeads 2a				
Pipeline	-2.67	-0.28	-0.09	0
WTW	N/A	N/A	N/A	2 59
Walton 2b				
Pipeline	-4 75	0 29	N/A	N/A
WTW	N/A	N/A	N/A	2 59
Lower Thames Reservoir Transfer 2a				
Pipeline	-1.14	-0.32	N/A	0
WTW	N/A	N/A	N/A	2 59
Beckton Reuse Indirect				
Pipeline	-1.42	N/A	N/A	0
WTW	N/A	N/A	N/A	-2.68

5 3 2 Summary of the Biodiversity Net Gain metric

Table 5.2 presents the summary of the BNG metrics for all 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 Name	On-Site Baseline (habitat units)	On-Site Post Intervention (habitat units)	Total Net Unit Change (habitat units)	Total Percentage Change (%)
Sunnymeads 1				
Pipeline	139.77	67.72	-72.05	-51.55%
WTW	9.12	0	-9.12	-100%
Maidenhead				
Pipeline	90.53	62.15	-28.38	-31.35%
WTW	9.12	0	-9.12	-100%
Teddington DRA				
Pipeline	154 77	46 27	108 50	70 10%
WTW	9 12	0	-9 12	100%
Sunnymeads 2a				
Pipeline	137.54	64.06	-73.48	-53.42%
WTW	11.4	0	-11.4	-100%
Walton 2b				
Pipeline	214.76	94.04	-120.72	-56.21%
WTW	11 4	0	11 4	100%
Lower Thames Reservoir Transfer 2a				
Pipeline	75 11	38 67	36 44	-48 52%
WTW	11 4	0	11 4	100%
Beckton Reuse Indirect				
Pipeline	69.43	31.43	-38.00	-54.73%
WTW	9.12	0	-9.12	-100%

5 3 3 Summary of the ecosystem services screening

Table 5.3 presents the summary of the ecosystem services quantitative assessment which monetises the losses in habitat 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

Option Name	Ecosystem Service (change in value £/year)					Estimated total change in value (£ per year)[6]
	Carbon Storage[1]	Natural Hazard Management[2]	Air Pollutant Removal[3]	Recreation and Amenity Value[4]	Food Production[5]	
Sunnymeads 1						
Pipeline	£1,007 59	-£394 27	-£3,413.45	Scoped out	Scoped out	-£4,815 31
WTW	£55 68	Scoped out	Scoped out	Scoped out	-£615 00	-£670 68
Maidenhead						
Pipeline	-£203.71	-£94.80	Scoped out	Scoped out	Scoped out	-£298.51

Option Name	Ecosystem Service (change in value £/year)					Estimated total change in value (£ per year)[6]
	Carbon Storage[1]	Natural Hazard Management[2]	Air Pollutant Removal[3]	Recreation and Amenity Value[4]	Food Production[5]	
WTW	£55 68	Scoped out	Scoped out	Scoped out	-£615 00	-£670 68
Teddington DRA						
Pipeline	-£627.34	-£452.75	-£3,939.81	Scoped out	Scoped out	-£5,019.89
WTW	£55 68	Scoped out	Scoped out	Scoped out	-£615 00	-£670 68
Sunnymeads 2a						
Pipeline	-£441.11	-£261.37	-£2,230.31	Scoped out	Scoped out	-£2,932.79
WTW	69 61	Scoped out	Scoped out	Scoped out	-£1,100 00	-£1,169 61
Walton 2b						
Pipeline	-£636.19	-£446.54	-£3,910.06	Scoped out	Scoped out	-£4,992.79
WTW	69 61	Scoped out	Scoped out	Scoped out	-£1,100 00	-£1,169 61
Lower Thames Reservoir Transfer 2a						
Pipeline	-£257.45	-£129.36	-£1,125.66	Scoped out	Scoped out	-£1,512.47
WTW	69 61	Scoped out	Scoped out	Scoped out	-£1,100 00	-£1,169 61
Beckton Reuse Indirect						
Pipeline	-£108.73	-£125.81	-£1,094.82	Scoped out	Scoped out	-£1,329.36
WTW	-£71.94	Scoped out	Scoped out	Scoped out	-£901.00	-£972.94

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. Scoped out when the option does not cause the loss of stocks within an AQMA. 4. Scoped out when the option does not permanently impact recreational and amenity sites. 5. Scoped out when the option does not cause permanent loss of associated stock. 6. GDP discounting has not been applied as part of the monetisation of values.

5.4 Conclusions

5.4.1 Natural Capital

The outputs of the methodology show the pipelines of all options are likely to generate a permanent loss of high value NC stocks broadleaved mixed woodland, coniferous woodland, and orchards and top fruit. Broadleaved mixed woodland, coniferous woodland, and orchard and top fruit cannot be easily replicated in a reasonable time frame. All options are also likely to generate a loss of NC stocks during construction However, best practice and compensation/reinstatement of habitat means that post construction these stocks are likely to have no to little permanent change.

The outputs of the methodology show the WTW of all options are likely to result in a permanent loss of pastures.

5.4.2 Biodiversity Net Gain

Applying the methodology, the pipelines of 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. The construction of the WTWs are expected to result in a loss of BNG units due to habitat clearance

5 4 3 Ecosystem Services

The pipelines for all options are likely to generate the permanent loss of NC stocks associated with the provision of several ecosystem services. Major construction impacts include the release of CO_2, loss of flood regulation, air pollutant removal and water purification due to habitat clearance. However, if the sites are returned to pre-construction condition following standard best practice techniques then there should be no permanent impact on ecosystem services provision from stocks other than woodland The time taken for woodland to mature means that the provision of these services will be lost for many years after construction has been completed.

All the options present opportunities to improve the existing habitats along the pipeline route through post-construction remediation and replacement of low value habitats with higher value habitats. The options present opportunities to provide offsetting planting of trees which will likely be permanently lost as a result of these options

The construction of the WTW for all options is expected to cause the loss of several ecosystem services namely carbon storage and food production It is anticipated that no new ecosystem services will be provide during operation As the proposed WTWs for all options are located within the Network Enhancement Zone 1[16], a suitable opportunity would be to create new woodland as part of these options

5.5 Comparison

The proposed pipeline route for Maidenhead would result in the lowest percentage loss of BNG (by a maximum of 31.35%) and in the lowest total loss of ecosystem services value (£298.51 per year), while Teddington DRA would result in the greatest percentage BNG loss (70 10%) and the greatest total loss of ecosystem services value (£5,019.89 per year).

As for the assessments undertaken for the WTWs, the percentage loss of BNG would be the same for all three potential WTW locations (100%) The [redacted] WTW (proposed WTW for Sunnymeads 1, Maidenhead and Teddington DRA options) would result in the lowest total loss of ecosystem services value (£670.68 per year), while the [redacted] 2 WTW (proposed WTW for Sunnymeads 2a, Walton 2b and Lower Thames Reservoir Transfer 2a) would result in the greatest total loss of ecosystem services value (£1,169.61).

When reviewing the assessments outputs of the pipelines and the proposed WTW locations, the best option overall would be Maidenhead, while the worst one would be Teddington DRA

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 which demonstrates rationale

As such, it is recommended that further investigation into the potential BNG and NC effects should be undertaken at Gate 2 in order to assess the developed pipeline routes and WTW sites and that proposed mitigations and opportunities are further defined to allow consideration in the assessments

[16] Land within close proximity to the existing habitat components that are more likely to be suitable for habitat re-creation for the particular habitat These areas are primarily based on soils but in many cases has been refined by also using other data such as hydrology, altitude and proximity to the coast This is termed the 'Network Enhancement Zone 1' Source: Natural England (2020) https://naturalengland-defra opendata arcgis com/datasets/habitat-networks-combined-habitats-england

6 Wider benefits

6.1 Introduction

Thames Water and Affinity Water, place emphasis on the need to provide public value in their activities [17] 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 Affinity 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 Further information on public engagement is provided in chapter 8 of the Gate 1 report *Stakeholder Engagement* and Annex D of the Gate 1 report *Engagement Report*.

The purpose of this section is to outline the potential social benefits of the T2AT scheme. The environmental assessment guidance[18] 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 T2AT 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.

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

[17] Thames Water (2021), '*What we stand for*' Available at: https://www thameswater co uk/about-us/who-we-are/what-we-stand-for; Affinity Water (2021), '*Corporate Responsibility*' Available at: https://www affinitywater co uk/corporate/about/responsibility#:~:text=Our%20Corporate%20Social%20Responsibility%20('CSR,STEM')%20education%20and%20future%20skills)

[18] Mott MacDonald (2020) All Companies Working Group WRMP environmental assessment guidance and applicability with SROs Document prepared in October 2020 51 pages

companies Many of the considerations that inform this process relate to delivering social benefits:

- 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 Water Industry National Environment Programme (WINEP), which will also deliver landscape, habitat and recreational benefits for people to enjoy.
- 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.

The unit cost of water is inevitably 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 however, environmental and social costs, such as cost of carbon and natural capital (which includes social and amenity values) are integrated into decision-making.

A WRSE research project on '*Customer Preferences to Inform Long term Water Resource Planning*'[19] identified 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 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 want to be 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
- Customers 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 SROs are the right choice for them
- Participants in the study were in favour of SROs as long as the environmental impact is considered and were of the view that efficiency for both cost and water yield would influence their preferences between options

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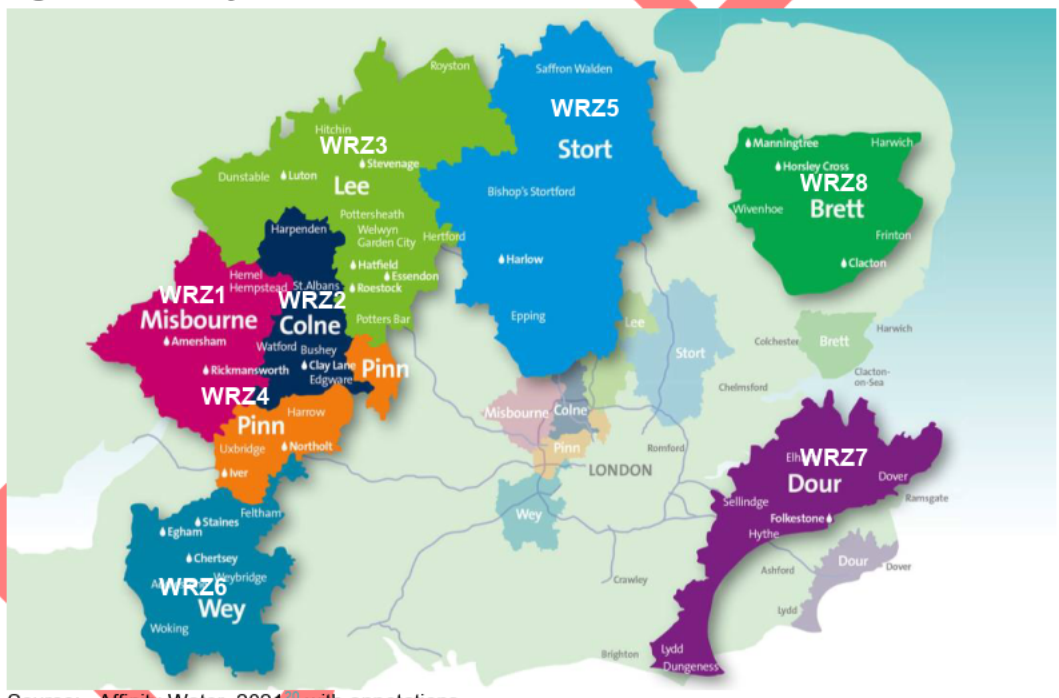
[19] eftec (2021) Customer Preferences to Inform Long-term Water Resource Planning Part B Deliberative Research' WRSE [Only published in draft as at Feb 21 – reference to be updated when final version published]

6 2 2 Sub-regional benefits of additional water supply

Water transfer schemes, such as T2AT, are designed to balance the supply and demand of water over large distances. The transfer is from an area with adequate water resource to an area where resources are more limited This co operative working between Thames Water and Affinity Water, which enables the sharing of water resources, contributes to the efficient use of water resources across the two areas.

The purpose of the T2AT scheme is to contribute to the secure supply, through water transfer, from the south-west to the north-east of Affinity Water's resource area. Within Affinity Water's areas of operation for water supply, there is projected to be population growth. The provision of a secure water supply to the communities of [redacted] and North [redacted] will assist in the delivery of other development required to realise growth aspirations within Affinity Water's water resource zones, such as the provision of 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 water scarcity to business growth and agriculture. A figure of the Affinity Water region is provided in Figure 6.1 below.

Figure 6 1: Affinity Water Water Resource Zones



Source: Affinity Water, 2021[20] with annotations

Avoiding placing additional pressure on local water sources will also benefit the region. The Central region of Affinity Water's resource area takes water from existing Chalk groundwater sources Increasing pressure on these sources can lead to environmental damage The T2AT scheme contributes to the protection of Chalk stream habitats by potentially enabling the future reduction in abstraction from existing Chalk groundwater sources. 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 to the local community.

[20] Affinity Water Ltd. (2021, February 08). Our Supply Area. Retrieved from Affinity Water: https://www.affinitywater.co.uk/my-water/our-supply-area

6 2 3 Localised impacts of T2AT

The T2AT 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 T2AT options. The impacts identified that affect people relate to:

- The route affecting community facilities through the temporary or permanent requirement for land of the community facility or access to the community facility;
- The route affecting open space (including sports facilities, playing fields and allotments) and recreational routes through the temporary or permanent requirements for land of the open space or access to the open space;
- 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 T2AT social impacts

The design of the T2AT route options have 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 T2AT scheme, it is envisaged that mitigation will be implemented during construction, which usually includes:

- Engagement with local communities before and 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.
- Maintenance or diversion of key routes used by the community such as footpaths and pedestrian and cycling routes

The T2AT SEA work also identifies mitigation measures which can be applied as the T2AT options are refined This is likely to include re routing of pipelines to avoid sensitive community facilities and open spaces or avoid some of the parts of community facilities/open space 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

Programmes and initiatives that could be implemented as part of T2AT scheme to deliver public value include are listed below.

- For example, Thames Water's 'Time to Give' programme encourages employees to undertake volunteering in local communities, including activities such as river restoration and school engagement.
- For example, the Affinity Water programme that develops community partnerships by introducing new fixed price and a capped Social Tariff for low income customers.
- 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 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 T2AT scheme, together with the spend by construction workers and contractors in local communities.
- 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 T2AT 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 Environment Net Gain

6 3 1 Approach

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 net environmental 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 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

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 net environmental gain have been considered from the outset of T2AT 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 net environmental gain could be delivered. This allows further work to be undertaken at Gates 2 and 3 to define specific proposals to delivery biodiversity and wider net environmental gain, with this timing linked to the anticipated programme for undertaking baseline field surveys and confirming the T2AT Preferred Design.

6.3.2 Opportunities for environment net gain

Whilst achievement of committed sustainability reductions contributes to the needs case for T2AT, opportunities for net environmental 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 Assessment of opportunities for net zero carbon contributions

7.1 Introduction

This Section reviews and summarises options for integrating the T2AT scheme with Thames Water's and Affinity Water's net zero carbon ambition.

7 1 1 Public Interest Commitments

In 2020 the sector, Water UK released its net zero routemap[21], which laid out a range of decarbonisation options and pathways the sector could look to adopt to move towards net zero emissions English Water companies have made several Public Interest Commitments[22] (PICs) 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 Individual companies are preparing their own net zero plans to be ready by July 2021[23]

The sector net zero commitment does not include capital carbon or user carbon emissions e.g. emissions associated with heating water within households Capital carbon is being addressed separately by the water companies, their regulators 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 T&D losses
- Net emissions taking into account export of surplus renewable generation and purchase of REGO backed green tariff electricity

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

7 1 2 Net Zero ambition what does it mean and how efficiently can it be achieved?

Net Zero reflects an ambition for 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 emissions will be reduced as far as possible and any residual emissions will be counterbalanced by an equivalent sequestration of carbon from the atmosphere

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 net zero is an important

[21] https://www water org uk/routemap2030/
[22] Public Interest Commitment | Water UK
[23] Net Zero 2030 - Strategies for Success (britishwater co uk)

commitment made by the sector, there is also the ongoing duty to deliver this transition cost effectively to maintain efficient and affordable services for customers.

Some companies may choose to set net zero targets across their overall operations, their investment plans or individual 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 the right level to set 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. 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 than purchasing market offsets for a project whose own carbon reductions can only reach 80%) 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 be 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 T2AT, 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 7.4 sets out some of the options for consideration during development of the T2AT transfer scheme to decarbonise and drive towards net zero.

7.2 Methodology

7 2 1 Decarbonisation considerations

The decarbonisation options take into account 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[24] 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 T2AT 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 in this assessment.

7 2 2 Net zero considerations

This section covers the emissions reduction hierarchy from the Water UK routemap (Figure 7 1) and the Carbon Reduction Hierarchy from the Infrastructure Carbon Review (Figure 7.2).

The emissions reduction hierarchy sets out a framework where 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 T2AT 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.

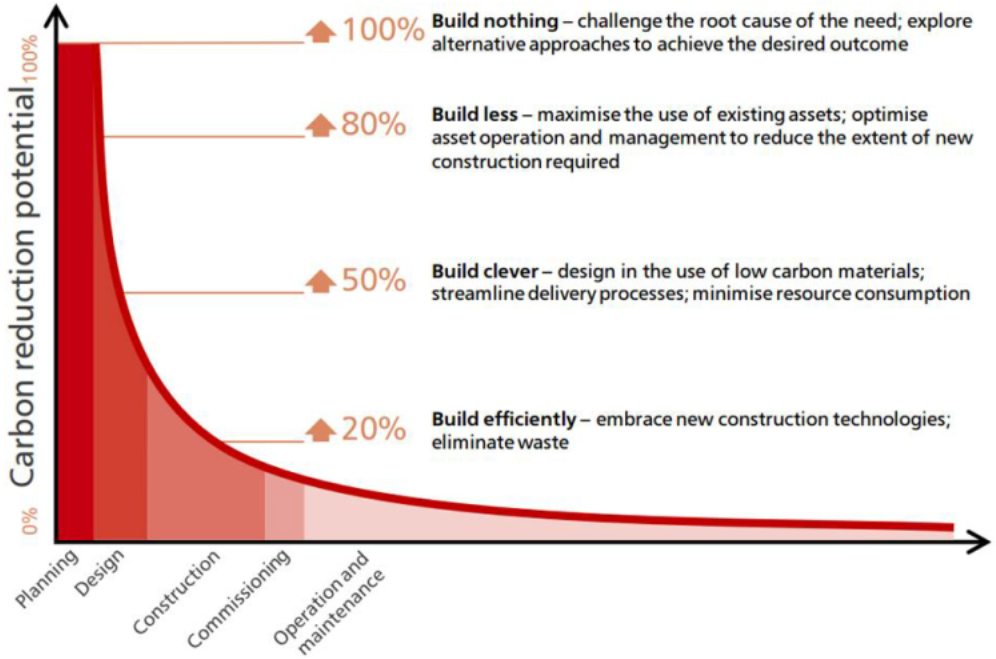
[24] Water resource planning guideline: consultation response summary - GOV UK (www.gov uk)

Figure 7 1: Emissions reduction hierarchy

Source: Water UK Net zero 2030 routemap

The carbon reduction hierarchy sets out emissions reduction opportunities during a project lifecycle into four categories summarised in Figure 7.2. This sets out a framework which looks to identify opportunities to reduce emissions as early as possible within a project lifecycle, where the greatest opportunities to influence carbon reductions are possible

Figure 7.2: Carbon reduction hierarchy



Source: Infrastructure Carbon Review, 2013

The first category 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 The opportunity to build less by using existing assets has been built into the concept design of the options through the following:

- All options deliver to an existing hub which reduces the requirement for new downstream infrastructure
- Options which deliver to [redacted] make use of an existing, unused [redacted]
- The Sunnymeads options make use of the existing [redacted]
- The Lower Thames Reservoir Transfer 2a option makes use of the [redacted], [redacted] and [redacted], and the existing [redacted]

The remaining decarbonisation considerations reviewed in section 7.4 thus focus on the *build clever* and *build efficiently* options for the T2AT transfer options

7.3 Options and baseline carbon estimates

The carbon assessment to determine the capital carbon baseline for the T2AT options was undertaken using the Mott MacDonald Carbon Portal. The portal has been developed by the company's carbon team working with Water UK to deliver the sector's Net Zero route map. They have also worked with the All Company Working Group and Ofwat Net Zero Task and Finish group to determine how carbon and net zero commitments will be incorporated into the SRO planning, which ensures that the approach has been consistent across WRMPs and SROs

Capital carbon emissions have been estimated using the carbon portal. Operational carbon emissions, excluding emissions related to power consumption, have been estimated using the Affinity Water LRMC tool, based on the estimated volumes of chemicals and sludge disposal. Carbon factors were provided by the carbon team where factors were not available within the LRMC tool Emissions relating to power consumption have been calculated separately to enable the WRSE regional model to apply incremental changes in carbon cost of power generation over time.

Table 7 1 and Table 7 2 list the baseline estimates of operational and capital carbon emissions for each option. Figure 7.3, Figure 7.4, Figure 7.5, and Figure 7.6 show the same data in graphical form. Note that the tables and figures only show the carbon footprint of the T2AT transfer option itself Whichever option is selected will require supporting infrastructure both upstream to provide a source and downstream to distribute the transferred flow into the Affinity Water network which will have additional carbon footprint

Table 7 1: Carbon footprint of 50Ml/d options

Option	Operational Carbon Emissions at full capacity)* ('000 tCO_2e/yr)	Capital Carbon Emissions ('000tCO_2e)
Sunnymeads 1	5.8	24
Maidenhead	5.7	22
Teddington DRA	6.5	31
Sunnymeads 2a	5.7	26
Walton 2b/Mogden Reuse Indirect 3	6.9	38
Lower Thames Reservoir 2a	5.3	20
Beckton Indirect Reuse	5.3	23

*Estimated based on WRSE upload MWh/yr and using the CAW v14 grid power emissions factor of 0 277kg/kWh including transmissions and distribution losses.

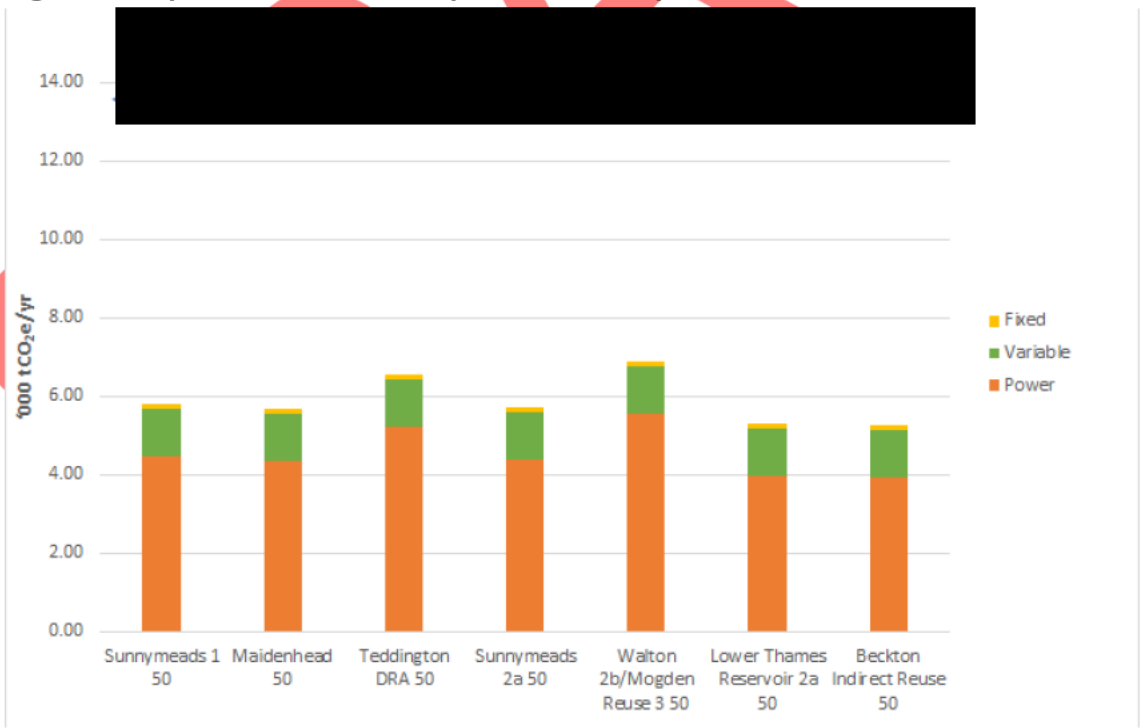
Table 7 2: Carbon footprint of 100Ml/d options

Option	Operational Carbon Emissions at full capacity)* ('000 tCO_2e/yr)	Capital Carbon Emissions ('000tCO_2e)
Sunnymeads 1	10.7	40
Maidenhead	10 4	38
Teddington DRA	11.8	52
Sunnymeads 2a	10 6	43
Walton 2b/Mogden Reuse Indirect 3	12.1	64
Lower Thames Reservoir 2a	10 1	33
Beckton Indirect Reuse 100	9.8	39

*Estimated based on WRSE upload MWh/yr and using the CAW v14 grid power emissions factor of 0 277kg/kWh including transmissions and distribution losses.

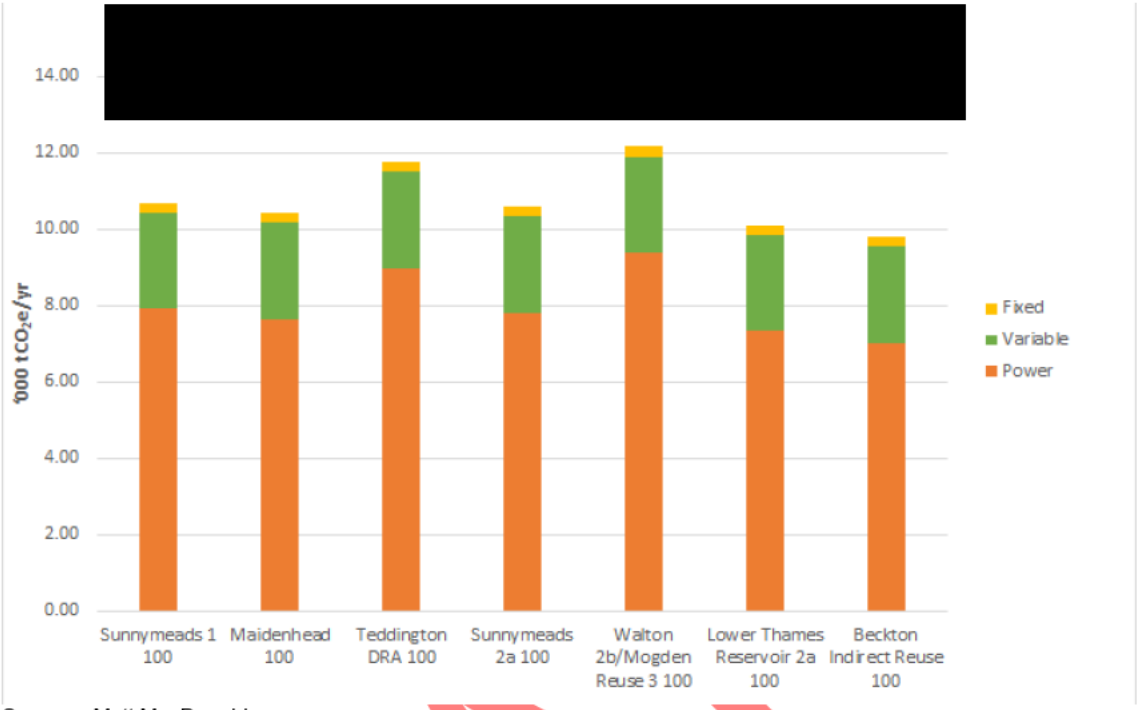
In the breakdown of operational carbon shown in Figure 7.3 and Figure 7.4 the fixed carbon footprint relates to items such as maintenance and lighting which do not vary with the amount the scheme is used. The variable footprint relates to such items as chemical use which are proportional to the amount of water treated and transferred. The power cost is also variable and is overwhelmingly associated with pumping water through the transfer pipelines Both variable and power footprints are shown as if the options were operating at 100% of capacity from the day they are commissioned. In practice, the utilisation of the scheme will rise gradually over time to match increasing demands and sustainability reductions, and also change from year to year depending on weather related demand and source fluctuations.

Figure 7.3: Operational carbon footprint of 50Ml/d options



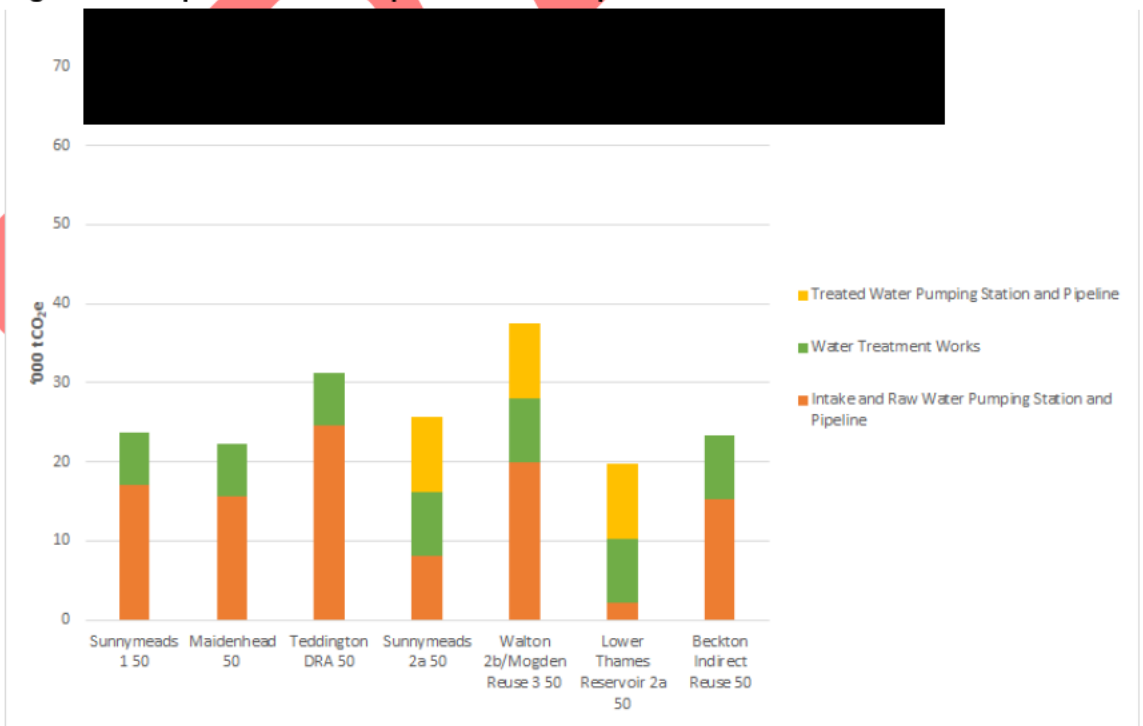
Source: Mott MacDonald

Figure 7 4: Operational carbon footprint of 100Ml/d options



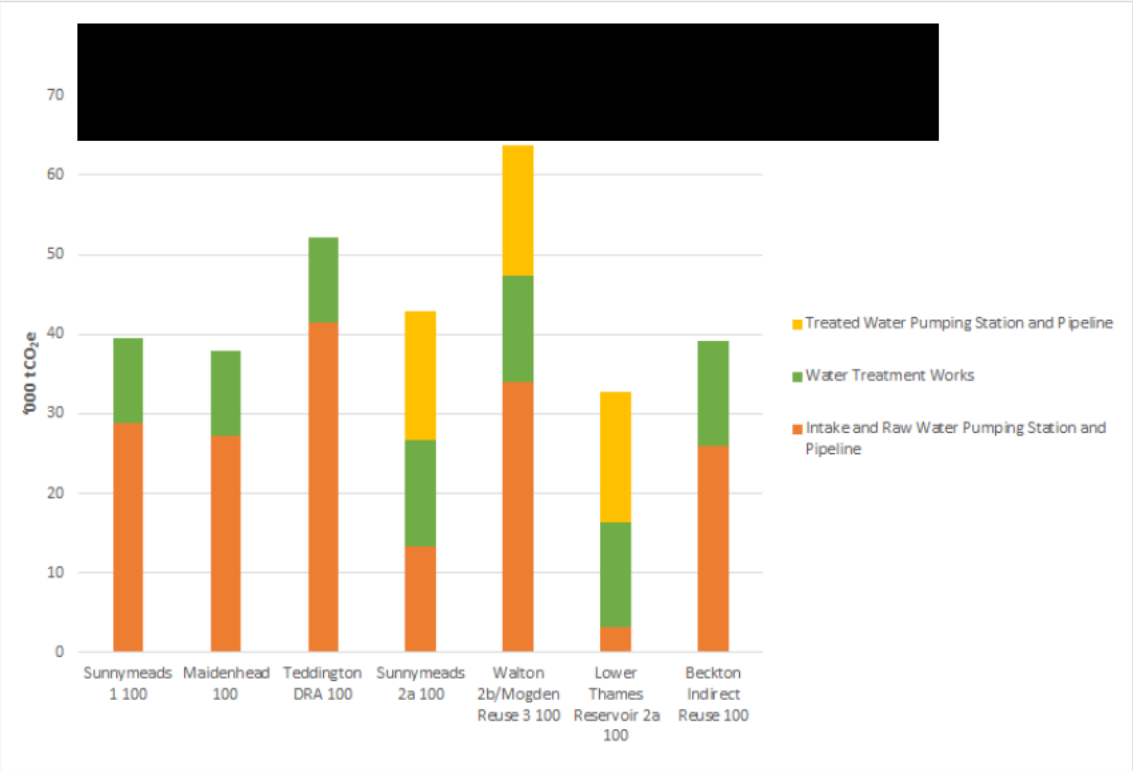
Source: Mott MacDonald

Figure 7 5: Capital carbon footprint of 50Ml/d options



Source: Mott MacDonald

Figure 7 6: Capital carbon footprint of 100Ml/d options



Source: Mott MacDonald

The above estimates in Figures 7.3 to 7.6 show that over the lifetime of the scheme the highest carbon emissions will be related to power use Some mitigation of this will occur over time as the electricity grid is decarbonised. Although this is not shown in the figures above it is taken into account in the WRSE regional modelling. Whichever option is selected there will need to be a focus on carbon optimisation, balancing the capital carbon which increases with pipe diameter, with the operational carbon which falls with increasing pipe diameter. A parallel assessment will be carried out for the scheme capital and operating cost and the final selection of pipe diameter will result from considering both factors

As expected, the higher capital and operational carbon footprints are associated with the longer pipelines, such as are required for the Walton 2b, Mogden Reuse Indirect 3 and Teddington DRA options, because these options will entail both more material and higher pumping head to overcome friction losses.

The lowest capital carbon is associated with the LTR options because of the use of the [redacted] and the [redacted], avoiding construction of 6km of new pipeline.

Both the LTR and the Beckton Reuse options have an operational carbon footprint which is lower than the other options, however it must be remembered that in both cases pumping is required which is not accounted for in the T2AT scheme; for the LTR options water has to be lifted from the River Thames into reservoirs, for the Beckton Reuse options water has to be transferred from [redacted] or [redacted] This will be taken into account in the WRSE regional modelling to identify the optimum combination of schemes.

Table 7.1 highlights that the majority of the embodied and operational carbon sits within the construction and pumping associated with the transfer pipelines

7 3 1 Establishing carbon hotspots

A key part of delivering an efficient net zero strategy is to focus efforts on where the 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 the capital carbon baseline footprint has been reviewed for each of the options based on the concept design scope 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 and how these might be mitigated.

Capital carbon hotspots

A summary of capital carbon hotspots 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;
- Transport of materials to site;
- Disposal of construction waste

Operational carbon hotspots

Operational hotspots include:

- Operational power consumption associated with pumping water and water treatment;
- Chemical consumption[25] at associated treatment works; and
- Maintenance emissions

7.4 T2AT Decarbonisation considerations

The following sections set out some considerations that the T2AT transfer options could take to decarbonise and drive towards net zero.

7 4 1 Material specification and procurement

The carbon intensity of the materials and products involved in the delivery of the T2AT options will play an important role in overall carbon footprint of the options. 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 options it is important to engage and challenge the supply chain to deliver products that meet performance specifications at the lowest carbon intensities possible

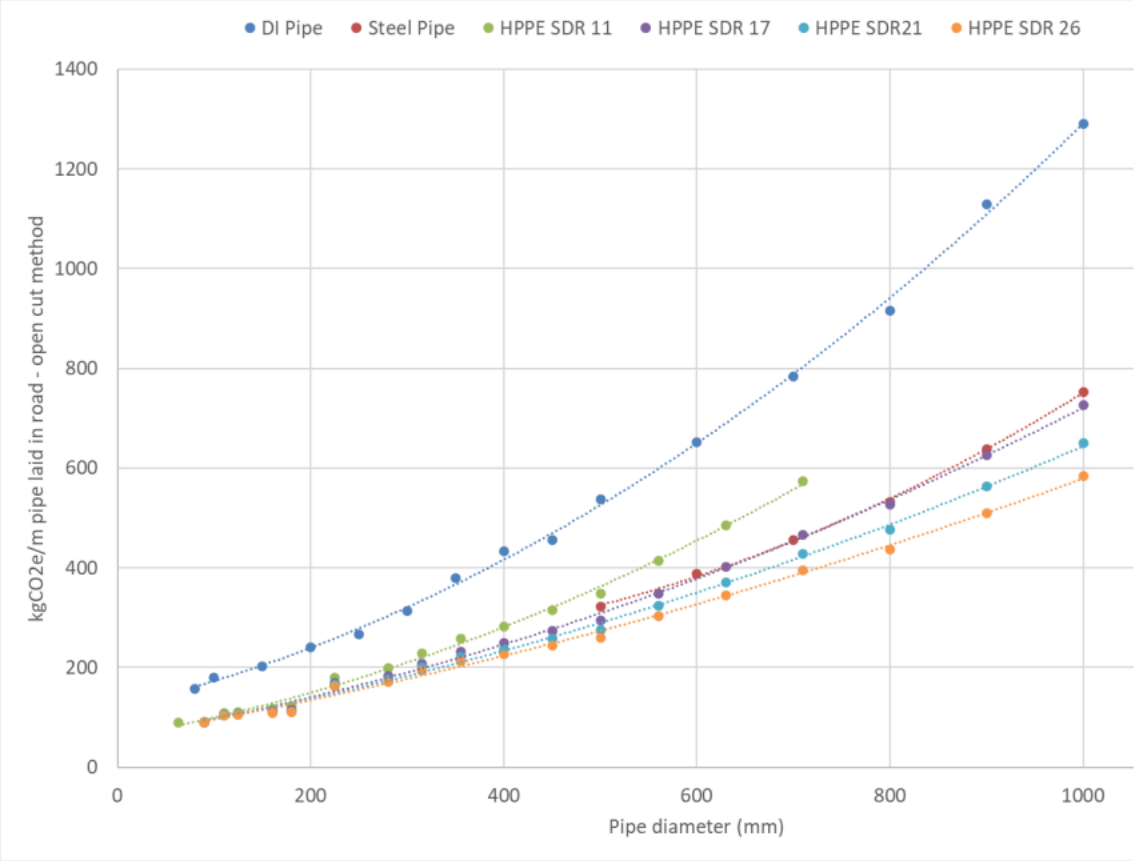
For example, for large pipeline projects the pipe materials, excavation, and reinstatement activities along with concrete and steel in any treatment or pumping station assets are going to be key sources of capital carbon emissions

Pipe materials have significantly different embodied carbon intensities but also different characteristics that may affect whole life maintenance and operational carbon performance Figure 7 7 provides a summary of estimated embodied carbon impact of different pipe materials

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

laid in road This is based on general industry estimates on excavation, reinstatement, plant fuel, materials disposal values and emissions factor data from the Inventory of Carbon and Energy (ICE) v2 and Civil Engineering Standard Method of Measurement (CESMM) 4 Carbon and Price book It shows that HDPE pipes tend to have a significantly lower embodied carbon impact than Ductile Iron (DI) and Steel. However, the diameter of the transfer pipelines is [redacted] and the higher SDR pipes will not be suitable for the pressures required There are also constructability, durability and whole life maintenance considerations that would need to be considered in more detail before making a decision.

Figure 7 7: Overview of estimated embodied carbon impact of different pipe materials



Source: Mott MacDonald Moata Carbon Portal data analysis

Even with similar materials the carbon intensity varies significantly depending 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, some PVC O pipe manufacturers claim their pipes require 30-50% less energy to manufacture than typical PVC and PE pipes. Therefore, 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 what the carbon intensities of their products are;
- Identifying whether lower carbon alternatives are available;
- Develop appropriate material carbon intensity specifications based on materials and products available in the market; and
- 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 T2AT 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; and
- 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 treatment chemicals, which can be a significant part of operational and whole life carbon emissions for water treatment schemes.

7 4 2 Efficient construction approaches and waste minimisation

The generation of waste and the requirement to dispose of it can generate significant emissions on construction projects, and significant costs Specifying particular construction techniques, such as modular and off-site manufacture can help reduce the amount of waste associated with construction projects and hence reduce carbon emissions, whilst at the same time 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 reuse waste either within the project site boundary or 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 waste disposal.

7 4 3 Low carbon construction plant

The T2AT 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; or
- Electric

There are likely to be significant barriers to adopting 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[26] 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.

7.4.4 Optimising energy efficiency and maintenance activities

The design teams 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 product with the optimum balance between cost, 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 improve performance of pumping assets and optimise energy consumption

Beyond Gate2, 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

Another factor which could provide greater operational carbon efficiency is to design the scheme to enable pumping to be carried out during off-peak periods. This would entail making greater use of available storage further downstream in the system and require larger pumping plant and pipeline capacity. Hence there is an capital carbon, cost and resilience penalty that would need to be balanced against the potential benefit.

Consideration should also be given to what addition external systems may affect the operation of the transfer scheme and affect 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 4 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 Renewable Energy Guarantees of Origin (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,

[26] Decarbonising Transport: Setting the Challenge (publishing service gov uk)

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 Business, Energy and Industrial Strategy (BEIS) grid carbon intensity forecasts[27] 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 T2AT 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 4 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 scope 3 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 and 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 BNG 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.

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 T2AT options

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

7.5 Recommendations and next steps

This report sets out a range of considerations and opportunities to help the T2AT scheme decarbonise and drive towards net zero emissions. This includes understanding scheme carbon emissions sources, challenging these through value engineering sessions and engaging into the broader supply chain to identify and implement lower carbon opportunities/technologies However, there is significant effort required to turn these opportunities into realised emissions reductions.

The key recommendations for next steps are:

1. A clear carbon management process be embedded into the option development process to identify low carbon opportunities and track them through to implementation (as is being implemented via the WRSE regional plan and individual company WRMPs)
2. The 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.
3 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
4. 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.

8 Comparison between options and summary conclusions

8.1 Comparison and conclusions

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 Appropriate Assessment undertaken for Maidenhead, Teddington DRA and Lower Thames Reservoir Transfer 2a options did not identify any transmission pathways by which a Likely Significant Effect could reasonably occur No key risks to Habitats Sites were identified during construction or operation of these options.

The HRA Appropriate Assessment undertaken for Sunnymeads 1, Sunnymeads 2a, Walton 2b and Beckton Reuse Indirect options identified transmission pathways, but concluded that no significant effects are foreseeable on the integrity of the following Habitats Sites if the suggested mitigation measures are observed

The Level 1 WFD assessment completed on all options indicated that Sunnymeads 1, Sunnymeads 2a, Lower Thames Reservoir Transfer 2a and Beckton Reuse Indirect options are anticipated to have very low risks of being non compliant with WFD objectives, therefore a further WFD assessment was not required for these options. Level 2 WFD assessments were completed for components of Maidenhead, Teddington DRA and Walton 2b options. For these three options, further WFD assessment will be required; the areas for future focus include consultation with the Environment Agency, data collation and review of Heavily Modified Waterbody measures and baseline data concerning WFD biological, physiochemical and hydromorphological elements, development of a conceptual model, further information on the design and operation of the options, and assessment of the combined effects of multiple options.

Based on the WRSE SEA outputs for residual effects (post mitigation), all options are predicted to generally result in the same minor positive, neutral or minor negative effects across all the SEA objectives, with the following exceptions:

- Biodiversity: The assessment outputs vary in the construction phase only The residual effects on biodiversity during construction are likely to be greater for Sunnymeads 1, Sunnymeads 2a, Walton 2b and Lower Thames Reservoir Transfer 2a options as a major residual effect is likely compared with a moderate effect on Maidenhead, Teddington DRA and Beckton Reuse Indirect options. No operational residual effects are expected on any of the options
- Soil: There is a potential for the construction and operation of Sunnymeads 1, Maidenhead, Teddington DRA and Beckton Reuse Indirect options to result in residual minor effects on soil No residual effect on soil is expected from the construction or operation of Sunnymeads 2a, Walton 2b or Lower Thames Reservoir Transfer 2a options
- Water: All options are likely to result in a residual operational effect on the objective of protecting and enhancing the quality of the water environment and water resources The operation of Sunnymeads 1, Teddington DRA, Sunnymeads 2a, Lower Thames Reservoir Transfer 2a and Beckton Reuse Indirect options would result in a minor residual effect, while the operation of Maidenhead and Walton 2b options would result in a moderate residual effect on water. No construction residual effects are expected on any of the options.

- Climatic factors: The operation of Sunnymeads 1 and Teddington DRA options would likely result in a major residual effect on carbon emissions, while the operation of all the other options would likely result in a moderate residual effect on carbon emissions.

Additional assessment considering local level data has been undertaken in line with the methodology in the All Companies Working Group (ACWG) Water Resource Management Plan (WRMP) environmental assessment guidance and applicability with SROs, October 2020.

In addition to WRSE assessment, an additional assessment was undertaken to consider local level data such as local wildlife sites. The local level data findings show that all options intersect or lie within 200m of a number of LWS or TPO. While direct loss may occur, the impact of the route on LWS and TPO will be reviewed at Gate 2 following the refinement of the routes and identification of mitigation to be put in place in order to reduce the potential effects on these areas.

The WRSE findings and additional assessment show the potential residual impact of all options is similar. Overall, Lower Thames Reservoir Transfer 2a and Beckton Reuse Indirect options performed slightly better while Sunnymeads 1 and Walton 2b options performed slightly worse

An Invasive Non Native Species (INNS) risk assessment was undertaken to screen, at a high level, and conduct an initial assessment of the INNS risk for the T2AT raw water transfer options, as the transfer of raw water from one location to another may increase the risk of spreading 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 Additionally, the presence of INNS in water company assets may compromise the supply of drinking water and the safe return of treated wastewater to the environment. The results of the high-level screening against the freshwater INNS invasion heatmap was the same for all T2AT options, with an indicative 'medium' risk of Ponto-Caspian invasions The future marine invasion risk of all source waters was classed as 'low', except for the Teddington DRA option, which being close to the tidal limit was precautionarily classed as 'high' risk The impact of all options on freshwater inflows, salinity within the Thames estuary, and resulting impacts on the distribution of invasive species, require further consideration.

High-level BNG and NC assessments were undertaken on the proposed pipeline routes and locations for the WTW for all options For each option, an assessment of the potential impact of construction and operation of the option on each NC stock was undertaken, using the BNG metric. The NC metrics were then quantified as ecosystem services in order to provide monetised values for NC benefit or loss The assessments identified the following:

- NC: The pipelines of all options are likely to generate a permanent loss of high value NC stocks broadleaved mixed woodland, coniferous woodland, and orchards and top fruit, while the WTWs are likely to result in a permanent loss of pastures
- BNG: The pipelines of 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 The construction of the WTWs are expected to result in a loss of BNG units due to habitat clearance.
- Ecosystem services: The pipelines for all options are likely to generate the permanent loss of NC stocks associated with the provision of several ecosystem services However, if the sites are returned to pre-construction condition following best practice techniques then there should be no permanent impact on ecosystem services provision from stocks other than woodland. There are opportunities to improve existing habitats along the route through post-construction planting. The construction of the WTW for all options is expected to cause the loss of several ecosystem services namely carbon storage and food production As the proposed WTWs are located within the Network enhancement zone 1, a suitable opportunity would be to create new woodland as part of these options.

When reviewing the assessments outputs of the pipelines and the proposed WTW locations, the best option overall, from a BNG/NC perspective, would be Maidenhead, while the worst one would be Teddington DRA.

The opportunities identified in the NC/BNG assessment have the potential to contribute to Government ambitions for environmental 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 between natural systems and social uses of land.

Potential social benefits of the T2AT scheme are presented in this report. The section on 'wider benefits' summarises the potential social benefits water transfer schemes as well as scheme options and details potential mitigation. While the T2AT options have been developed with the aim of avoiding impacts on people, for all options, there is the potential that even with mitigation, there may be temporary disruption for communities Programmes and initiatives which could be implemented as part of T2AT scheme to deliver public value are detailed in this section.

A high level carbon assessment was undertaken to review and summarise the net zero considerations for the T2AT options The assessment includes measures which should be considered to mitigate capital carbon emissions and operational carbon emissions, and how residual emissions could be tackled to get to net zero carbon emissions. The embedded carbon footprint of most options is similar with the Lower Thames Reservoir option being significantly lower than other options and the Walton 2b and Teddington options being somewhat higher than the others Operational carbon footprint, which will be more significant than embedded carbon over time, is broadly similar across the options. The ideas provided in the assessment 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 to start to decarbonise these It is recommended a robust carbon management process is embedded into the scheme development to ensure ideas are developed into opportunities

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.

Table 8.1 below provides a summary of the assessments for each option

Table 8 1: Summary of the assessments for the T2AT options

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
Sunnymeads 1	Transmission pathways identified, however no significant effects expected if mitigation measures implemented	Only WFD level 1 - very low risks of non-compliance	Potential residual effects similar for all options - but this option performed slightly worse.	Same for all options (no risk of INNS spread)	All options similar	Same for all options	Embodied Carbon – similar to most other options. Operational carbon – similar across all options.
Maidenhead	No transmission pathways - No likely significant effects	Level 2 completed and further assessment needed	Potential residual effects similar for all options	Same for all options (no risk of INNS spread)	All options similar - best overall	Same for all options	Embodied Carbon – similar to most other options. Operational carbon – similar across all options.
Teddington DRA	No transmission pathways - No likely significant effects	Level 2 completed and further assessment needed	Potential residual effects similar for all options	Same for all options (no risk of INNS spread)	All options similar - worst overall	Same for all options	Embodied Carbon higher than other options. Operational carbon – similar across all options.
Sunnymeads 2a	Transmission pathways identified, however no significant effects expected if mitigation measures implemented	Only WFD level 1 - very low risks of non-compliance	Potential residual effects similar for all options	Same for all options (no risk of INNS spread)	All options similar	Same for all options	Embodied Carbon similar to most other options Operational carbon – similar across all options.
Walton 2b	Transmission pathways identified, however no significant effects expected if mitigation measures implemented	Level 2 completed and further assessment needed	Potential residual effects similar for all options - but this option performed slightly worse.	Same for all options (no risk of INNS spread)	All options similar	Same for all options	Embodied Carbon – higher than other options. Operational carbon – similar across all options.
Lower Thames Reservoir Transfer 2a	No transmission pathways - No likely significant effects	Only WFD level 1 - very low risks of non-compliance	Potential residual effects similar for all options - but this option performed slightly better	Same for all options (no risk of INNS spread)	All options similar	Same for all options	Embodied Carbon – significantly lower than other options. Operational carbon – similar across all options
Beckton Reuse Indirect	Transmission pathways identified, however no significant effects expected if mitigation measures implemented	Only WFD level 1 - very low risks of non-compliance	Potential residual effects similar for all options - but this option performed slightly better.	Same for all options (no risk of INNS spread)	All options similar	Same for all options	Embodied Carbon – similar to most other options. Operational carbon – similar across all options.

8.2 Mitigations and next steps

The assessments undertaken as part of this SRO have identified a number of areas where mitigation of the impacts of the scheme should be further developed:

The opportunity for pipeline routes to be refined and re-routed in order to avoid entering Conservation Areas and to avoid sensitive community facilities

Further opportunities for directional drilling should be explored, in order to avoid or reduce likely effects on watercourses and sensitive community facilities Detailed assessments on the construction methods should be carried out to confirm these methods would reduce the impact to an acceptable level.

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 the use of high efficiency pumps and operating regimes which keep peak flows to a minimum

A. WRSE NC and BNG output tables

The WRSE NC and BNG outputs are available on [redacted]

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