MOTT MACDONALD

Anglian to Affinity Transfer Strategic Regional Option - A2AT Environment Assessment Report

RAPID Gate 1 submission - Annex 2A

June 2021

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Abbreviations

Acronym	Definition
ACWG	All Companies Working Group
A2AT	Anglian to Affinity Transfer
BEIS	Business, Energy, and Industrial Strategy
BNG	Biodiversity Net Gain
CAW	Carbon Accounting Workbook
CESMM	Civil Engineering Standard Method of Measurement
CWS	County Wildlife Sites
CRT	Canal and Rivers Trust
DEFRA	Department for Environment, Food and Rural Affairs
DI	Ductile Iron
EAR	Environment Assessment Report
GEP	Good Ecological Potential
GHG	Green House Gas
HMWB	Heavily Modified Waterbody
HGV	Heavy Goods Vehicle
HRA	Habitats Regulations Assessment
ICE	Inventory of Carbon and Energy
INNS	Invasive Non-Native Species
LRMC	Long Run Marginal Cost
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
SINC	Site of Importance for Nature Conservation
SNCI	Sites of Nature Conservation Importance
SPA	Special Protection Area
SR	Service Reservoir
SRO	Strategic Regional Option
TPO	Tree Preservation Order
VSD	Variable Speed Drive

Acronym	Definition
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
WRE	Water Resources East
WRSE	Water Resources South East
WRZ	Water Resources Zone
ZOI	Zone of Influence

Executive summary

The Environment Assessment Report (EAR) supports the Gate 1 submission report to the Regulators' Alliance for Progressing Infrastructure Development (RAPID) for the Anglian Water to Affinity Water Transfer (A2AT) Strategic Regional Option (SRO).

Four options have been assessed for the Gate 1 submission. The options are the following:

- Fens Reservoir option
- The South Lincolnshire Reservoir (SLR) to Preston option
- The SLR to WRZ5 Hub option
- The River Trent option.

These options would enable the transfer water from the east Midlands/East Anglia region to either Preston or the Uttlesford area, in the Affinity Region.

While A2AT is a Water Resources East (WRE) scheme, the initial assessments to support the Gate 1 submission were undertaken using the method developed for use on the Water Resources South East (WRSE) regional programme. The WRE environmental assessment approach is currently being finalised following completion of the Integrated Environmental Assessment scoping consultation exercise. It is expected that the WRE methodology will be used to support the work for Gate 2 submission. As the WRSE and WRE methodologies are directly comparable, this will not invalidate the Gate 1 assessments undertaken for the A2AT SRO.

Three regulatory assessments have been completed for the A2AT options:

- Habitats Regulations Assessment (HRA)
- Water Framework Directive Assessment (WFD), and
- Strategic Environmental Assessment (SEA).

The regulatory assessments are summarised in this report and the full assessments are presented as standalone documents: the A2AT *Habitats Regulations Assessment*, the A2AT *Water Framework Directive Assessment* and the A2AT *Strategic Environmental Assessment* respectively). In addition to the regulatory assessments, the four options have been assessed in respect of:

- Invasive Non-Native Species risk assessment
- Natural Capital and Biodiversity Net Gain
- Wider benefits
- Opportunities for net zero carbon contributions

Habitats Regulations Assessment

The HRA Appropriate Assessment undertaken for the Fens Reservoir option 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 this option.

The Appropriate Assessment undertaken for the SLR to Preston option identified a transmission pathway to the Ouse Washes SPA/Ramsar site/SAC where the pipeline is required to cross the River Great Ouse, but concluded that no significant adverse effects on the integrity of the Habitats Site are foreseeable if the identified mitigation measures are observed.

For the River Trent option, significant adverse effects have been identified on the Humber Estuary Ramsar site/SAC: the potential reduction in flows on the River Trent, as a result of the new licenced abstraction at East Bridgford, would likely affect the behaviour of river and sea lamprey. Further hydrological modelling is required to understand the impact of abstraction on surface water levels and flows, and a full investigation into the indirect impacts on migratory fish behaviour is required. Other significant adverse effects have been identified on Rutland Water SPA/Ramsar site: residual effects would occur during construction of the pipeline, pumping station and new WTW in and directly adjacent to the reservoir. Further noise and hydrogeological investigation to ensure construction-related effects are negated will be required. Relocating the pumping station and WTW at least 500m from the boundary of Rutland Water is recommended to reduce the significance of construction-related disturbance, especially from visual and noise impacts. A hydrological modelling assessment will also be required to understand the impact of the alteration in abstraction regime on surface water levels in the reservoir and the indirect impact this will have on usable habitat to qualifying bird species.

For the SLR to WRZ5 Hub option, the Appropriate Assessment identified the potential for significant adverse effects on the Nene Washes SPA/Ramsar site/SAC which cannot be fully excluded at this stage. The effects relate to the location of the pipeline corridor within the boundary of the designated site. The consequential impacts on habitats and qualifying bird and fish species as a result of construction activities and potential pollution events during operation are certain. In order to avoid onerous further assessment where there is uncertainty in the outcome, it is recommended that consideration be given to rerouting the pipeline corridor to avoid the Nene Washes altogether at this stage. If this is not possible, further investigation of the impacts through a detailed project-stage HRA, informed by baseline surveys, and further hydrological and noise assessments will be required.

As options develop, should adverse effects on the integrity of the designated sites remain, the options would need to be granted derogation.

Water Framework Directive Assessment

The Level 1 WFD assessment completed on all options indicated that the Fens Reservoir, SLR to Preston and the SLR to WRZ5 Hub 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. A Level 2 WFD assessment was completed for components of the River Trent option. For this option, 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 (HMWB) measures and baseline data concerning WFD biological, physiochemical and hydromorphological elements, development of a conceptual model, and further information on the design and operation of the options.

Strategic Environmental Assessment

Based on the SEA outputs for residual effects (post mitigation), the options rated the same across the SEA objectives, with the following exceptions:

- Biodiversity: construction of the Fens Reservoir and SLR to Preston options would result in moderate negative residual effects while construction of the SLR to WRZ5 Hub and River Trent options would result in major negative residual effects on biodiversity. Operation of the SLR to Preston, SLR to WRZ5 Hub and River Trent options would result in moderate negative residual effects while operation of the Fens Reservoir option would not impact on biodiversity.
- Water: while all options would result in minor negative residual effects on resilience and flood risk during construction, only the Fens Reservoir option would result in minor negative residual effects during operation. Regarding the impact of the options on water quality and

water resources, the River Trent option is the only option which would likely result in negative residual effects (moderate negative effects during construction and neutral effects during operation); none of the other options would have an adverse effect on water resources.

- Climatic factors: while construction of all options would result in minor negative residual effects on carbon emissions, operation of the Fens Reservoir, SLR to Preston and SLR to WRZ5 Hub options would result in moderate negative residual effects on carbon emissions while operation of the River Trent option would result in major negative residual effects. Regarding the vulnerability to climate change risks, there are no residual effects expected from any of the options during construction. However operation of the SLR to WRZ5 Hub and River Trent options would result in minor negative residual effects, while the Fens Reservoir and SLR to Preston options would not impact on the vulnerability to climate change.
- Landscape: construction of all options would result in minor negative residual effects on the landscape and visual amenity. Operation of the SLR to Preston, SLR to WRZ5 Hub and River Trent options would result in minor negative residual effects while operation of the Fens Reservoir option would not impact on landscape and visual amenity.

Additional assessment considering local level data has been undertaken in-line with the methodology in the All Companies Working Group (ACWG)[1]

The local level data findings show that all options intersect or lie within 200m of a number of locally important wildlife sites (including Local Wildlife Sites (LWS), Sites of Importance for Nature Conservation (SINCs), Sites of Nature Conservation Importance (SNCIs) and County Wildlife Sites (CWS)) and Tree Preservation Orders (TPO). All options except the Fens Reservoir option intersect or lie within 200m of Conservation Areas. Mitigation can be put in place in order to reduce the potential effects on these areas.

The SEA findings and additional assessment show potential residual impact for all options, with the Fens Reservoir option performing slightly better and the River Trent option performing worse.

Invasive Non-Native Species risk assessment

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 A2AT raw water transfer options, prior to applying mitigation, 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 requirement to conduct an INNS risk assessment relates only to raw water transfers.

Of the four proposed A2AT options, only the River Trent option involves the transfer of raw water. The results from both the high-level screening and risk assessment tool components of the assessment suggest that there is a significant INNS risk associated with raw water transfer between the River Trent and Rutland Water. Mitigation measures would have to be developed to eliminate or minimise the INNS risk if this option is selected.

Note that in response to the INNS risk assessment the River Trent option includes for an INNS treatment plant at the River Trent intake including clarification and rapid gravity filters to minimise the risk of INNS transfer.

All Companies Working Group (2020). WRMP environmental assessment guidance and applicability with SROs. Guidance prepared in October 2020.

Natural Capital and Biodiversity Net Gain

High-level Biodiversity Net Gain (BNG) and Natural Capital (NC) assessments were undertaken on the proposed pipeline routes and locations 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 BNG metrics were then quantified as ecosystem services in order to provide monetised values for NC benefit or loss. The assessments identified the following:

- NC: all options are likely to generate a temporary loss of arable farmland stocks.
- BNG: all options are likely to result in a loss of BNG habitat units due to the removal of habitats during construction.
- Ecosystem services: all options are likely to generate the permanent loss of NC stocks associated with the provision of several ecosystem services, namely carbon storage, natural hazard management and food production. However, construction is not expected to affect the future value as stocks are expected to be reinstated.

When reviewing the assessment outputs, the best option overall would be the SLR to Preston option, while the worst option would be the River Trent option.

The opportunities identified in the BNG/NC assessment have the potential to contribute to Government ambitions for environmental net gain. This could take the form of habitat compensation, 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.

Wider Benefits

Potential social benefits of the A2AT scheme are presented in this report. The section on ‘wider benefits’ summarises the potential social benefits of water transfer schemes as well as scheme options and details potential mitigation. For customers and communities, these benefits include the opportunity to develop plans that avoid water use restrictions without damaging the environment. For the region, the benefits include the chance to balance the supply and demand of water, to promote the cooperate working between two water companies and to contribute to the efficient use of water resources. And for the local communities, the benefits include the possibility to implement programmes and initiatives, to promote job and training and the opportunity for the companies in the supply chain to provide social value.

While the A2AT 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 A2AT scheme to deliver public value are detailed in this section.

Opportunities for net zero carbon contributions

A high-level carbon assessment was undertaken to review and summarise the net zero considerations for the A2AT 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 is the lowest for the Fens Reservoir option and the greatest for the River Trent option. Operational carbon footprint, which will be more significant than embedded carbon over the life of the scheme, is broadly similar across the SLR to Preston, SLR to WRZ5 Hub and Fens Reservoir options, with a greater footprint for the River Trent option. The net zero considerations provided in section 7.4 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 plan to ensure ideas are developed into opportunities.

The combination of these assessments and studies shows that while positive benefits are likely to 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 also be likely to result in some negative effects, even with mitigation applied.

1 Introduction

1.1 Overview

This report accompanies the Gate 1 submission to RAPID for the A2AT scheme.

1.2 A2AT options

The outputs of the route options screening identified four unconstrained options for transferring water to Affinity Water's Central region, from the Anglian Water region. These options are shown in Table 1.1. Further details on the options are set out in Section 2.

Table 1.1: A2AT options

Option name	Description overview
Fens Reservoir	Abstraction of raw water from the proposed Fens Reservoir, and treatment at a new WTW. The treated water would then be pumped, via a break tank and intermediate pumping station, to a conditioning plant in WRZ5 – Stort (henceforth called WRZ5 Hub). The treated water would feed a new SR servicing supply zone WRZ5, Stort, in the Affinity Water network.
SLR to Preston	Abstraction of raw water from the proposed South Lincolnshire Reservoir where it would be treated at a new WTW and transferred to a break tank and pumping station near Etton Service Reservoir. The potable water would then be pumped, via an intermediate break tank and pumping station, to Sundon WTW for conditioning. From Sundon, the water would be transferred to Preston SR in WRZ3 for further distribution into the Affinity network.
SLR to WRZ5 Hub	Abstraction of raw water from the proposed South Lincolnshire Reservoir, and conveyance to a new SLR WTW. The treated water would then be pumped, via a break tank and intermediate pumping station, to a conditioning plant in WRZ5 – Stort (henceforth called WRZ5 Hub). The treated water would feed a new SR servicing supply zone WRZ5, Stort, in the Affinity Water network.
River Trent	Abstraction of raw water from the River Trent in the vicinity of East Bridgford, where it would be partially treated to prevent Invasive Non-Native Species (INNS) transfer. The partially treated water would then be transferred via a pipeline to Rutland Water. A new draw-off arrangement and WTW at Rutland Water would abstract, treat, and pump water from Rutland Water to Sundon WTW for conditioning, via an intermediate break tank and pumping station near Grafham. From Sundon, the water would be transferred to Preston SR in WRZ3 for further distribution into the Affinity network.

1.3 Structure of the report

This document presents:

- Section 2 Scheme Description: An overview of each of the four A2AT options.
- Section 3 Regulatory Assessment Reports: Information on the regulatory assessments undertaken as part of the Gate 1 submission including HRA, WFD and SEA.
- 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 social assessment undertaken on the options.
- Section 7 Assessment of opportunities for net zero carbon contributions: High level carbon assessment undertaken for the A2AT scheme.
- Section 8 Comparison between options and summary conclusions.

2 Scheme Description

2.1 Overview

The aim of the A2AT scheme is to address long term water deficits in Affinity Water's Central region, with the objective of abstracting available raw water from the Anglian Water region, treating it to potable water standards and delivering to Affinity Water customers in WRZ3 and WRZ5 (Lee and Stort communities, respectively). Potential sources of raw water are the River Trent, proposed South Lincolnshire Reservoir, and proposed Fens Reservoir. Treated water would be delivered to one of two existing distribution points: Preston Service Reservoir in WRZ3 or a new hub in WRZ5.

A full scheme description can be found in the A2AT *Concept Design Report*, however a summary of the main aspects of the options is included below:

2.2 Option descriptions

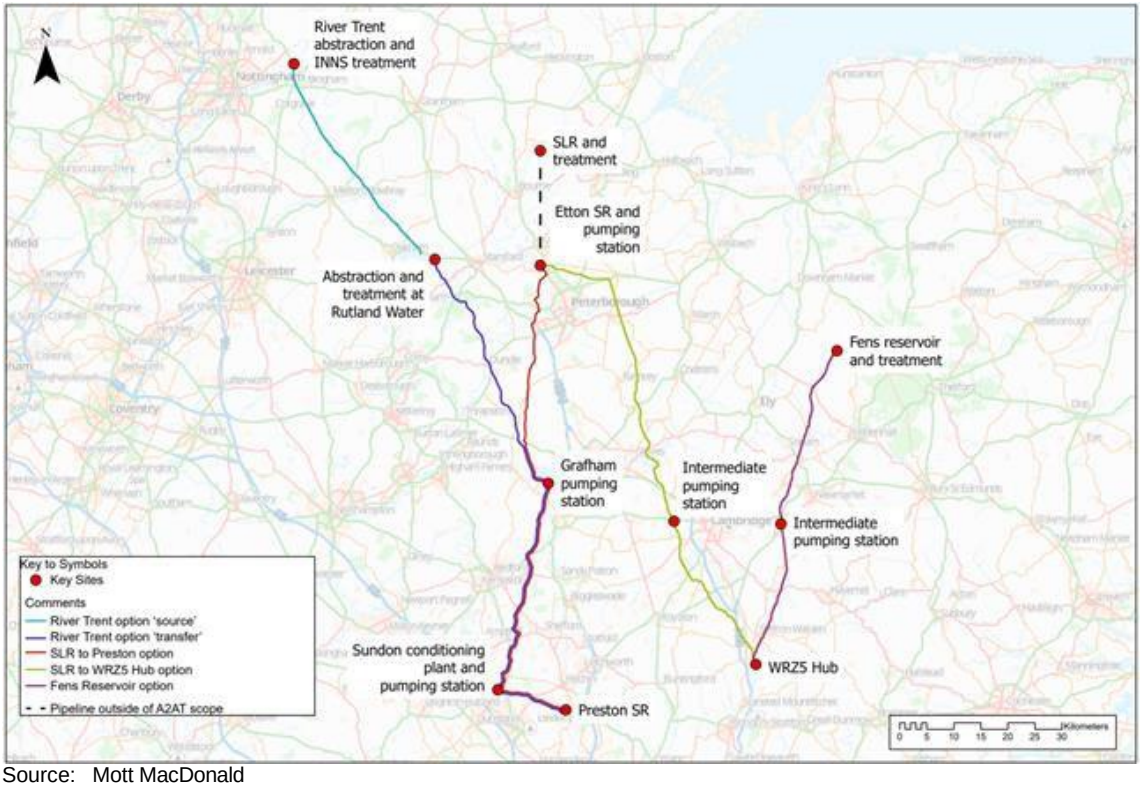
For Gate 1, there are four options for A2AT as described in Table 2.1. A map of the options is shown in Figure 2.1.

Table 2.1: A2AT Gate 1 options

Option name	Option description
Fens Reservoir	Abstraction of raw water from the proposed Fens Reservoir, and treatment at a new Fens Reservoir WTW. The potable water will then be conveyed to a conditioning plant and SR in WRZ5 Hub via an intermediate break tank and pumping station. 50Ml/d and 70Ml/d alternatives. Interdependencies of the option: Fens Reservoir and network enhancement in WRZ5. Indicative intake location: Fens Reservoir Abstraction infrastructure: See Fens Reservoir scheme
SLR to Preston	Abstraction of raw water from the proposed South Lincolnshire Reservoir, and conveyance to new SLR WTW. The potable water will then be conveyed to Sundon WTW for conditioning, via Etton Service Reservoir and routing past and intermediate break tank and pumping station near Grafham. The treated water will be transferred to Preston SR. 50Ml/d and 100Ml/d alternatives. Interdependencies of the option: SLR SRO and network enhancement downstream of Preston Indicative intake location: South Lincolnshire Reservoir Abstraction infrastructure: See SLR SRO
SLR to WRZ5 Hub	Abstraction of raw water from the proposed South Lincolnshire Reservoir, and conveyance to new SLR WTW. The potable water will then be conveyed to a conditioning plant and SR in WRZ 5 Hub, routing past Etton SR and an intermediate break tank and pumping station. 50Ml/d and 100Ml/d alternatives. Interdependencies of the option: SLR SRO and network enhancement in WRZ5 Indicative intake location: South Lincolnshire Reservoir Abstraction infrastructure: See SLR SRO

Option name	Option description
River Trent	Abstraction of raw water from the River Trent at East Bridgford, and treatment to prevent Invasive Non-Native Species (INNS) transfer. The partially treated raw water will be conveyed to Rutland Water, where a new draw-off arrangement and Rutland Water WTW will abstract, treat, and convey water to Sundon WTW for conditioning, routing via an intermediate break tank and pumping station near Grafham. The treated water will be transferred to Preston SR. 50Ml/d and 100Ml/d alternatives. Interdependencies of the option: Network enhancement downstream of Preston Indicative intake location: River Trent at East Bridgford and Rutland Water Abstraction infrastructure: Inlet bar and fine screens (River Trent), and draw-off arrangement (Rutland Water).

Figure 2.1: Overview of A2AT scheme



Source: Mott MacDonald

3 Regulatory Assessment Reports

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

3.1 Habitats Regulations Assessment

The A2AT *Habitats Regulations Assessment* contains the results of the HRA undertaken for the four A2AT options. It provides information on the HRA screening (HRA stage 1) and the further, Appropriate Assessments (HRA stage 2) undertaken to assess the potential effects of the options on UK's Habitats Sites.

The Appropriate Assessment undertaken for the Fens Reservoir option 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 this option.

The Appropriate Assessment undertaken for the SLR to Preston option identified a transmission pathway to the Ouse Washes SPA/Ramsar site/SAC where the pipeline is required to cross the River Great Ouse, but concluded that no significant adverse effects on the integrity of the Habitats Site are foreseeable if the identified mitigation measures are observed.

For the River Trent option, significant adverse effects have been identified on the Humber Estuary Ramsar site/SAC: The potential reduction in flows on the River Trent, as a result of the new licenced abstraction at East Bridgford, would likely affect the behaviour of river and sea lamprey. Further hydrological modelling is required to understand the impact of abstraction on surface water levels and flows and a full investigation into the indirect impacts on migratory fish behaviour is required. Other significant adverse effects have been identified on Rutland Water SPA/Ramsar site: Residual effects would occur during construction of the pipeline, booster station and new WTW in and directly adjacent to the reservoir. Further noise and hydrogeological investigation to ensure construction-related effects are negated will be required. Relocating the booster station and WTW at least 500m from the boundary of Rutland Water is recommended to reduce the significance of construction-related disturbance, especially from visual and noise impacts. A hydrological modelling assessment will also be required to understand the impact of the alteration in abstraction regime on surface water levels in the reservoir and the indirect impact this will have on usable habitat to qualifying bird species.

For the SLR to WRZ5 Hub option, the Appropriate Assessment identified the potential for significant adverse effects on the Nene Washes SPA/Ramsar site/SAC which cannot be fully excluded at this stage. The effects relate to the location of the pipeline corridor within the boundary of the designated site. The consequential impacts on habitats and qualifying bird and fish species as a result of construction activities and potential pollution events during operation are certain. In order to avoid onerous further assessment where there is uncertainty in the outcome, it is recommended that consideration be given to rerouting the pipeline corridor to avoid the Nene Washes altogether at this stage. If this is not possible, further investigation of the impacts through a detailed project-stage HRA, informed by baseline surveys, and further hydrological and noise assessments will be required.

As options develop, should adverse effects on the integrity of the designated sites remain, the options would need to be granted derogation.

It should be noted that at this stage an in-combination assessment to identify potential cumulative effects of A2AT with other non-related plans or projects has not been conducted. An in-combination assessment would not be considered proportionate at this stage, due to the

early stages of the plan, and the consequential lack of further design details on A2AT and other SROs available. An updated HRA will be conducted at Gate 2 to include an in-combination assessment of the options within A2AT, between different SROs and between any other external plans or projects that may put pressure on the same water resources. As A2AT 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 possible.

3.2 Water Framework Directive Assessment

The A2AT *Water Framework Directive Assessment* contains the results of the WFD assessment undertaken for the A2AT options. It provides information on the WFD screening (Level 1 – basic screening) applied to all A2AT options and on the further assessment (Level 2 – detailed impact screening) undertaken for the A2AT options that were screened in at Level 1.

The Level 1 WFD assessment indicated that a number of options are anticipated to have very low risks of being non-compliant with WFD objectives, and do not require further assessment:

- Fens Reservoir
- SLR to Preston
- SLR to WRZ5 Hub

Where waterbodies and option impacts were ‘screened in’, a further assessment was undertaken. A Level 2 WFD assessment was completed for components of the below option:

- River Trent

The findings indicate that there are potentially precautionary WFD compliance risks associated primarily with the operation of 100Ml/d additional/new abstractions on two waterbodies. The potential effects could conflict with achieving WFD status objectives. This is particularly the case where physical modifications or water quality are an existing limiting factor, recorded in WFD baseline data as a ‘reason for not achieving good status’. The potential biological effects, particularly on physico-chemical changes (for example, reduced dilution) would require further assessment.

For new intakes, it is recognised that appropriate fish and eel screening would be required to prevent entrainment, although neither waterbody has a status classification for fish.

Subject to their progression through the approvals process, further WFD assessment would be required for the River Trent option, to improve the certainty of the levels of WFD risk outlined in the Gate 1 WFD Level 2 assessment. 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 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, physico-chemical 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 assessment
- 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
- Update the Level 2 WFD assessments to incorporate additional information, and
- Outlining further work or modelling required to demonstrate compliance into Gate 3.

3.3 Strategic Environmental Assessment

The A2AT *Strategic Environmental Assessment* presents the findings of a SEA applied to the options for the A2AT options. The SEA was completed in-line with the methodology in the *WRSE Regional Plan Environmental Assessment Methodology Guidance* July 2020.

Based on the SEA outputs for residual effects (post mitigation), the options rated the same across the SEA objectives, with the following exceptions:

- Biodiversity: Construction of the Fens Reservoir and SLR to Preston options would result in moderate negative residual effects while construction of the SLR to WRZ5 Hub and River Trent options would result in major negative residual effects on biodiversity. Operation of the SLR to Preston, SLR to WRZ5 Hub and River Trent options would result in moderate negative residual effects while operation of the Fens Reservoir option would not impact on biodiversity.
- Water: While all options would result in minor negative residual effects on resilience and flood risk during construction, only the Fens Reservoir option would result in minor negative residual effects during operation. Regarding the impact of the options on water quality and water resources, The River Trent option is the only option which would likely result in negative residual effects (moderate negative effects during construction and neutral effects during operation); none of the other options would have an adverse effect on water resources.
- Climatic factors: While construction of all options would result in minor negative residual effects on carbon emissions, operation of the Fens Reservoir, SLR to Preston and SLR to WRZ5 Hub options would result in moderate negative residual effects on carbon emissions while operation of the River Trent option would result in major negative residual effects. Regarding the vulnerability to climate change risks, there are no residual effects expected from any of the options during construction; However operation of the SLR to WRZ5 Hub and River Trent options would result in minor negative residual effects, while the Fens Reservoir and SLR to Preston options would not impact on the vulnerability to climate change.
- Landscape: Construction of all options would result in minor negative residual effects on the landscape and visual amenity. Operation of the SLR to Preston, SLR to WRZ5 Hub and River Trent options would result in minor negative residual effects while operation of the Fens Reservoir would not impact on landscape and visual amenity.

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 200m of a number of locally important wildlife sites (including Local Wildlife Sites (LWS), Sites of Importance for Nature Conservation (SINCs), Sites of Nature Conservation Importance (SNCIs) and County Wildlife Sites (CWS)) and Tree Preservation Orders (TPO). All of the options except the Fens Reservoir option are within 200m of Conservation Areas. Mitigation can be put in place in order to reduce the potential effects on these areas.

The initial findings and additional assessment show potential residual impact for all options, with the Fens Reservoir option performing slightly better and the River Trent option performing 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.[2] 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, or incur high costs to control them or eliminate them from the system. 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, 2015).[3]

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 A2AT raw water transfer options being considered, prior to applying mitigation. The overall aim was underpinned by the following objectives:

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

[3] 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.

1. To review potential A2AT options against relevant EA guidance.
2. To determine whether potential A2AT options are located within areas of high risk of INNS invasion.
3. To identify INNS within an appropriate study area to understand current INNS distribution.
4. To undertake a high-level screening of potential A2AT options against key legislation.
5. To use an INNS risk assessment tool to assess risk for potential A2AT options based on the conceptual design information currently available.

4.1.4 A2AT raw water transfers

Of the four A2AT transfer options, three involve the treatment of water at source and subsequent transfer to potable water, and therefore pose no INNS risk. The following assessment was only applied to the River Trent option, as it involves the transfer of untreated water between waterbodies.

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 waterbody is located. It is proposed that the River Trent option abstracts raw water from the River Trent near to East Bridgford, Nottinghamshire, which is located within the Trent Lower and Erewash WFD Management Catchment, as shown on Figure 4.1.

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*[4] outlines the organisation's position on how it will manage INNS risks associated with raw water transfers. The key points of relevance to this report are as follows:

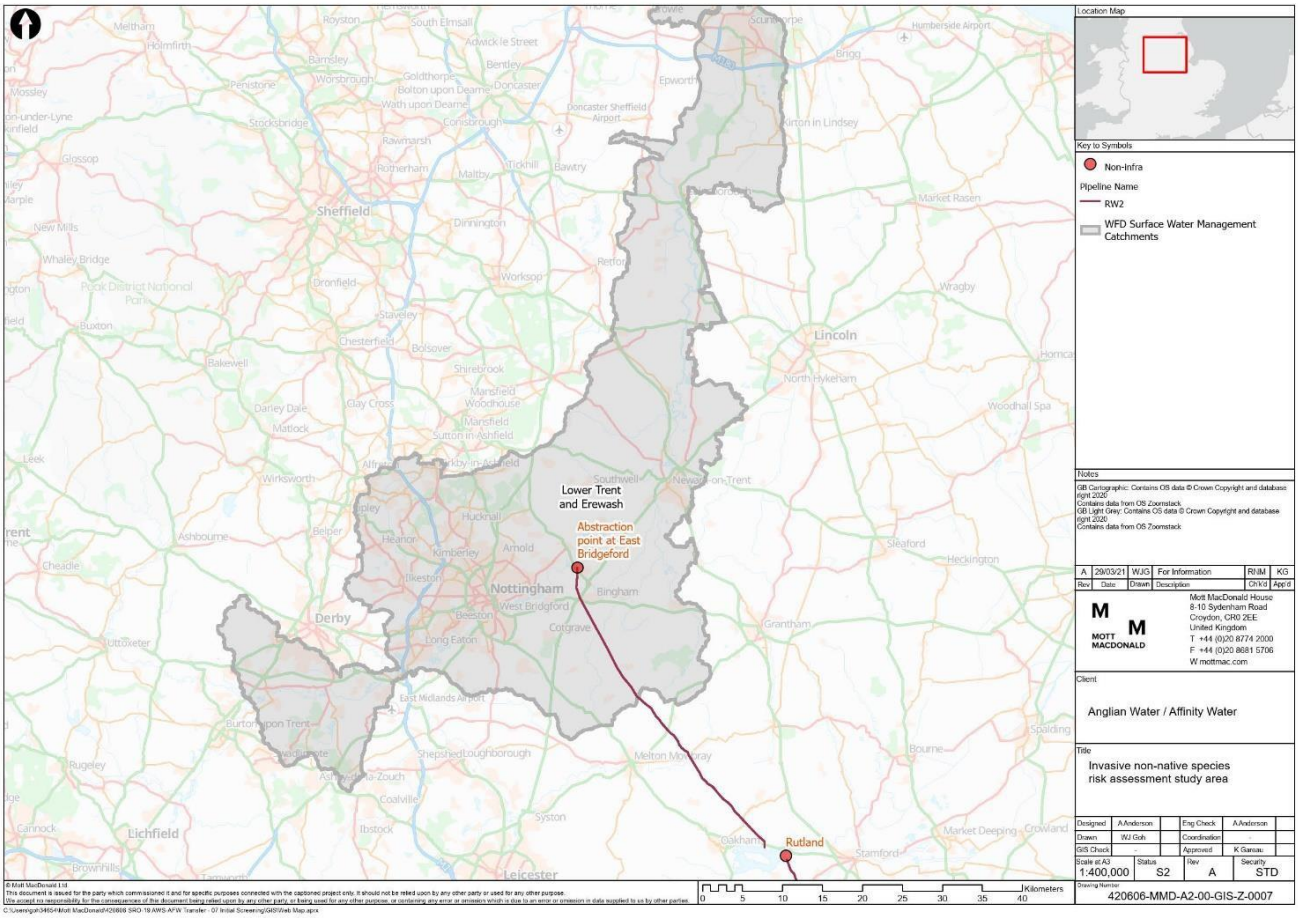
- The focus of the EA's approach is on the pathways that the transfers create, not on current INNS distribution.
- New schemes that create a hydrological connection between isolated catchments must have mitigation measures in place to ensure INNS cannot be spread by the new transfer.
- Where water transfer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

The River Trent option was screened to determine if the 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 4.1. A freshwater invasion risk category was assigned to the A2AT Trent River option based upon the risk category of the source and transfer locations. Where these sites encompassed multiple 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 4.1: 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 4.2. The River Trent option was assigned a marine invasion risk category based upon the invasion risk of the source estuary. Where an estuary encompassed multiple risk categories, the highest was assigned.

Table 4.2: 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 and Figure 4.1) 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

INNS records for the study area were screened against key national legislation to provide an indicative risk of contravention. Risk categories were assigned as shown in Table 4.3.

Table 4.3: Assignment of legislative risk categories

Legislation	Risk Category	Justification
	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.'

[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
Wildlife and Countryside Act (as amended) 1981 Schedule 9	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, • 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 (Hiley and Renals, 2017). 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 4.4.

Table 4.4: 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 A2AT Trent River option were entered and used to generate a risk score. 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 types 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

Test scenarios were developed for the River Trent option for use in the risk assessment tool. The test scenarios were based on the current available conceptual design.

A key feature of the proposed transfer is that it will convey raw water, at a rate of up to 300Ml/d via a new underground pipeline between the River Trent and Rutland Water.

The conceptual design includes washouts along the route of the pipeline. Specific details about the washouts were not available at the time of this assessment (Gate 1), e.g. location of the washouts, frequency of use and volumetric flow rate. A separate test scenario was developed for the washouts based on the assumptions that they would operate very infrequently (e.g. less than 1 in 10 years) and that all other features would be the same as those of the main transfer to Rutland Water.

The test scenarios for the main transfer to Rutland Water and the washout transfer were run separately. The scores were then combined to generate an overall INNS risk score for the River Trent option.

The conceptual design was not finalised at the time of this assessment. It is likely that mitigation measures will include as a minimum the screening of raw water at source and adherence to specific operational instructions to minimise the risk of INNS transfer. Both test scenarios were run twice, once without mitigation measures and once with the incorporation of these mitigation measures to determine their impact on INNS risk scores.

The test scenarios are detailed in Table 4.5.

Table 4.5: INNS risk assessment test scenarios for River Trent option

Risk type	Input variable	Main Transfer	Washout
Inherent	Transfer pathway	New raw water transfer	Water discharge / washout along route of transfer
	Transfer frequency	Year round - continuous	Very infrequent, short timeframe, e.g. in emergency situations or for testing
	Transfer volume	50 – 100Ml/d	Pipeline section
	Transfer distance	Between WFD Management Catchments	Between WFD Management Catchments
Adjusted	How raw water is conveyed	Whole length – underground pipeline	Whole length – underground pipeline
	Facilitation works	Lay new underground pipeline	Lay new underground pipeline
	Storage at transfer destination	Long-term storage in large reservoir	Unknown (assumed discharge to an open waterbody or flowing watercourse)
	Navigation along transfer route	Not applicable to pathway	Not applicable to pathway
	Recreation at transfer destination	Boats and equipment being brought to and leaving site regularly	Unknown (assumed no recreation for purposes of assessment)
	Riparian/land-based recreational access at transfer	Equipment being brought to and leaving site regularly	Unknown (assumed no recreation for purposes of assessment)
	Risk of arrival of new INNS at source	High for functional groups already at source	High for functional groups already at source

Risk type	Input variable	Main Transfer	Washout
		Low for functional groups not currently at source	Low for functional groups not currently at source
	Screening at source	Screens 3 – 10 mm mesh	Screens 3 – 10 mm mesh
	Chlorination at source or along route	No	No
	Transfer of water direct to WTW	No	No
	Screening before discharge to receptor waterbody	No	No
	Salt water barrier	No	No
	Specific operational protocol to mitigate risk	Yes	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	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	Unknown (assumed no protected species in or near washout receptor for purposes of this assessment)
	Protected sites in or near receptor	Yes – Rutland Water is designated as a Ramsar site and a Special Protection Area (SPA)	Unknown (assumed no protected sites in or near washout receptor for purposes of assessment)

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.

As the conceptual design is still in development, the details outlined in Section 4.2.6.2 will 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 A2AT 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 INNS risk assessment tool generates risk scores that are not particularly useful when a single raw water transfer option is being considered. It is intended that risk scores are compared between different raw water transfer options to determine the relative INNS risk presented by each. This report presents the risk associated with a single raw water transfer option. However, the methodology used in this assessment was consistent with that used in generating INNS risk scores for other SRO raw water transfer options to allow for comparison.

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.

The freshwater INNS heatmap only accounts for species from the Ponto-Caspian region. This screening exercise was undertaken on the basis that Ponto-Caspian aquatic species represent a high proportion of recent and predicted future invasions. Although there is risk of invasion by freshwater species from other regions, it would be unfeasible to conduct this specific assessment at a global-scale.

4.3 Results

4.3.1 High-Level Screening Related to EA Guidance

The proposed intake for the River Trent option is located within Area 97 of the classification map in *Invasive Non-Native Species Isolated Catchment Mapping* (EA, 2018). The receptor site, Rutland Water, is located within Area 92 of the map. The A2AT Trent River transfer will therefore span the two adjoining areas. Both areas are classified as 'Canal – CRT', meaning that hydrological connections to areas out with the catchment already exist through intersection of the river network with Canal and Rivers Trust (CRT) navigable canals. Connecting watercourses common to Areas 92 and 97 are the Grand Union Canal, Grantham Canal and Fossdyke Canal. Area 92 is also connected to other catchments via the River Witham. Area 97 is connected to other catchments via the Stainforth and Keadby Canal, Coventry Canal, North Stratford Canal, Worcester and Birmingham Canal, Dudley No. 2 Canal, Dudley Tunnel Branch, Old Main Line, Staffordshire and Worcestershire Canal, Shropshire Union Canal, Trent and Mersey Canal, and the Dane Feeder. Therefore, development of the A2AT Trent River option will not 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.

4.3.2 High-Level Screening Related to INNS Invasion Heatmaps

4.3.2.1 Freshwater Invasion Risk

The proposed intake for the River Trent option is located within an area in which between six and nine of the 16 modelled Ponto-Caspian INNS are predicted, according to the predictive distribution heatmaps produced by Gallardo and Aldridge (2012). This equates to a Medium risk of future freshwater INNS invasion of the source watercourse.

Rutland Water is also located within an area for which six to nine of the modelled Ponto-Caspian INNS are predicted. Therefore, the overall risk of freshwater INNS invasion for the River Trent option is categorised as Medium.

4.3.2.2 Marine Invasion Risk

The source watercourse for the River Trent option discharges to the Humber estuary. The Humber estuary is at elevated risk of future marine INNS invasion through the presence of offshore structures and commercial shipping activity. The mouth of the Humber estuary is interpreted to have a High marine invasion risk as it falls within a 50 x 50 km grid square of the marine non-native species introduction heatmap (Cefas, 2014) that has a pathway activity intensity of 50 to 74.99.

Although the marine invasion risk of the Humber is High, the tidal limit of the River Trent is downstream of the proposed intake location at East Bridgford. Therefore, the actual risk of marine INNS spreading upstream to the intake and their subsequent spread to Rutland Water via the proposed transfer was determined to be Low.

4.3.3 Invasive Non-Native Species Records

Twenty-nine INNS were identified in the EA records for Trent Lower and Erewash Management Catchment, including three fish, 12 macrophytes and 14 macroinvertebrates.

High Impact INNS were identified for all functional groups identified in the EA records for the Trent Lower and Erewash Management Catchment. Common carp *Cyprinus carpio* was the only High Impact fish species identified. Six High Impact macrophyte species were identified: floating pennywort *Hydrocotyle ranunculoides*, Nuttall's pondweed *Elodea nuttallii*, Canadian pondweed *Elodea canadensis*, water fern *Azolla filiculoides*, Indian balsam *Impatiens glandulifera* and Japanese knotweed *Fallopia japonica.* High Impact macroinvertebrates include Asiatic clam *Corbicula fluminea*, bloody red mysid *Hemimysis anomala*, Chinese mitten crab *Eriocheir sinensis*, demon shrimp *Dikerogammarus haemobaphes*, signal crayfish *Pacifastacus leniusculus* and zebra mussel *Dreissena polymorpha*.

EA INNS records for the study area are summarised in Table 4.6 (fish), Table 4.7 (macrophytes) and Table 4.8 (macroinvertebrates).

Table 4.6: INNS of fish identified in EA records

Common name	Scientific name	Functional group	Non-native status
Common carp	*Cyprinus carpio*	4	UKTAG – high[11]
Rainbow trout	*Oncorhynchus mykiss*	4	UKTAG – low
Zander	*Sander lucioperca*	4	UKTAG – moderate

Table 4.7: INNS of macrophyte identified in EA records

Common name	Scientific name	Functional group	Non-native status
Brazilian waterweed	*Egeria densa*	1	UKTAG - moderate
Canadian pondweed	*Elodea canadensis*	1	UKTAG – high WACA 1981 Sch. 9[12]
Floating pennywort	*Hydrocotyle ranunculoides*	1	UKTAG – high EU species of special concern[13] WACA 1981 Sch. 9 IAS Order 2019 Sch.2[14]
Least duckweed	*Lemna minuta*	1	UKTAG – unknown
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
Indian balsam	*Impatiens glandulifera*	2	UKTAG – high EU species of special concern WACA 1981 Sch. 9

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

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

[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
Japanese knotweed	*Fallopia japonica*	2	UKTAG – high WACA 1981 Sch. 9
Sweet flag	*Acorus calamus*	2	UKTAG – low

Table 4.8: INNS of macroinvertebrate identified in EA records

Common name	Scientific name	Functional group	Non-native status
Asiatic clam	*Corbicula fluminea*	5	UKTAG – high
Bladder snail	*Physa acuta*	5	UKTAG – unknown
Bloody red mysid	*Hemimysis anomala*	5	UKTAG – high
Caspian mud shrimp	*Chelicorophium curvispinum*	5	UKTAG – unknown
Chinese mitten crab	*Eriocheir sinensis*	5	UKTAG – high EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch.2
Demon shrimp	*Dikerogammarus haemobaphes*	5	UKTAG – high
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
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

4.3.4 High-Level Screening Against INNS Legislation

Rutland Water has an overall WFD classification of Moderate Status. As such, there is no risk that transfer of raw water to Rutland Water will result in its down-classification from WFD High Status due to the introduction of UKTAG High Impact INNS. However, there may still be a risk of deterioration of WFD elements due to other impacts from INNS, for example predation and competition, which would require further assessment.

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 the River Trent option source catchment (Trent Lower and Erewash Management Catchment). The River Trent option is therefore categorised as presenting a High legal risk as defined in this assessment (see Table 4.3). This assessment highlights the need for mitigation measures to reduce the risk of spreading these species, and to work closely with regulators to achieve this.

4.3.5 Risk assessment

The INNS risk scores generated for each of the raw water transfer options are presented in Table 4.9.

The Inherent Risk Score calculated for the transfer of raw water from the River Trent at East Bridgford to Rutland Water was 864, based on the current conceptual design. The Inherent Risk score for washouts along the pipeline route was calculated as 45. It was assumed that the washouts would involve the transfer of raw water to a different WFD Management Catchment. The difference between the main transfer and washout Inherent Risk Scores can be accounted for by their operation frequency. The main transfer to Rutland Water is likely to operate on a 'year-round – continuous' basis, which incurs the highest multiplier score in the risk assessment tool. In contrast, it was assumed that the washout would only be operational very infrequently (e.g. on a less than 1 in 10-year basis), which introduces the lowest possible multiplier score to the calculation. An overall Inherent Risk Score of 909 was calculated for the River Trent option by combining the main transfer and washout Inherent Risk Scores.

The Adjusted Risk Score accounts for factors that can either facilitate or inhibit the transfer of functional INNS groups present in the source waters to the receptor waterbody. The River Trent option would transfer raw water via an underground pipeline, which limits the INNS risk compared to transfer via an open channel. However, the option would require a new pipeline to be constructed between the source and receptor, which incurs a high multiplier score in the tool compared to the multiplier score incurred for re-valving of an existing pipeline. Discharge of raw water to a reservoir, as for the main transfer to Rutland Reservoir, introduces a lower multiplier score than discharge of raw water to an open watercourse, which was assumed to be the case for the pipeline washouts. Given that the transfer will be via an underground pipeline, navigation along the route is not possible, and therefore presents no additional INNS risk. However, the use of Rutland Water for recreational activities does amplify the Adjusted Risk Score.

Calculation of the Adjusted Risk Score was conducted twice, once without any mitigation measures and once with the inclusion of a couple of mitigation measures. The inclusion of raw water screening at source with a 3 to 10 mm mesh and the implementation of specific operational protocol to mitigate INNS risk significantly reduced the Adjusted Risk Score for both the main transfer and the pipeline washout. The combined Adjusted Risk Score without any mitigation was calculated as 8,688, whereas the score with mitigation included was calculated as 5,381. INNS mitigation measures for the River Trent option are still in development and may differ from those included in this assessment. However, these calculations demonstrate the beneficial impact that mitigation measures can have on the INNS risk.

The Adjusted Risk Score is carried forward as a multiplier in the calculation of the Weighted Risk Score. 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 four functional groups were identified in the EA monitoring data for the source waters: (1) aquatic plant spread by fragments; (2) riparian plant spread by seed or fragments; (4) free swimming fish; and (5) freely mobile invertebrate. Species categorised as High Impact by WFD UKTAG were identified for each of the functional groups present.

Rutland Water is designated as both a Special Protection Area (SPA) and as a Ramsar site. Discharge of raw water to a protected site doubles the Weighted Risk Score. It was assumed that the pipeline washout will not discharge within the vicinity of a protected site.

The Weighted Risk Score for the main transfer to Rutland Water was calculated as 36,024 and the Weighted Risk Score for the pipeline washout was calculated as 753, which combine to give a total score of 36,777. This overall Weighted Risk Score was reduced to 22,596 when mitigation options were included for both the main transfer and the washout transfer.

4.3.6 Results summary

The results of all components of this assessment are summarised in Table 4.9.

Table 4.9: INNS assessments results summary

Assessment component	Main transfer no mitigation	Washout no mitigation	Combined score no mitigation	Main transfer with mitigation	Washout with mitigation	Combined score with mitigation
Inherent Risk Score	864	45	**909**	864	45	**909**
Adjusted Risk Score	8,340	348	**8,688**	5,136	245	**5,381**
Weighted Risk Score	36,024	753	**36,777**	22,069	527	**22,596**
Transfer between isolated catchments	No					
Freshwater INNS invasion risk	Medium					
Marine INNS invasion risk	Low					
Risk of contravening INNS legislation	High					

4.3.7 Conclusions and recommendations

The following conclusions have been drawn from the assessment of the River Trent option:

- Source and receptor locations have existing man-made connections to other catchments via Canal and River Trust canals. The development of the transfer would not introduce a connection between previously isolated catchments. This outcome necessitates an INNS risk assessment, which the EA will use to decide whether subsequent mitigation is required, to ensure the risk of INNS transfer is not significantly increased.
- The source waters contain eight species that are listed in at least one key piece of INNS legislation designed to reduce their spread. The River Trent option therefore presents a legal risk with regards to their transfer to other waterbodies, which will need to be addressed through mitigation measures.
- No threat of re-classification of High Status WFD waterbodies due to the spread of UKTAG High Impact species was identified.
- High-level screening against INNS invasion heatmaps suggest a Low risk of marine INNS invasion in the source waters and a Medium risk of invasion by freshwater Ponto-Caspian INNS in both source and receptor waters.
- The Risk Scores generated by the risk assessment tool indicate that there is a significant INNS risk associated with raw water transfer between the River Trent and Rutland Water. Mitigation measures would have to be developed to eliminate or minimise the INNS risk if this option is selected.

At the time this pre-mitigation risk assessment was conducted, the conceptual design was still in development. Consideration of appropriate INNS mitigation should ideally be a continual process that evolves alongside development of the conceptual design. Mitigation measures should be developed to effectively mitigate against a wide range of INNS functional groups, including measures to target pathogens.

It is recommended that the INNS risk associated with A2AT transfers is reviewed at Gate 2 when further design information is available. It is particularly important that the impact of mitigation measures is accounted for and that the risk assessment scores for pipeline washout are refined.

Note that following the above INNS risk assessment the River Trent option now includes for an INNS treatment at the River Trent intake including clarification and rapid gravity filters to minimise the risk of INNS transfer.

5 Natural Capital and Biodiversity Net Gain

5.1 Introduction

As part of Gate 1 environmental assessment, each SRO is expected to undertake an initial assessment of any potential impacts on NC and Biodiversity resulting from the scheme. The group of water companies involved in developing SROs have been working together to increase consistency in approaches for SRO development across the country.

The NC and BNG assessment were undertaken by WRSE, following the latest guidance from the Environment Agency, Natural England and the ACWG. Section 5.2 provides information on the assessment methodology and Section 5.3 and 5.4 respectively provide the NC and BNG assessment findings and conclusions.

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 Zone of Influence (ZOI). The potential impact of each option on each 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 method, three other NC metrics were considered, these were food production, air pollutant removal and recreation and amenity value.

While A2AT is a Water Resources East (WRE) scheme, the initial assessments to support the Gate 1 submission were undertaken using the method developed for use on the Water Resources South East (WRSE) regional programme. The WRE environmental assessment

[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.

approach is currently being finalised following completion of the Integrated Environmental Assessment scoping consultation exercise. It is expected that the WRE methodology will be used to support the work for Gate 2 submission. As the WRSE and WRE methodologies are very similar, this will not invalidate the Gate 1 assessments undertaken for the A2AT SRO.

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 of loss. The assessments were undertaken to a level considered suitable for the available information. No additional assessment took place on the NC and BNG outputs provided using the WRSE method.

The NC and BNG output tables 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
- 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
- Mitigation of natural capital stocks has only been considered when outlined in the options description, or where standard mitigation must be applied

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
- At this stage of design development and for RAPID Gate 1, it is assumed that options will require further assessment as the design evolves. For RAPID Gate 2, this will include surveys to ground truth the BNG assessment in the form of Phase 1 habitat surveys. It is likely that these could result in a net increase/decrease in the BNG outputs. At this point, the BNG assessment can be revisited and mitigation or enhancement opportunities developed further to provide a clearer commitment to BNG.

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 Natural Capital and Biodiversity Net Gain findings

The findings of the NC and BNG assessment undertaken by WRSE, per option, are presented below.

Each option assessed both pipeline and WTWs together. 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.

5.3.1 Summary of the Natural Capital assessment

Table 5.1 presents a summary of the area of NC stock that would likely change as a result of the construction of the options.

Table 5.1: Summary of the NC assessment: Change in area of the stock post-construction

Option Name	Broadleaved Mixed Woodland	Coniferous Woodland	Orchards and Top Fruit	Pastures	Arable (ha)
Fens Reservoir	0	0	0	0	-2.24
SLR to Preston	0	0	0	0	-1.12
SLR to WRZ5 Hub	0	0	0	0	-1.12
River Trent	0	0	0	0	-3.36

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 unmitigated 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 (%)
Fens Reservoir	313.13	280.99	-32.14	-10.26%
SLR to Preston	551.13	479.33	-71.79	-13.03%
SLR to WRZ5 Hub	560.35	433.8	-126.55	-22.58%
River Trent	837.8	696.1	-141.7	-16.91%

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)
	Carbon Storage[1]	Natural Hazard Management[2]	Air Pollutant Removal[3]	Recreation and Amenity Value[4]	Food Production[5]	
Fens Reservoir	-£65.24	-£21.80	Scoped out	Scoped out	-£1,037.00	-£1,124.04
SLR to	-£36.85	-£15.08	Scoped out	Scoped out	-£659.00	-£710.92
SLR to WRZ5 Hub	-£91.91	-£49.11	Scoped out	Scoped out	-£431.00	-£572.02
River	-£160.26	-£73.77	Scoped out	Scoped out	-£1,300.00	-£1,534.03

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.

5.4 Conclusions

5.4.1 Natural Capital

The outputs of the methodology show all options are likely to cause temporary loss of arable farmland Natural Capital stocks. However, compensation/reinstatement of arable farmland means that post construction these stocks are likely to have little to no change.

5.4.2 Biodiversity Net Gain

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

5.4.3 Ecosystem services

The pipelines for all options are likely to generate the 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 and loss of provision of food production due to habitat clearance. Construction is not expected to affect the future value as stocks are expected to be reinstated, however the permanent loss of arable land would have a permanent impact on the provision of food provision.

All the options present potential opportunities to improve the existing habitats along the pipeline route through post construction remediation and replacement of low value habitats with higher value habitats. All options cross several Natural England habitat, Network Enhancement Zones and are therefore suitable for planting. Potential opportunities provided have not been factored into the NCA, BNG or ecosystem services assessment.

5.5 Comparison

The Fens Reservoir option would result in the lowest percentage loss of BNG (by a maximum of 10.26%), while the SLR to WRZ5 Hub option would result in the greatest loss (by a maximum of 22.58%). Based on the ecosystem services results, the best option would be the SLR to WRZ5

Hub option (-£572.02 per year) and the worst option would be the River Trent option (-£1,534.03 per year).

The proposed SLR to Preston option would result in the second lowest percentage BNG loss (by a maximum of 13.03%), and the second lowest total loss of ecosystem services value (£710.92 per year). The proposed River Trent option would result in the second greatest percentage BNG loss (by a maximum of -16.91%) and the greatest total loss of ecosystem services value (£1,534.03 per year).

When reviewing the assessments outputs, the best option overall would be the SLR to Preston option, while the worst one would be the River Trent option.

While the NC and BNG assessments undertaken provide an indication of the impact of the options, it is important to note the limitation that the calculations do not consider the implementation of mitigation measures.

As such, we recommend that further investigation into the potential BNG and NC effects should be undertaken at Gate 2 in order to assess the developed options and that proposed mitigation and opportunities are further defined to allow consideration in the assessments.

6 Wider Benefits

6.1 Introduction

Affinity Water and Anglian Water place emphasis on the need to provide greater public value in their activities. This is in line with the wider water industry, where public commitment to contribute positively to society and the environment enables companies to increase customer trust and improve reputations for responsible and socially aware business. A trusted relationship between Affinity Water and Anglian 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 the Customer and Engagement document prepared to support the Gate 1 report[16].

The purpose of this section is to outline the potential social benefits of the A2AT scheme. This section summarises the potential social benefits of water transfer schemes as well as scheme options, and details potential mitigation. The environmental assessment guidance[17] 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 A2AT are:

- Provisioning services, for example, where water resources provide the welfare benefit of a public water supply; and
- 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 for customers and communities

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

[16] Customer and Stakeholder Engagement. A2AT GATE 1 REPORT.

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

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

Overall, water resource planning will help identify the best value long term strategic regional supply options for East Anglia and the South East.

A WRSE research project, which covers the relevant region for customers served by the A2AT project, on 'Customer Preferences to Inform Long-term Water Resource Planning'[18] identifies customer preferences and priorities to support water resource and resilience planning. The research involved nearly 100 customers from different water company areas in the south east. Findings from this study include:

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

[18] 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

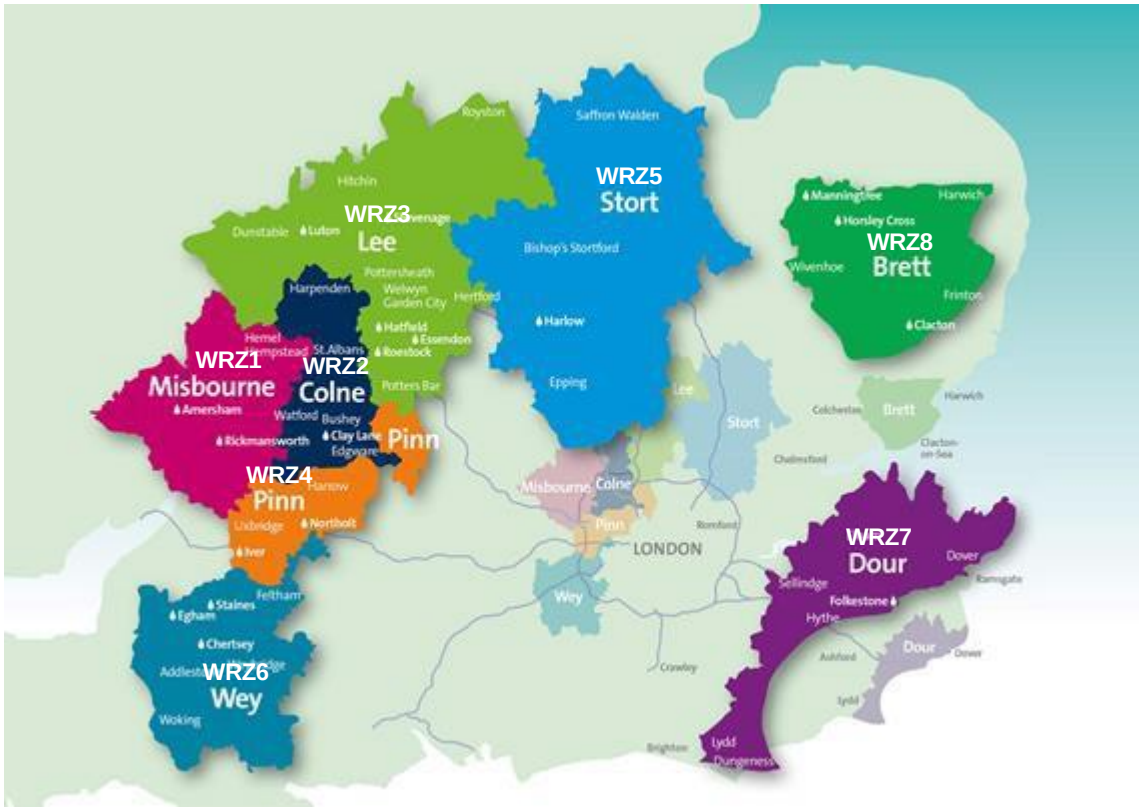
Water transfer schemes, such as A2AT, are designed to balance the supply and demand of water over large distances. The transfer is from an area with adequate water resource to an area where resources are more limited. This cooperative working between Affinity Water and Anglian Water which enables the sharing of water resources, contributes to the efficient use of water resources across these two regions.

Of Affinity Water's supply regions, the Central region is projected to have a considerable shortfall in water supply from 2025 onwards, due to population growth, the likely impact of climate change and plans to reduce water abstraction from Chalk catchments in the area. Population growth in the area is expected due to substantial planned housing growth across the region.[19] The provision of a secure water supply to the Central region will assist in the delivery of other developments required to realise the growth aspirations of the local areas, particularly in Water Resource Zones 3 and 5. Such developments include the provision of new affordable housing, regenerated town centres, sustainable transport networks, and other infrastructure requirements outlined in local authority growth plans, such as Hertfordshire County Council and Essex County Council in relation to WRZ 3 and 5.[20] The security of water supply is also likely to have a positive impact on local business water users, particularly in these areas, reducing the risk of water availability to business growth and agriculture. A figure of the Affinity Water region is provided in Figure 6.1 below.

[19] Affinity Water, 2020, 'Water Resource Management Plan 2020-2080', https://www.affinitywater.co.uk/corporate/plans/water-resources-plan

[20] Hertfordshire County Council, 2020 'Hertfordshire: Fit for the Future', https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/planning/hertfordshire-fit-for-the-future.pdf ; Essex County Council, 2017, 'Essex County Council Organisation Strategy', https://assets.ctfassets.net/knkzaf64jx5x/6wHOsBT1Q2JZ1hqoB7BoeC/16a828c2792afa75df4de87baf1b134d/ESSEX_ORGANISATION_STRATEGY.pdf

Figure 6.1: Affinity Water's Water Resource Zones



Source: Affinity Water, 2021[21] with annotations

The Central region supply area has 8-9% of globally rare Chalk streams. The planned reduction in water abstractions from Chalk catchments is intended to reduce environmental damage and protect the ecosystems, habitats and wildlife which rely on them.[22] 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 for the local community.

6.2.3 Localised impacts of A2AT

The A2AT *Strategic Environmental Assessment* includes consideration of the social effects of each pipeline option, 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 A2AT 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;

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

[22] Affinity Water, 2020, 'Water Resource Management Plan 2020-2080', https://www.affinitywater.co.uk/corporate/plans/water-resources-plan

- 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; and
- Predicted impacts from construction activity, specifically noise and visual, affecting amenity of local residents or users of community facilities.

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 A2AT is likely to generate direct and indirect social benefits.

6.3 Mitigation of A2AT social impacts

The designs of the A2AT pipeline route options have been developed with the aim of avoiding impacts on people. Considerations include:

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

The SEA work also identifies mitigation measures which can be applied as the A2AT options are refined. To avoid or mitigate potential disruption and disturbance to communities during construction and operation of the A2AT scheme, it is envisaged that the best practice mitigation will be implemented during construction, which usually includes:

- Setting out how engagement with local communities will be undertaken 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 A2AT SEA work also identifies mitigation measures which can be applied as the A2AT options are refined. This is likely to include 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.

Potential programmes and initiatives could be implemented as part of the A2AT scheme to deliver public value:

- For example, the Affinity Water ‘Corporate Social Responsibility’ programme aims to deliver social responsibility through developing community partnerships; the introduction of a new Social Tariff for low income customers; and investing in STEM education through school visits and work placements.[23]
- For example, the Anglian Water ‘Social Contract’, to be published in Spring 2021, will have an explicit focus on having a positive impact on communities, with exact details to come with

[23] 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

publication. Their current Community Plan focuses on education programmes, fundraising for Water Aid; and supporting front- line coronavirus relief in their communities.[24]

- 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 A2AT 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.

6.4 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 A2AT 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.

[24] Anglian Water, 2020, 'Annual Integrated Report 2020'. Available at: https://www.anglianwater.co.uk/siteassets/household/about-us/air-2020.pdf

7 Assessment of opportunities for net zero carbon contributions

7.1 Introduction

This Section reviews and summarises options for integrating the A2AT scheme with Anglian Water's and Affinity Water's net zero carbon ambition.

In 2020 Water UK released its net zero routemap, 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[25] (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[26].

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

- Scope 1: Emissions from burning of fossil fuels, process and fugitive emissions (e.g. Nitrous oxide and methane from wastewater/sludge treatment and emissions from owned or leased vehicles)
- Scope 2: Purchased electricity
- Some scope 3 emissions, e.g. business travel, outsourced activities and 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 and individual companies have the discretion to broaden their boundary to include further scopes of emissions.

The SLR has not set its own Net Zero target at this stage, as such no definitive Net Zero boundary for individual schemes is set. Our assessment for gate 1 has, however, sought to consider both operational and capital carbon emissions, as appropriate to the stage of design, and we will continue to develop our approach in line with relevant guidance, sector, AWS and Affinity Net Zero approaches in the Gate 2 assessment.

7.1.1 Net zero ambition

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

[25] Public Interest Commitment | Water UK

[26] Link to 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.

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 factor 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.

7.1.2 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 greenhouse 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, it is possible for schemes to achieve net zero without focussing on reducing emissions from their activities and purely focussing on offsets instead. However, the water sector net zero target follows a decarbonisation hierarchy that is based on good international practice – emissions must 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). An important point to note for sequestration options is that companies will have to assess what opportunities for natural sequestration exist in their own landholdings before considering purchasing offsets in the international carbon markets.

All schemes will need to reduce their carbon emissions as much as possible to minimise the required level of offsets. This is because there are not enough offsets available to cover the current level of global emissions and so it is expected that there will be significant competition for available offsets going forward and likely significant costs. Therefore, reducing emissions on the scheme will also reduce residual emissions offsetting costs if market-based options are considered.

7.1.3 Delivering net zero efficiently at scheme level

Companies will need to consider the overall impact of new strategic schemes, such as A2AT, 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 A2AT transfer scheme to decarbonise and drive towards net zero.

7.2 Methodology

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, as of February 2021. The latest guidance[27] states the WRMPs:

- should assess the carbon cost of both the construction and operation of your options, along with the impact of land use change on carbon sequestration
- take into account any mitigation. For example using renewable energy or carbon off-setting. Carbon off-setting can contribute to wider environmental benefits such as tree planting or upland and peatland restoration, if there is no alternative to reducing emissions.
- use the carbon costs as per government guidance and present these costs together with your options cost. You should also present the tonnes of carbon you will emit from the construction and operation of your preferred options.

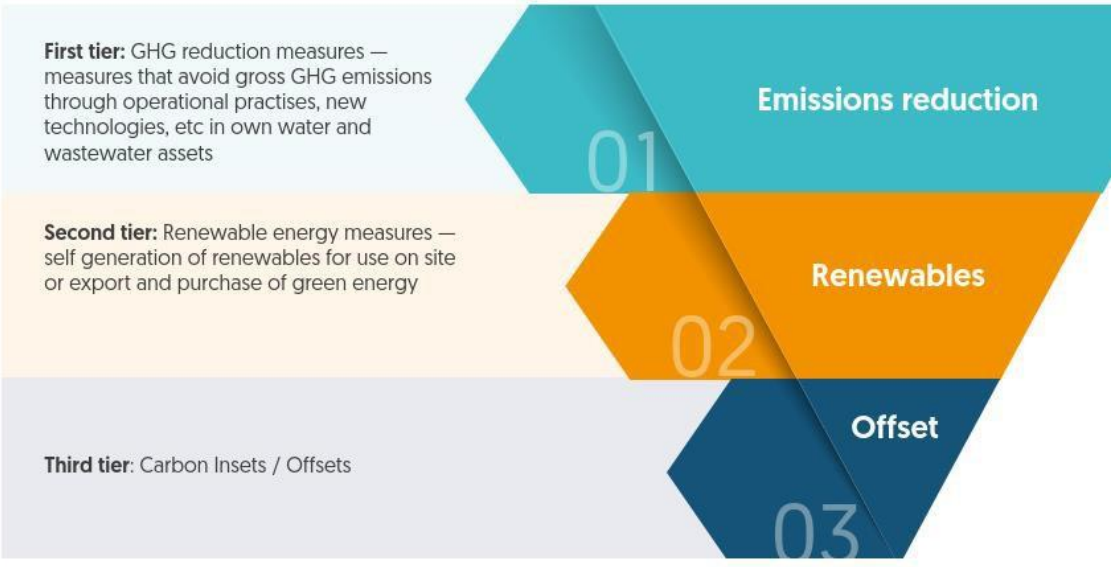
User carbon emissions (i.e. the emissions associated with the heating of water in the home) are not considered in this assessment.

7.2.1 Net zero considerations

The considerations made take on the principles of the emissions reduction hierarchy (Figure 7.1), whereby 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 embedded carbon in the A2AT options are included, however it will be down to the water company to decide whether capital carbon emissions will be part of the company's or the scheme's net zero consideration.

Figure 7.1: Emissions reduction hierarchy

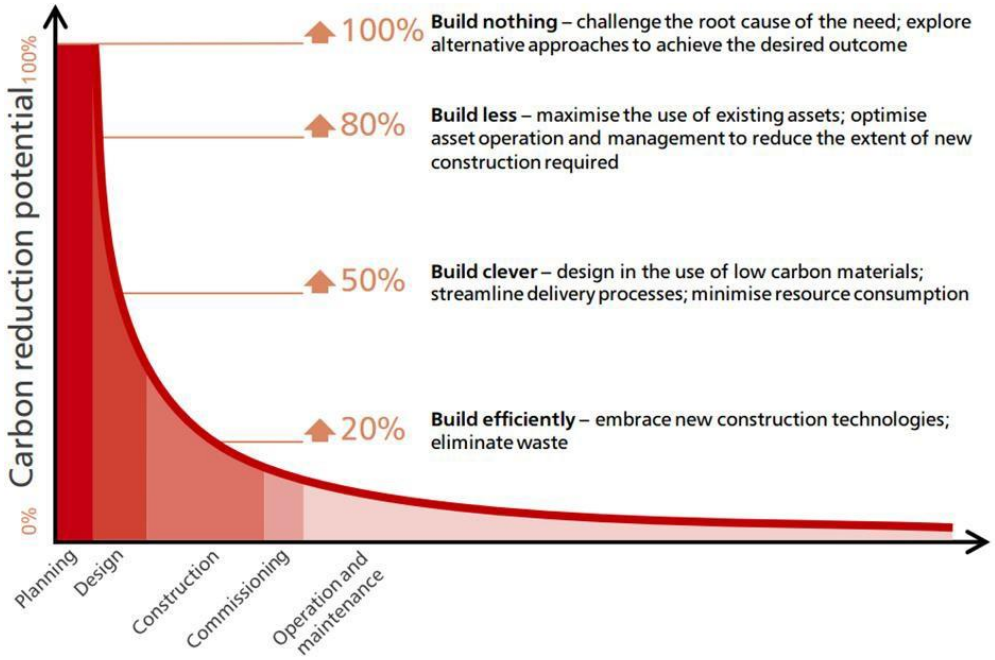


Source: Water UK Net zero 2030 routemap (Figure 4.1)

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

[27] Water resources planning guideline - GOV.UK (www.gov.uk)

Figure 7.2: Carbon reduction hierarchy



Source: Infrastructure Carbon Review, 2013

The *build nothing* option is not considered as the options appraisal approach for the individual company WRMPs and the WRE 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:

- The River Trent option avoids the need to build a new raw water reservoir altogether by making use of storage in the existing Rutland Water.
- The River Trent and SLR to Preston options deliver to an existing hub at Sundon conditioning plant. Although capacity of the plant will need to be expanded, there is potential for reuse of existing assets.
- Laying a new transfer pipeline next to the existing Grafham to Sundon pipe to provide redundancy and maximise use of existing assets.
- The River Trent and SLR to Preston options make use of the existing Preston service reservoir.

The remaining considerations thus focus on the *build clever* and *build efficiently* options for the A2AT transfer options.

7.2.2 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. As a starting point it would be important to develop an understanding of 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.

Capital carbon hotspots

A summary of embedded 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[28] at associated treatment works; and
- Maintenance emissions.

7.3 Options and baseline carbon estimates

The carbon assessment 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 ACWG 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.

Embedded 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 Long Run Marginal Cost (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 WRE regional model to apply incremental changes in carbon cost of power generation over time, should that be required.

Table 7.1 and Table 7.2 list the baseline estimates of operational and embedded carbon emissions for each option. Note that the tables only show the carbon footprint of the A2AT 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

Options for 50Ml/d deployable output to Affinity Water	Element	Embodied carbon (tCO_2e)	Operational carbon (tCO_2e/ year)
River Trent	Source	87,526	3,745
	Transfer	73,879	6,654
SLR to Preston	Transfer	71,580	6,849

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

Options for 50Ml/d deployable output to Affinity Water	Element	Embodied carbon (tCO_2e)	Operational carbon (tCO_2e/ year)
SLR to WRZ5 Hub	Transfer	71,626	5,688
Fens Reservoir	Transfer	44,758	4,675

*Estimated based on calculated power used at full capacity in 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 70Ml/d and 100Ml/d options

Options for 70Ml/d and 100Ml/d deployable output to Affinity Water	Element	Embodied carbon (tCO_2e)	Operational carbon (tCO_2e/ year)
River Trent	Source	146,353	7,286
	Transfer	173,501	13,349
SLR to Preston	Transfer	167,902	15,862
SLR to WRZ5 Hub	Transfer	156,633	13,177
Fens Reservoir (70Ml/d)	Transfer	55,169	6,769

*Estimated based on calculated power used at full capacity in MWh/yr and using the CAW v14 grid power emissions factor of 0.277kg/kWh including transmissions and distribution losses.

The operational carbon emissions of all options are largely due to the emissions associated with electricity consumption of the pumping stations transferring the water between source and destination. Therefore, grid decarbonisation and minimising distance between the source and destination will have a large impact on operational carbon. The operational carbon due to chemical usage is minor in comparison.

The embodied carbon of the options in this scheme is largely due to the embodied carbon of the conveyance pipelines. Therefore, shorter schemes are less carbon intensive per megalitre compared to schemes which transfer water over a long distance. The difference in embodied carbon for different treatment processes between the different options are minor.

Longer pipeline options, such as the River Trent option, are therefore higher in both embodied and operational carbon footprints due to both more material requirements and higher pumping head to overcome friction losses.

With respect to pipe sizing, there will need to be a focus on carbon optimisation, balancing the embodied carbon which increases with pipe diameter, with the operational carbon which, for a given flow rate, falls with increasing pipe diameter.

7.4 A2AT Decarbonisation considerations

The following sections set out some considerations that the A2AT transfer options could take to decarbonise and drive towards net zero.

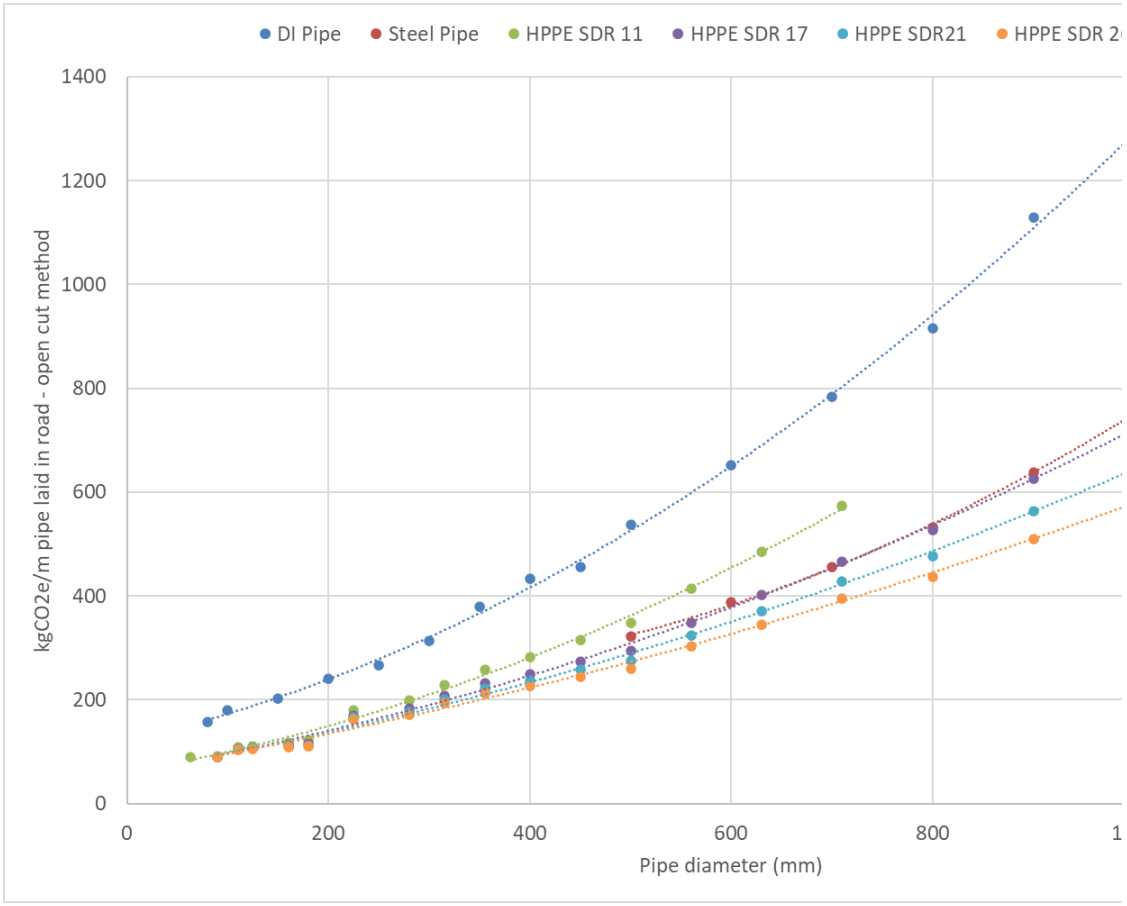
7.4.1 Material specification and procurement

The carbon intensity of the materials and products involved in the delivery of the A2AT options will play an important role in overall carbon footprint of the schemes. The current capital carbon estimates for the options are based on generic or industry standard carbon intensities of materials and products. To drive down emissions on specific schemes it is important to engage and challenge the supply chain to deliver products that meet performance specifications at the lowest carbon intensities possible.

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 embodied carbon emissions.

For pipes, different materials have significantly different embodied carbon intensities but also different characteristics that may affect whole life maintenance and operational carbon performance. Figure 7.3 provides a summary of estimated embodied carbon impact of different pipe materials 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 at or beyond the limit of standard SDR 11 PE production 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 7.3: 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 of these materials 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 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 A2AT 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 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 re-use 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 A2AT 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 relatively low penetration into Heavy Goods Vehicle (HGV) and plant fleets. However, as other sectors decarbonise to help support national decarbonisation activities, more opportunities to adopt these lower carbon vehicles as part of projects will develop over time. The project team should look to identify what options there are for low carbon vehicles for spoil removal activities and engage appropriate suppliers who may be able to supply these services to better understand how feasible this would be.

7.4.4 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 embedded 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, 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[29] 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 A2AT 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 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

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

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 A2AT options.

7.5 Recommendations and next steps

An important part of turning some of the above considerations into deliverable opportunities is to have a robust carbon management process embedded into the scheme development. 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.

The key recommendations for next steps are:

1. 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.
2. A low carbon workshop should 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.
3. Design principles should 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.
4. A clear carbon management process should be embedded into the option development process to identify low carbon opportunities and track them through to implementation.

8 Comparison between options and summary conclusions

8.1 Comparison and conclusions

The assessments undertaken as part of this SRO Gate 1 study indicate that adverse 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.

8.1.1 Habitats Regulations Assessment

The HRA Appropriate Assessment undertaken for the Fens Reservoir option 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 this option.

The Appropriate Assessment undertaken for the SLR to Preston option identified a transmission pathway to the Ouse Washes SPA/Ramsar site/SAC where the pipeline is required to cross the River Great Ouse, but concluded that no significant adverse effects on the integrity of the Habitats Site are foreseeable if the identified mitigation measures are observed.

For the River Trent option, significant adverse effects have been identified on the Humber Estuary Ramsar site/SAC: The potential reduction in flows on the River Trent, as a result of the new licenced abstraction at East Bridgford, would likely affect the behaviour of river and sea lamprey. Further hydrological modelling is required to understand the impact of abstraction on surface water levels and flows and a full investigation into the indirect impacts on migratory fish behaviour is required. Other significant adverse effects have been identified on Rutland Water SPA/Ramsar site: Residual effects would occur during construction of the pipeline, booster station and new WTW in and directly adjacent to the reservoir. Further noise and hydrogeological investigation to ensure construction-related effects are negated will be required. Relocating the booster station and WTW at least 500m from the boundary of Rutland Water is recommended to reduce the significance of construction-related disturbance, especially from visual and noise impacts. A hydrological modelling assessment will also be required to understand the impact of the alteration in abstraction regime on surface water levels in the reservoir and the indirect impact this will have on usable habitat to qualifying bird species.

For the SLR to WRZ5 Hub option, the Appropriate Assessment identified the potential for significant adverse effects on the Nene Washes SPA/Ramsar site/SAC which cannot be fully excluded at this stage. The effects relate to the location of the pipeline corridor within the boundary of the designated site. The consequential impacts on habitats and qualifying bird and fish species as a result of construction activities and potential pollution events during operation are certain. In order to avoid onerous further assessment where there is uncertainty in the outcome, it is recommended that consideration be given to rerouting the pipeline corridor to avoid the Nene Washes altogether at this stage. If this is not possible, further investigation of the impacts through a detailed project-stage HRA, informed by baseline surveys, and further hydrological and noise assessments will be required.

As options develop, should adverse effects on the integrity of the designated sites remain, the options would need to be granted derogation.

8.1.2 Water Framework Directive Assessment

The Level 1 WFD assessment completed on all options indicated that the Fens Reservoir, SLR to Preston and SLR to WRZ5 Hub 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. A Level 2 WFD assessment was completed for components of the River Trent option. For this option, further WFD assessment will be required; the areas for future focus include consultation with the Environment Agency (EA), data collation and review of HMWB measures and baseline data concerning WFD biological, physiochemical and hydromorphological elements, development of a conceptual model, and further information on the design and operation of the options.

8.1.3 Strategic Environmental Assessment

Based on the SEA outputs for residual effects (post mitigation), the options rated the same across the SEA objectives, with the following exceptions:

- Biodiversity: Construction of the Fens Reservoir and the SLR to Preston options would result in moderate negative residual effects while construction of the SLR to WRZ5 Hub and River Trent options would result in major negative residual effects on biodiversity. Operation of the SLR to Preston, SLR to WRZ5 Hub and River Trent options would result in moderate negative residual effects while operation of the Fens Reservoir would not impact on biodiversity.
- Water: While all options would result in minor negative residual effects on resilience and flood risk during construction, only the Fens Reservoir option would result in minor negative residual effects during operation. Regarding the impact of the options on water quality and water resources, the River Trent option is the only option which would likely result in negative residual effects (moderate negative effects during construction and neutral effects during operation); none of the other options would have an adverse effect on water resources.
- Climatic factors: While construction of all options would result in minor negative residual effects on carbon emissions, operation of the Fens Reservoir, SLR to Preston and SLR to WRZ5 Hub options would result in moderate negative residual effects on carbon emissions while operation of the River Trent would result in major negative residual effects. Regarding the vulnerability to climate change risks, there are no residual effects expected from any of the options during construction; However operation of the SLR to WRZ5 Hub and River Trent options would result in minor negative residual effects, while the Fens Reservoir and SLR to Preston options would not impact on the vulnerability to climate change.
- Landscape: Construction of all options would result in minor negative residual effects on the landscape and visual amenity. Operation of the SLR to Preston, SLR to WRZ5 Hub and River Trent options would result in minor negative residual effects while operation of the Fens Reservoir would not impact on landscape and visual amenity.

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

The local level data findings show that all options intersect or lie within 200m of a number of locally important wildlife sites (including LWS, SINCs, SNCIs and CWS) and TPO. All of the options except the Fens Reservoir option intersect or lie within 200m of Conservation Areas. Mitigation can be put in place in order to reduce the potential effects on these areas.

The initial findings and additional assessment show potential residual impact for all options, with the Fens Reservoir option performing slightly better and River Trent option performing worse.

8.1.4 Invasive Non-Native Species risk assessment

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 A2AT raw water transfer

options, prior to applying mitigation, 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 requirement to conduct an INNS risk assessment relates only to raw water transfers. Of the four proposed A2AT options, only the River Trent option involves the transfer of raw water. The results from both the high-level screening and risk assessment tool components of the assessment suggest that there is a significant INNS risk associated with raw water transfer between the River Trent and Rutland Water. Mitigation measures would have to be developed to eliminate or minimise the INNS risk if this option is selected.

Note that in response to the INNS risk assessment the River Trent option includes for an INNS treatment plant at the River Trent intake including clarification and rapid gravity filters to minimise the risk of INNS transfer.

8.1.5 Natural Capital and Biodiversity Net Gain

High-level Biodiversity Net Gain (BNG) and Natural Capital (NC) assessments were undertaken on the proposed 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: All options are likely to generate a temporary loss of arable farmland stocks.
- BNG: All options are likely to result in a loss of BNG habitat units due to the removal of habitats during construction.
- Ecosystem services: All options are likely to generate the permanent loss of NC stocks associated with the provision of several ecosystem services, namely carbon storage, natural hazard management and food production. However, construction is not expected to affect the future value as stocks are expected to be reinstated.

When reviewing the assessments outputs, the best option overall would be the SLR to Preston option, while the worst one would be the River Trent option.

The opportunities identified in the BNG/NC assessment have the potential to contribute to Government ambitions for environmental net gain. This could take the form of habitat compensation, 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.

8.1.6 Wider benefits

Potential social benefits of the A2AT 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 A2AT 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 A2AT scheme to deliver public value are detailed in this section.

8.1.7 Opportunities for net zero carbon contributions

A high-level carbon assessment was undertaken to review and summarise the net zero considerations for the A2AT 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 is the lowest for the Fens Reservoir option and the greatest for the River Trent option. Operational carbon footprint, which will be more significant than embedded carbon over time, is broadly similar across the SLR to Preston, SLR to WRZ5 Hub and the Fens Reservoir options, with a greater footprint for the River Trent option.

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.

8.1.8 Summary

The combination of these assessments and studies shows that while positive benefits are likely to 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 is likely to 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 A2AT 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
Fens Reservoir	No transmission pathways identified.	Only WFD level 1 - very low risks of non-compliance	Potential residual effects similar for all options – but this operation performed the best overall	INNS risk assessment not applicable as this option does not require the transfer of raw water.	All options similar	Same for all options	Embodied Carbon – lowest footprint among all options. Operational carbon – similar across the Fens Reservoir, SLR to Preston and SLR to WRZ5 Hub options.
SLR to Preston	One transmission pathway identified but no significant adverse effects would be expected if mitigation measures are implemented.	Only WFD level 1 - very low risks of non-compliance	Potential residual effects similar for all options	INNS risk assessment not applicable as this option does not require the transfer of raw water.	All options similar - best overall	Same for all options	Embodied Carbon – similar footprint for the SLR to Preston and SLR to WRZ5 Hub options. Operational carbon – similar across the Fens Reservoir, SLR to Preston and SLR to WRZ5 Hub options.
SLR to WRZ5 Hub	Significant adverse effects have been identified which cannot be excluded at this stage.	Only WFD level 1 - very low risks of non-compliance	Potential residual effects similar for all options	INNS risk assessment not applicable as this option does not require the transfer of raw water.	All options similar	Same for all options	Embodied Carbon – similar footprint for the SLR to Preston and SLR to WRZ5 Hub options. Operational carbon – similar across the Fens Reservoir, SLR to Preston and SLR to WRZ5 Hub options.
River Trent	Significant adverse effects have been identified which cannot be excluded at this stage.	Level 2 completed and further assessment needed	Potential residual effects similar for all options - but this option performed slightly worse	Significant INNS risk associated with raw water transfer between the River Trent and Rutland Water. Mitigated by the construction of an INNS treatment plant at the River Trent intake.	All options similar – worst overall	Same for all options	Embodied Carbon – greatest footprint among all options. Operational carbon – greatest footprint among 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 intercepting designated sites and to avoid sensitive community facilities.
- Further opportunities for directional drilling or other non-disruptive methods should be explored 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. NC and BNG output tables

The NC and BNG outputs are available on the South Lincs Reservoir Community SharePoint site here:

https://anglianwater.sharepoint.com/:f:/r/sites/fcmSouthLincsReservoir/Shared%20Documents/A2AT/Gate%201%20submission%20-%20ready%20for%20review/02%20Environmental%20Assessment%20Report/Stage%201%20Environmental%20Assessments/NC%20and%20BNG?csf=1&web=1&e=5UyWJ5

The outputs can be provided as digital files upon request.

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