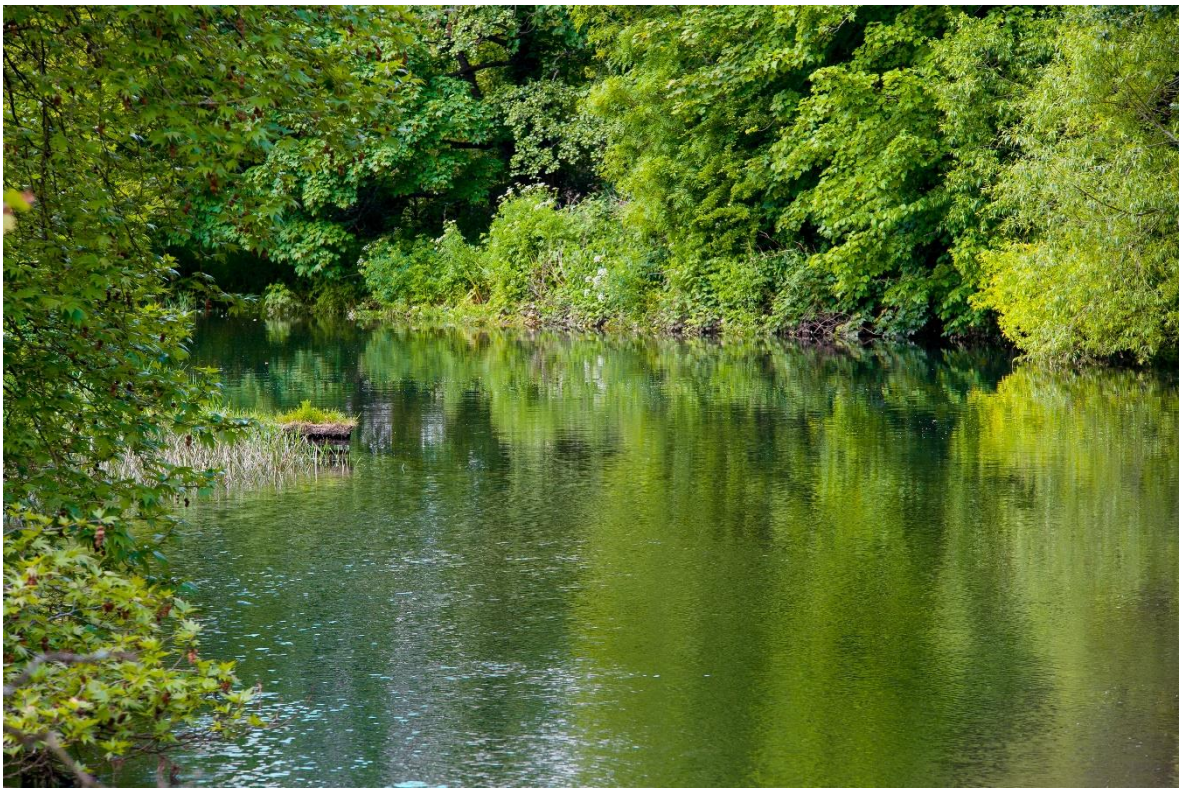
Strategic Regional Water Resource Solutions: Annex B1 Environmental Appraisal Report

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

Date: November 2022



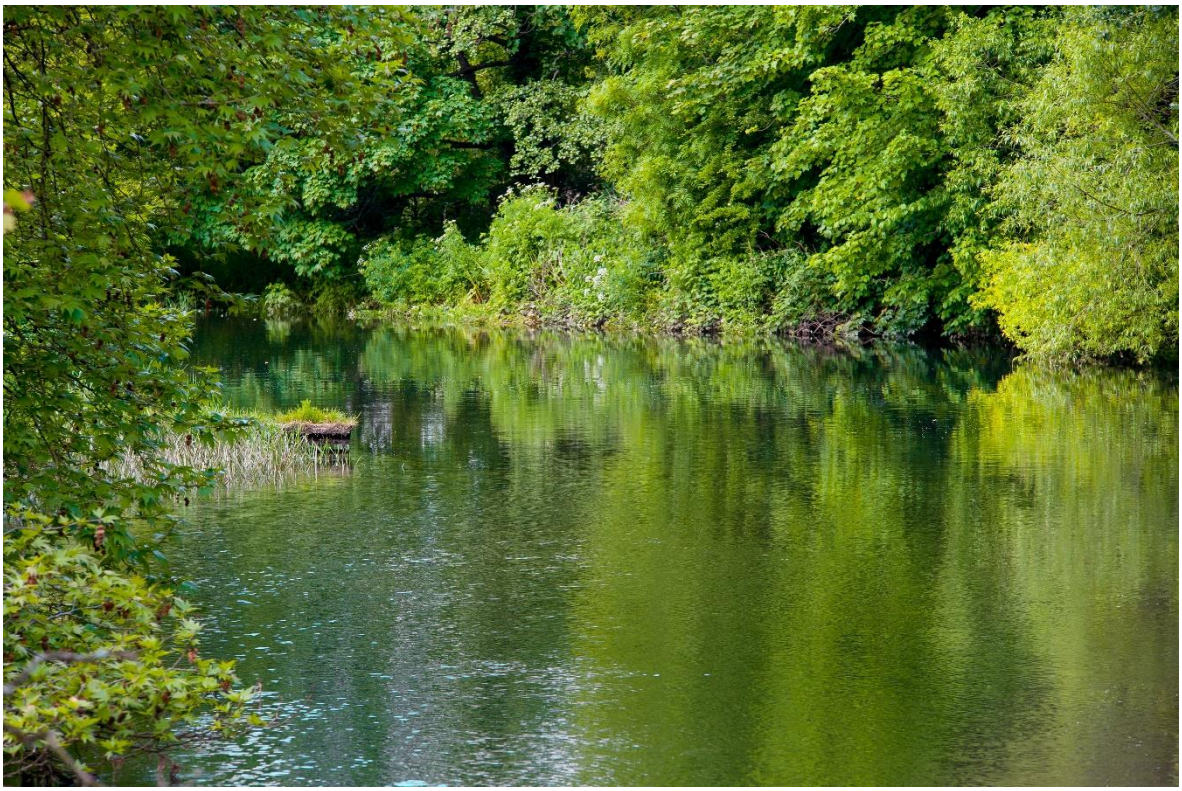
Notice

Position Statement

- *This document has been produced as the part of the process set out by RAPID for the development of the Strategic Resource Options (SROs). This is a regulatory gated process allowing there to be control and appropriate scrutiny on the activities that are undertaken by the water companies to investigate and develop efficient solutions on behalf of customers to meet future drought resilience challenges.*
- *This report forms part of suite of documents that make up the 'Gate 2 submission.' That submission details all the work undertaken by Thames Water and Southern Water in the ongoing development of the proposed SROs. The intention of this stage is to provide RAPID with an update on the concept design, feasibility, cost estimates and programme for the schemes, allowing decisions to be made on their progress and future funding requirements.*
- *Should a scheme be selected and confirmed in the Thames Water and Southern Water final Water Resources Management Plans, in most cases it would need to enter a separate process to gain permission to build and run the final solution. That could be through either the Town and Country Planning Act 1990 or the Planning Act 2008 development consent order process. Both options require the designs to be fully appraised, and in most cases an environmental statement to be produced. Where required that statement sets out the likely environmental impacts and what mitigation is required.*
- *Community and stakeholder engagement is crucial to the development of the SROs. Some 'high level' activity has been undertaken to date. Much more detailed community engagement and formal consultation is required on all the schemes at the appropriate point. Before applying for permission Thames Water and Southern Water will need to demonstrate that they have presented information about the proposals to the community, gathered feedback and considered the views of stakeholders. We will have regard to that feedback and, where possible, make changes to the designs as a result.*
- *The SROs are at a very early stage of development, despite some options having been considered for several years. The details set out in the Gate 2 documents are still at a formative stage and consideration should be given to that when reviewing the proposals. They are for the purposes of allocating further funding not seeking permission.*

Disclaimer

This document has been written in line with the requirements of the RAPID Gate 2 Guidance and to comply with the regulatory process pursuant to Thames Water's and Southern Water's statutory duties. The information presented relates to material or data which is still in the course of completion. Should the solution presented in this document be taken forward, Thames Water and Southern Water will be subject to the statutory duties pursuant to the necessary consenting process, including environmental assessment and consultation as required. This document should be read with those duties in mind.



THAMES TO SOUTHERN TRANSFER (T2ST)

Annex B1 Environmental Appraisal Report

Atkins Ref: T2ST-G2-REP-03 (Annex B1)

November 2022

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Glossary

Acronym	Definition
AA	Appropriate Assessment
ACWG	All Companies Working Group
AEP	Annual Exceedance Probability
ALC	Agricultural Land Classification
AQMA	Air Quality Management Areas
BAP	Biodiversity Action Plan
BEIS	Business, Energy and Industrial Strategy
BGS	British Geological Survey
BMV	Best Most Versitile
BN	Biodiversity Network
BNG	Biodiversity Net Gain
BOA	Biodiversity Opportunity Areas
BPM	Best Practicable Means
BPT	Break Pressure Tank
BRC	Biological Record Centres
BU	Biodiversity Units
CA	Conservation Areas
CAW	Carbon Accounting Workbook
CAZ	Clean Air Zones
CCRA	Climate Change Risk Assessments
CEH	Centre for Ecology and Hydrology
CEMP	Construction Environmental Management Plan
CRT	Canal and River Trust
CTMP	Construction Traffic Management Plan
DAF	Dissolved Air Flotation
DCO	Development Consent Order
Defra	Department for Environment, Food and Rural Affairs
EAR	Environmental Appraisal Report
EfW	Energy from Waste
ENCA	Enabling a Natural Capital Approach
GAC	Granular Activated Carbon
GDP	Gross Domestic Product
GVA	Gross Value Added
GWDTE	Groundwater Dependent Terrestrial Ecosystems
HER	Historic Environment Record

Acronym	Definition
HGV	Heavy Goods Vehicle
HRA	Habitats Regulations Assessment
IAQM	Institute of Air Quality Management
IMD	Indices of Multiple Deprivation
INNS	Invasive non-native species
JNCC	Joint Nature Conservation Committee
LCM	Land Cover Map
LNP	Local Nature Partnership
LNR	Local Nature Reserve
LNRS	Local Nature Recovery Strategies
LWS	Local Wildlife Site
MAGIC	Multi Agency Geographic Information for the Countryside
NAU	National Appraisal Unit
NBN	National Biodiversity Network
NC	Natural Capital
NCA	National Character Area
NFM	Natural Flood Management
NNR	National Nature Reserves
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NPSE	Noise Policy Statement for England
NRN	Nature Recovery Network
NWG	Northumbrian Water Group
ONS	Office for National Statistic
ORVal	Outdoor Recreation Valuation Tool
OS	Ordnance Survey
PIC	Public Interest Commitments
PPA	Power Purchase Agreement
PPE	Personal Protective Equipment
PRoW	Public Right of Way
PS	Pumping Station
RAPID	Regulators' Alliance for Progressing Infrastructure Development
RCP	Representative Concentration Pathway
REGO	Renewable Energy Guarantees of Origin
RGF	Rapid Gravity Filter
RLB	Red Line Boundary
RPA	Root Protection Area
SAC	Special Areas of Conservation
SEA	Strategic Environmental Assessment

Acronym	Definition
SESRO	South East Strategic Reservoir Option
SPZ	Source Protection Zone
SRO	Strategic Recourse Option
SSSI	Site of Special Scientific Interests
STT	Severn to Thames Transfer
STW	Sewage Treatment Works
tCO2e	Tonnes of CO2 equivalent
T2ST	Thames to Southern Transfer
TPO	Tree Preservation Orders
UKWIR	United Kingdom Water Industry Research
VSD	Variable Speed Drives
WFD	Water Framework Directive
WRMP	Water Resources Management Plan
WRPG	Water Resources Planning Guideline
WSR	Water Supply Reservoir
WRSE	Water Resources South East
WTW	Water Treatment Works
ZoI	Zone of Influence

Executive summary

The Environment Assessment Report (EAR) accompanies the Gate 2 submission to the Regulators' Alliance for Progressing Infrastructure Development (RAPID) for the Thames to Southern Transfer (T2ST) Strategic Resource Option (SRO).

The assessments presented here develop work undertaken at Gate 1. The assessments undertaken at Gate 1 were applied to six options for transferring water between the Thames Water Region and the Southern Water Region. Route and site selection undertaken at Gate 2 has identified two options for the T2ST SRO, transferring potable water from new Water Treatment Works (WTW) at the intake location to be located on existing agricultural land to the west of A34 near Drayton in Oxfordshire in the Thames Water region to the existing Yew Hill Water Supply Reservoir (WSR) near Winchester in the Southern Water region. These options have been developed based on series of criteria that consider engineering, environmental, social, and planning constraints. The route for each option has been identified within a wider corridor that meets a majority of the criteria and therefore avoids a large number of environmental designations and communities along its route.

These options are: Option B – Central route via Newbury (West of Newbury and remaining west of the A34, to Winchester); and Option C – Central route via Newbury (West of Newbury and then crossing to the east of the A34, to Winchester). Option C is a variation of option B. The majority of the route is common to both, with the only difference being the central section of the route to the south of Newbury which goes west of the A34 in Option B, and east of the A34 in Option C.

Option B and C are similar in their location, which results in their impacts on receptors also being similar, with the key differences between them being the following:

- Option B affects Cliffeville authorised landfill and an additional scheduled monument, which is not affected by Option C;
- Option C affects Bere Mill Meadows Site of Special Scientific Interest (SSSI), which is not affected by Option B, and is in close proximity (within 15m) to a greater number of Ancient Woodlands than Option B; and
- Option C requires an additional crossing of the River Test SSSI.

Three regulatory assessments have been undertaken for the two T2ST options: an Informal Habitats Regulations Assessment (HRA); a Water Framework Directive (WFD) Assessment; and a Strategic Environmental Assessment (SEA) (a SEA level assessment was applied to the options). The regulatory assessments are summarised in the EAR and the full assessments are presented as separate annexes (Annex B2, B3 and B4 respectively).

The informal Habitats Regulations Assessment reports the findings of the HRA Stage 2/ Appropriate Assessment (AA) undertaken at plan level for Options B and C. The HRA report assesses the potential impacts of the options on Natura 2000 sites and the UK's National Site Network and Ramsar sites. These sites are collectively referred to throughout the Gate 2 submission as 'Habitats Sites'. The HRA screening identified a number of potential 'likely significant effects', and a number of 'uncertain effects' for each of the options. Following the AA, no adverse effects resulting from the implementation of Option B (alone and in-combination with other projects or plans), or Option C (alone and in-combination with other projects or plans) are reasonably foreseeable on the integrity of the Habitats Sites, if the suggested mitigation measures are observed. Mitigation measures suggested included implementing pipejack or micro tunnel crossings to cross watercourses that are designated as a Habitats Site. No

adverse effects to the site integrity have been identified resulting from the implementation of either Option B or Option C, and any residual effects are considered negligible. Consequently an in-combination assessment with other projects or plans is not required for the HRA. This assessment must be revised if further design iterations result in changes to potential impact pathways and potential significant effects upon Habitats Sites. This would be undertaken as part of a formal HRA to be completed at the appropriate stage of design, pursuant to the consenting regime.

The WFD Assessment reports the findings of the Level 1 and Level 2 WFD Assessment undertaken at plan level for Options B and C. Potential impacts on the water environment from pipeline route options have been assessed and summarised. For both Option B and Option C, the Gate 2 Level 1 WFD assessment indicated that 16 out of 24 waterbodies could be screened out as not requiring further assessment. The Gate 2 Level 2 WFD assessment has been completed for the remaining eight waterbodies that were screened in. The Level 2 assessment considers that Option B will have a direct impact on WFD supporting conditions as part of the scheme in one waterbody (River Test Chalk). The findings indicate that there are potential WFD compliance risks associated with the operation of the scheme, due to the works taking place adjacent to and potentially within the River Test SSSI which is also a Groundwater Dependent Terrestrial Ecosystems (GWDTE) and East Aston Common SSSI & GWDTE. For Option C the Gate 2 Level 2 WFD assessment has been completed for the remaining eight waterbodies that were screened in. The Level 2 assessment considers that the scheme will have a direct impact on WFD supporting conditions as part of the scheme in one waterbody (River Test Chalk). The findings indicate that there are potential WFD compliance risks associated with the operation of the scheme, due to the works taking place adjacent to and potentially within the River Test SSSI & GWDTE, East Aston Common SSSI & GWDTE and Bere Mill Meadows SSSI & GWDTE. Further design detail and mitigation is required to ensure that there is no risk of WFD deterioration to the waterbodies due to the construction and presence of the scheme. Mitigation might include returning groundwater abstracted during temporary construction dewatering back into the ground to help maintain groundwater levels, or additional measures, such as gravel beds and clay stanks, to minimise the disruption to groundwater flow paths from the presence of the pipeline. Proposed mitigation measures for reducing option impact have also been included as part of the WFD assessment. If all measures are agreed and considered, then no adverse, permanent impacts on the water environment is anticipated to occur as a result of the implementation of Option B or Option C. Examples of mitigation measures include standard best practice dewatering methods and standard best practice water pollution control measures. A WFD cumulative effects assessment was undertaken on both route options B and C. The assessment found that cumulative WFD effects were likely during operation from other SROs (South East Strategic Reservoir Option (SESRO) and Severn to Thames Transfer (STT)), but cumulative effects during construction were unlikely. These effects were identified given the potential for changes in flow and water quality in the River Thames, from SESRO, STT and T2ST. Since T2ST cannot be considered as an option without the use of either SESRO or STT, the in-combination assessment in the River Thames water body is integrated into this assessment. No construction cumulative effects were identified. T2ST is not identified to have any construction or operational related cumulative effects with other water company schemes, or other projects under Local Development Frameworks and Planning Applications. Further WFD assessment would be required for future planning/consent applications, to improve the confidence and certainty of WFD risks outlined in the Gate 2 WFD Level 2 assessments.

The Strategic Environmental Assessment reports the findings of the options level SEA applied to the two options. The approach to the SEA is aligned with the Water Resources South East (WRSE) regional plan environmental assessment process. It should be noted that the T2ST SEA is not a formal SEA under The Environmental Assessment of Plans and Programmes Regulations 2004 as it is a project not a plan/programme and is therefore, outside the scope of

the SEA Regulations. The SEA level assessment applied to the options identified that both options (Route B and Route C) have similar effects for each of the SEA objectives with both options scoring the same against each objective. The results highlighted that following mitigation, residual negative impacts were predicted on a number of the objectives during construction, but these mostly became a neutral impact during operation. During construction, moderate negative residual effects were identified for biodiversity, flora and fauna as a result of the options intersecting international (Natura 2000 sites) and nationally designated sites, and potential impacts on priority habitats and Ancient Woodland. Minor negative residual effects were identified for landscape during construction and operation due to impacts on the North Wessex Downs Area of Outstanding Natural Beauty (AONB), minor negative residual effects for soil during construction due to proximity to landfill sites, and minor negative residual effects were identified for material assets (built assets and infrastructure) during construction due to crossing of highways and railways during construction. Major positive residual effects during operation were identified for the SEA objective on delivering reliable and resilient water supplies given the options improve the transfer of water across regions. Mitigation measures to prevent, reduce or off-set adverse environmental effects have been identified as part of the SEA. A cumulative effects assessment was undertaken on both route options B and C, as per the cumulative effects assessment methodology which considered the potential cumulative effects of both options (Route B and C) with other SROs, water company schemes, local development frameworks and planning applications. A full cumulative effects assessment, as would be reported in an Environmental Impact Assessment (EIA), is not appropriate for Gate 2 due to the conceptual design stage of the T2ST SRO. It was identified that T2ST has the potential to result in cumulative effects with other SROs, local development frameworks and planning applications during the construction phase (prior to 2035, or 2049 depending on which scenario goes forward following the WRSE emerging plan). These effects were identified given there is potential for the timing of the construction phases of T2ST to overlap with the construction phase of these other plans, programmes and projects. No operational cumulative effects were identified. T2ST is not identified to have any construction or operational related cumulative effects with other water company schemes.

During Gate 2, desk-based assessments were undertaken to identify potential impacts on the environment from the pipeline corridors and above ground infrastructure required as part of the T2ST SRO. The results of the regulatory assessments fed into the environmental appraisal. In applying the environmental assessments to the route corridors and sites comprising the options, a number of constraints and issues for further investigation and work were identified. However, the assessments did not identify any significant environmental risks where mitigation could not be provided and the viability of the T2ST scheme would be affected. Constraints and issues identified include the potential for impacts on sensitive habitats, including several SSSI, Special Areas of Conservation (SAC) and Local Wildlife Sites (LWS) and some priority habitats and species. The proposed pipeline intersects SPZs, including five SPZ1s. There is an opportunity to move the indicative location of the new WTW at the intake location to just outside Flood Zone 2 and 3. Temporary construction activity and intermittent operational activity is likely to affect tranquillity within the North Wessex Downs AONB which is noted for its quiet rural character from views. It is expected that, during construction, the temporary diversion or closure of several footpaths and cycleways, would temporarily reduce recreational connectivity. In terms of historic environment, the impacts of the options are minor and temporary, mainly affecting conservation areas and non-designated assets, although one Scheduled Monument has the potential to be temporarily impacted. The setting of several Grade II listed buildings could also be affected. The options avoid the requirement for land affecting residential property, business premises and community facilities. There may be some temporary impacts on the amenity of those close to construction activity and from temporary disturbance to Public Rights of Way. The options also involve crossings of transport and utility infrastructure, as well as historic landfills and one active landfill (Option B only).

The risk of spreading invasive non-native species (INNS) associated with the options has been investigated. The INNS risk assessment identified that the risk of spreading INNS is the same for both options B and C. The proposed transfers will introduce a new hydrological connection between previously isolated catchments. The SRO involves the transfer of treated water from a WTW to an enclosed WSR. At no point during the normal operation of the transfer will raw or treated water be discharged to an open waterbody. Therefore, there is no risk of INNS introduction to the receptor catchment. Biosecurity measures have already been incorporated into aspects of the design and this will need to continue as the design develops.

The Natural Capital Assessment (NCA) identified that the options will likely cause the temporary and permanent loss of natural capital stocks during construction. Stocks that are likely to be permanently lost include arable land, pasture, other semi-natural grassland, and active floodplain. However, best practice mitigation (such as pipejack or micro tunnel crossings) and reinstatement/compensation of habitat means that most Natural Capital stocks post construction will have no to little change. The NCA has identified that pipeline routes through the route corridors exist that avoid the majority of impacts on ancient woodland.

The assessment of Biodiversity Net Gain (BNG) calculates that in the range 240-260 BNG habitat units would be lost due to the temporary removal of habitats during construction.

The routes present an opportunity to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats. The route option crosses several priority habitats, Network Enhancement Zones, Fragmentation Action Zones, and Network Expansion Zones and is therefore suitable for the planting of new high value habitats.

The wider benefits that are predicted to arise from implementing the T2ST SRO options have been reviewed and areas of disbenefit are also considered. The wider benefits are those areas of environmental and social value that are associated with constructing and operating the scheme. Beneficial economic impacts associated with new operational phase jobs are expected to generate approximately £22 million (over the 30 year appraisal period). Proposals to enhance green infrastructure links and local footpaths could lead to health and well-being benefits.

Reducing whole life carbon is an important aspiration and opportunities have been investigated. The estimations of carbon costs show that the estimated carbon capital and operational carbon impacts for the T2ST transfer options B and C are relatively similar. The estimated capital carbon (tCO2e) required for the 80Ml/d and 120Ml/d options are similar for both transfer options B and C, although the 50Ml/d option is somewhat higher for Option C. Operational carbon is similar for both route options, but higher for Option B than Option C. Whole life carbon and the monetised carbon values are also similar for both route options, with the 50Ml/d option being higher for Option C, and the 80 Ml/d and 120Ml/d options being higher for Option B. The cost base for the monetised whole life carbon estimates is 2020. Some considerations have been identified that the T2ST transfer options could take to decarbonise and drive towards net zero. An important part of turning some of the considerations into deliverable opportunities is to have a robust carbon management process embedded into the scheme development.

The assessments undertaken as part of this SRO have identified a number of issues that can feed into the ongoing design and a number of mitigation measures and management plans that need to be developed to avoid and reduce predicted impacts. Potential high risk issues identified at this stage include the crossing an active landfill site in Option B (Cliffeville landfill), potential impacts on SSSI GWDTE (both options, but an additional one for Option C) and loss of ancient woodland (both options, but higher risk in Option C). However, no significant environmental issues have been identified at this stage.

1 Introduction

1.1 Purpose and structure of the report

This Annex is the Environmental Appraisal Report (EAR) which accompanies the Gate 2 submission to the Regulators' Alliance for Progressing Infrastructure Development (RAPID) for the Thames to Southern Transfer (T2ST) Strategic Resource Option (SRO). The aim of this EAR is to meet the requirements for the RAPID Gate 2 guidance[1], to draw together the conclusions of all the Gate 2 environmental appraisal work into a single document. The All Companies Working Group (ACWG) guidance[2] that was released in Gate 1 is still largely relevant and has been followed, however it has been somewhat superseded by the RAPID Gate 2 guidance, which the Gate 2 assessments have followed.

This document presents the results of the environmental appraisal of the options for the T2ST SRO at Gate 2. This document is an update of the work undertaken at Gate 1, presenting information on the same topics. Information is presented for two options and identifies the effects and opportunities of each.

This document is presented in the following sections:

- Section 2 Scheme Description: An overview of the T2ST options.
- Section 2.1 Regulatory Assessment Report: Information on the regulatory assessments undertaken as part of the Gate 2 submission.
- Section 4 Environmental Appraisal: desk-based assessments identifying potential effects (positive and negative) and opportunities from the pipeline corridors and above ground infrastructure.
- Section 5 Invasive non-native species (INNS) Risk Assessment: INNS risk assessment undertaken on the options.
- Section 6 Natural Capital (NC) and Biodiversity Net Gain (BNG): NC and BNG assessment undertaken on the options.
- Section 7 Wider benefits: High level socio-economic assessment undertaken on the options.
- Section 8 Carbon: Appraisal of opportunities for net zero carbon contributions: High level carbon assessment undertaken for the T2ST scheme.
- Section 9 Comparison between options and summary conclusions:

1.2 Background

The Gate 1 submission to RAPID for the T2ST SRO confirmed that there were six feasible options to transfer water from Thames Water's area to Southern Water's Hampshire zones. These options included raw water and potable water options and there was no preferred option at Gate 1.

The Gate 1 environmental assessment included a Habitats Regulations Assessment (HRA); a Water Framework Directive (WFD) Assessment; and an options level Strategic Environmental Assessment (SEA). In addition, the risk of spreading INNS was investigated; BNG and NC assessments were undertaken; the wider benefits of the scheme was reviewed; and

[1] Regulators' Alliance for Progressing Infrastructure Development (RAPID) Strategic Regional Water Resource Solutions Guidance for Gate Two. Available at: Strategic-regional-water-resource-solutions-guidance-for-gate-two_Feb_2022.pdf (ofwat.gov.uk) [accessed April 2022]

[2] All Companies Working Group, WRMP environmental assessment guidance and applicability with SROs, Mott MacDonald, October 2020.

opportunities for the six options to contribute to net zero carbon emission objectives were investigated. These assessments identified a number of mitigations that would be required to be put in place, should the options be taken forward.

The combination of the Gate 1 environmental assessments and studies showed that positive benefits would likely result from operation of the T2ST scheme, but construction of the scheme would likely result in some negative effects, mostly temporary, even with the application of mitigation measures.

1.3 Gate 2 Thames to Southern Transfer Options

The assessments presented here develop work undertaken at Gate 1. The assessments undertaken at Gate 1 were applied to six options for transferring water between the Thames Water Region and the Southern Water Region.

Route and site selection undertaken at Gate 2 has identified two options for the T2ST SRO, with 3 possible capacities of 50Ml/d, 80Ml/d and 120Ml/d, transferring potable water from a new Water Treatment Works (WTW) at the intake location to be located on existing agricultural land to the west of A34 near Drayton in Oxfordshire in the Thames Water region to the existing Yew Hill Water Supply Reservoir (WSR) near Winchester in the Southern Water region. These options have been developed based on series of criteria that consider engineering, environmental, social, and planning constraints. The route for each option has been identified within a wider corridor that meets the majority of the criteria and therefore the pipeline can avoid a large number of environmental designations and communities along its route. These options are listed below and further detailed in Section 2.

- Option B – Central route via Newbury (West of Newbury and remaining west of the A34, to Winchester); and
- Option C – Central route via Newbury (West of Newbury and then crossing to the east of the A34, to Winchester).

Option C is a variation of option B. The majority of the route is common to both, with the only difference being the central section of the route to the south of Newbury which goes west of the A34 in Option B, and east of the A34 in Option C.

Full details of the route and site selection undertaken at Gate 2 is included in the Route and Site Selection Annex A2, which also details the discounted options.

Option B and C are similar in their location, which results in their impacts on receptors also being similar, with the key differences between them being the following:

- Option B affects Cliffeville authorised landfill and an additional scheduled monument, which is not affected by Option C;
- Option C affects Bere Mill Meadows Site of Specailis Scientific Interest (SSSI) and Groundwater Dependent Terrestrial Ecosystem (GWDTE), which is not affected by Option B, and is in close proximity (within 15m) to a greater number of Ancient Woodlands than Option B; and
- Option C requires an additional crossing of the River Test SSSI.

1.4 Stakeholder engagement

The principles for our approach to environmental engagement are as follows:

- To build on the engagement undertaken to date, taking account of any issues and concerns raised by local communities or stakeholders, ensuring discussions are timely;

- To fit within the regulatory process established under the guidance to understand and agree expectations; and,
- To be integrated with regional/company water resource planning.

Engagement during Gate 2 has focused on development of the pipeline route corridor and location of above ground infrastructure.

Regular engagement has been undertaken with the National Appraisal Unit (NAU) during Gate 2. Key areas of engagement include NAU feedback on risks of options that involved raw water transfers. NAU provided some data on environmental constraints to inform the route and site selection process, as well as providing feedback on the shortlisted options, recognising there remained challenges with all options. NAU did not indicate that the preferred routes were not feasible and provided information on the expected mitigation, for example, for crossing watercourses.

Engagement with the NAU has helped refine the options to potable transfers. Information and feedback provided by NAU has informed route and site selection, helping to avoid sensitive areas. Mitigation suggestions provided by NAU have been included in the design and environmental assessments. Constraints and location-specific challenges flagged by NAU have been identified as areas for further work.

Stakeholder engagement activity with other stakeholders is described in the Gate 2 Report.

1.5 Assumptions and limitations

Throughout this report, assessments have been undertaken assuming the maximum transfer capacity of 120Ml/d.

Information provided by third parties, including publicly available information and databases, is considered correct at the time of assessment (March 2022). Due to the dynamic nature of the environment, conditions may change in the period between the preparation of these reports, and the undertaking of the proposed works. Changes since the date of assessment, such as additional designated sites, will be taken into account in future assessments.

For assumptions and limitations for the regulatory assessments, see the full assessments in Annex B2 HRA, Annex B3 WFD and Annex B4 SEA.

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

For assumptions and limitations of the NC and BNG assessment, see Section 6.6.

For assumptions and limitations of the carbon assessment, see Section 8.5.

2 Scheme description

2.1 Overview

The T2ST route begins at a new WTW at the intake location to be located on existing agricultural land to the west of A34 near Drayton in Oxfordshire in the Thames Water region and ends at the existing Yew Hill WSR near Winchester in the Southern Water region. The transfer scheme has 3 possible capacities of 50Ml/d, 80Ml/d and 120Ml/d and includes a number of intermediate break pressure tanks and pumping stations to allow hydraulic transfer of the water between the new WTW at the intake location and Yew Hill WSR. In practice T2ST will either be supplied by either the Severn to Thames Transfer SRO (STT) or the South East Strategic Reservoir Option (SESRO).

A full scheme description can be found in the RAPID Gate 2 Report and in Annex A3 the Concept Design Report, however a summary of the main aspects of the options are included below.

The transfer route between the new WTW at the intake location and Yew Hill WSR is approximately 80-85km in length.

The majority of the pipeline installed will be 1000 to 1100mm diameter at maximum capacity of 120Ml/d which will be installed primarily using open cut excavation. The pipeline route passes predominantly through open rural countryside, crossing a number of roads, rivers and railways. To provide sufficient working space to construct the pipeline a temporary working easement will be required, typically up to 40m wide depending on the final design depth of the pipeline. During construction the topsoil within the easement would be stripped back and stored locally within the easement, followed by excavation of the pipe trench which would be approximately 1.8m wide x 2.2m deep, to allow minimum cover of 900mm above the pipe and 300mm pipe bedding under the pipeline, for a 1000mm diameter pipeline.

Smaller diameter connection pipelines are also required in two locations, to the existing water supply network at Beacon Hill WSR and Micheldever WSR, as detailed in the sections below.

There are expected to be several major road, rail and river crossings located along the preliminary pipeline routes which are anticipated to require trenchless technology. Through consultation with Thames Water and Southern Water it has been assumed at concept design stage that all expected trenchless crossings will comprise a single tunnelled crossing, using pipe jacking and micro tunnelling. Launch and reception shafts would be constructed either side of the surface feature and a concrete tunnel section then constructed between the two shafts.

Pipejack or micro tunnel crossings will be required to cross existing railways, motorways, A roads and B Roads. Other minor road crossings will be installed using open cut methods and temporary road closure.

Pipejack or micro tunnel crossings will also be required to cross main watercourses. Crossings for ordinary watercourses will be installed using open cut methods and temporary culverts.

Full details of the crossings lengths and locations can be found in Annex A3, the Concept Design Report.

There are two options within the T2ST SRO for transferring water from the new WTW site at the intake location to the west of A34 near Drayton to the existing Yew Hill WSR near Winchester as described below:

- Option B - Central route via Newbury (West of Newbury and remaining west of the A34, to Winchester), with a total pipeline length including spur connections of 93.8km; and
- Option C - Central route via Newbury (West of Newbury and then crossing to the east of the A34, to Winchester), with a total pipeline length including spur connections of 94.2km.

Option C is a variation of option B. The majority of the route is common to both, with the only difference being the central section of the route to the south of Newbury which goes west of the A34 in Option B, and east of the A34 in Option C.

A schematic of the Options B and C is provided in Figure 2.1 which shows indicative locations for the WTW, pipe route corridors and connection points to the existing water network.

Figure 2.1: Schematic of preferred T2ST options B and C

Each route can be split into 4 sections as discussed in the below sections.

2.2 Option B - Central route via Newbury (West of Newbury and remaining west of the A34, to Winchester)

2.2.1 Option B Section 1 – Water Treatment Works to BS3

This section is approximately 18.0km in length.

2no. Pipe jack crossings will be required along this section including the Didcot to Swindon railway line and the A417. The following above ground assets are located within this section:

- BS1 Water Treatment Works (WTW) and Pumping Station (PS) - 120Ml/d, approx. land area 300m x 150m;
- BS2 Break Pressure Tank (BPT) – 5Ml/d, approx. land area 75 x 55m; and
- BS3 PS and BPT - 5Ml/d, approx. land area 80 x 80m.

2.2.2 Option B Section 2 – BS3 to north of the River Enbourne

This section is approximately 19.6km in length.

8no. Pipe jack crossings will be required along this section including B4494, M4, Winterbourne Road, River Lambourn, B4000, A4, Wick Wood, and River Kennet & Newbury railway line (including the Kennet and Avon Canal). There are no above ground assets required within this section.

2.2.3 Option B Section 3 – River Enbourne, west of the A34 to River Test

This section is approximately 32.1km in length.

The route includes a 250mm diameter pipeline connection to an existing tank at Beacon Hill, approximately 1.8km in length.

The route also includes a 700mm diameter pipeline connection to the existing Micheldever WSR, approximately 7km in length.

9no. Pipe jack crossings will be required along this section including River Enbourne, A343, Bourne Rivulet/B3048, Andover railway line, B3400, A303 (1), A303 (2), B3048 and the River Test.

The following assets are located within this section:

- BS4 PS and BPT – Options 1, 2 and 3 (only one location required, but currently reviewing 3 options) – 5Ml/d, approx. land area 80 x 80m;
- BS5 BPT – 5Ml/d, approx. land area 75 x 55m;
- Beacon Hill WSR – existing asset, not part of this assessment;
- Micheldever WSR - existing asset, not part of this assessment; and
- BS6 PS, approx. size 65 x 40m.

2.2.4 Option B Section 4 – River Test to Yew Hill WSR

This section is approximately 24.1km in length.

6no. Pipe jack crossings will be required along this section including A303, River Dever, A30, A272, B3049, and A3090.

The route includes a connection to the existing Crabwood WSR.

The route ends with a connection to the existing Yew Hill WSR.

There are no above ground assets proposed for this section.

2.2.5 Option B summary

Table 2.1 summarises the proposed works for Option B.

Table 2.1: Option B scheme description summary

Section	Pipe length	New assets	Trenchless crossings of natural features
Section 1 – Water Treatment Works to BS3	18.0km	BS1 WTW and PS BS2 BPT BS3 PS and BPT	None
Section 2 –BS3 to north of the River Enbourne	19.6km	None	River Lambourn Wick Wood River Kennet
Section 3 – River Enbourne, west of A34 to River Test	32.1km	BS4 PS and BPT BS5 BPT BS6 PS	River Enbourne Bourne Rivulet River Test
Section 4 – River Test to Yew Hill WSR	24.1km	None	River Dever

2.3 Option C - Central route via Newbury (West of Newbury and then crossing to the east of the A34, to Winchester)

2.3.1 Option C Section 1 –Water Treatment Works to CS3

As per option B.

This section is approximately 18.0km in length.

2no. Pipe jack crossings will be required along this section including the Didcot to Swindon railway line and the A417.

The following assets are located within this section:

- CS1 WTW and PS - 120Ml/d, approx. land area 300m x 150m;
- CS2 BPT – 5Ml/d, approx. land area 75 x 55m; and
- CS3 PS and BPT - 5Ml/d, approx. land area 80 x 80m.

2.3.2 Option C Section 2 – CS3 to north of the River Enbourne

As per option B.

This section is approximately 19.6km in length.

8no. Pipe jack crossings will be required along this section including B4494, M4, Winterbourne Road, River Lambourn, B4000, A4, Wick Wood, and River Kennet & Newbury railway line (including the Kennet and Avon Canal).

There are no above ground assets required within this section.

2.3.3 Option C Section 3 – River Enbourne, east of the A34 to River Test

This section is approximately 32.5km in length.

The route includes a 250mm diameter pipeline connection to an existing tank at Beacon Hill, approximately 4.2km in length.

The route also includes a 700mm diameter pipeline connection to the existing Micheldever WSR, approximately 9.2km in length.

15No. Pipe jack or micro tunnel crossings will be required along this section including, River Enbourne, A34 (1), A343, Penwood Road, Woodland (1), Hopping Common and B4640,

Woodland (2), A34 (2), Whitchurch railway line, B3400, River Test (1), A34 (3), River Test (2), B3048, A303 (1), A303 (2).

The following assets are located within this section:

- CS4 PS and BPT – 5Ml/d, approx. land area 80 x 80m;
- Beacon Hill WSR – existing asset, not part of this assessment;
- Micheldever WSR - existing asset, not part of this assessment; and
- CS5 PS, approx. land area 65 x 40m.

2.3.4 Option C Section 4 – River Test to Yew Hill WSR

As per option B.

This section is approximately 24.1km in length.

6no. Pipe jack crossings will be required along this section including A303, River Dever, A30, A272, B3049, and A3090.

The route includes a connection to the existing Crabwood WSR.

The route ends with a connection to the existing Yew Hill WSR.

There are no above ground assets proposed for this section.

2.3.5 Option C summary

Table 2.1 summarises the proposed works for Option C.

Table 2.2: Option C scheme description summary

Section	Pipe length	New assets	Trenchless crossings of natural features
Section 1 – Water Treatment Works to CS3	18.0km	CS1 WTW and PS CS2 BPT CS3 PS and BPT	None
Section 2 – CS3 to River Enbourne	19.6km	None	River Lambourn Wick Wood River Kennet
Section 3 – River Enbourne, east of the A34 to River Test	32.5km	CS4 PS and BPT CS5 PS	River Enbourne Woodland and Hopping Common Woodland (west of Burghclere) River Test (two crossings required)
Section 4 – River Test to Yew Hill WSR	24.1km	None	River Dever

2.4 Asset description

The below sections describe the new assets to be installed as part of the SRO and list the equipment expected to be associated with them.

2.4.1 BS1/CS1 WTW and PS

The WTW is to be located at the north end of both corridor options B and C. Raw water will enter the screening and treatment processing before entering the option pipelines. The waste

water by-product of the treatment process will be sent for treatment to a local sewage treatment works. The WTW has approximately a 45,000m^2 area and will contain the following equipment

- Waste and sludge handling
- Ozone contact tanks
- Granular Activated Carbon (GAC) Plant
- UV plant
- Rapid Gravity Filter (RGF) plant
- Chlorine contact tank
- Dissolved Air Flotation (DAF) plant
- Flocculation tank
- Welfare
- Chemical storage
- Treated water storage
- Pumping station

It should be noted that at the time of writing no formal plans of the WTW has been issued. It is unknown at this point where equipment will be located on the site. An area has been identified with an approximate boundary for the location of the WTW and will be assessed against flood risk and other environmental impacts.

2.4.2 BS2/CS2 BPT, BS5 BPT

The area size of the BPT is approximately 4125m^2 and only includes a 5MI storage tank and access roads.

2.4.3 BS3/CS3 PS and BPT, BS4 PS and BPT and CS4 PS and BPT

For each of the PS and BPT assets, the PS and BPT are located on one site with area size approximately 6400m^2 and includes the following equipment:

- HV/LV transformer x2
- Surge tanks
- Standby generator
- Pumping station
- 5Ml Storage tanks

2.4.4 BS6/CS5 PS

The PS area size is approximately 2600m^2 and includes the following equipment.

- HV/LV transformer
- Surge tanks
- Standby generator
- Pumping station

2.5 Programme assumptions

The draft Water Resources South East (WRSE) regional plan sets out the overall need for T2ST and this feeds into the relevant Water Resource Management Plans (WRMPs) from both Thames Water and Southern Water. The draft WRSE regional plan has determined a need for a T2ST scheme of up to 120Ml/d by 2040-2053 depending on the scenario in the adaptive plan. Therefore, at this stage, it is envisaged the project will not be operational until at least 2040.

3 Regulatory assessments

The following regulatory assessments have been undertaken as desk based assessments to meet the requirements for the RAPID Gate 2 guidance [1], and the ACWG guidance[2]. It is recommended that the environmental assessment information from these assesments is fed into the WRSE Regional Plan and the Thames Water and Southern Water WRMP24s.

3.1 Informal Habitats Regulations Assessment

An Informal HRA and Stage 2 Appropriate Assessment (AA) was undertaken at plan level for Options B and C in the T2ST SRO. The findings of the informal HRA & Stage 2 AA are presented in Annex B2. The informal HRA & Stage 2 AA report assesses the potential impacts of the options on Natura 2000 sites and the UK's National Site Network and Ramsar sites. These sites are collectively referred to in this document as 'Habitats Sites'.

The informal HRA and AA followed the methodology in the *Environmental Assessment Guidance for Water Resources Management Plans and Drought Plans (21/WR/02/15)*.

The HRA screening identified a number of potential 'likely significant effects', and a number of 'uncertain effects' for each of the options.

Following the AA, no adverse effects resulting from the implementation of Option B (alone and in-combination with other projects or plans), or Option C (alone and in-combination with other projects or plans) are reasonably foreseeable on the integrity of the Habitats Sites, if the suggested mitigation measures are observed.

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

- Trenchless crossings: The current design of all options includes a pipeline route that will cross watercourses that are designated as a Habitats Site (River Lambourn Special Area of Conservation (SAC) in Options B and C). The identified result of 'no likely significant effects' depends on the use of pipejack or micro tunnel crossings in all options, in order to avoid effects on watercourses;
- Any mature tree lines or hedgerows that might be traversed by the route are either preserved in situ (such as through pipe jacking beneath the hedge) or are immediately reinstated in order to avoid effects on bats;
- Standard best practice pollution control measures;
- Standard best practice biosecurity measures;
- Disturbance mitigation measures: including light, noise and visual mitigation measures; and
- A Construction Environmental Management Plan (CEMP) must be developed at the appropriate stage in the SRO development that will include the proposed mitigation measures in this AA as well as any other specific measures identified following further HRA activities or formal HRA.

No adverse effects to the site integrity have been identified resulting from the implementation of either Option B or Option C, and any residual effects are considered negligible. Consequently an in-combination assessment with other projects or plans is not required.

This assessment must be revised if further design iterations result in changes to potential impact pathways and potential significant effects upon Habitats Sites. This would be undertaken as part of a formal HRA to be completed at the appropriate stage of design, pursuant to the consenting regime.

3.2 Water Framework Directive Assessment

3.2.1 Methodology

A Water Framework Directive[3] assessment was undertaken for Options B and C in the T2ST SRO. The findings of the WFD assessment are presented in Annex B3. The WFD report assesses the potential impacts of the options on all potentially affected waterbodies.

The Water Framework Directive requires that waterbodies experience no deterioration in status. Overall good status is a function of good ecological status (biological, physico-chemical and hydromorphological elements and specific pollutants) and good chemical status (Priority Substances and Priority Hazardous Substances). The ACWG has developed a consistent framework for undertaking WFD assessments for SROs, considering mitigation which would need to be put in place to protect waterbody status.

Two stages of assessment are completed under this approach – an initial Level 1 basic screening and a Level 2 detailed impact screening. These use a spreadsheet assessment tool which is automated based on option information for Level 1 and expert judgement for Level 2.

3.2.2 Level 1 screening assessment results

Multiple waterbodies identified at Gate 1 were assessed during the Gate 2 Level 1 screening assessment, with further design development work refining this list. This means that 24 WFD river and groundwater bodies were identified for Level 1 screening.

Overall, the Gate 2 Level 1 WFD assessment indicated that for both Option B and Option C, 16 out of 24 waterbodies could be screened out as not requiring further assessment.

3.2.3 Level 2 detailed impact screening assessment results

3.2.3.1 Option B

The Option B Gate 2 Level 2 WFD assessment has been completed for the remaining eight waterbodies that were screened in. The Level 2 assessment considers that the scheme will have a direct impact on WFD supporting conditions as part of the scheme in one waterbody (River Test Chalk). The findings indicate that there are potential WFD compliance risks associated with the operation of the scheme, due to the works taking place adjacent to and potentially within the River Test SSSI also a GWDTE and East Aston Common SSSI & GWDTE. Further design detail and mitigation is required to ensure that there is no risk of WFD deterioration to the waterbodies due to the construction and presence of the scheme. Mitigation might include returning groundwater abstracted during temporary construction dewatering back into the ground to help maintain groundwater levels, or additional measures, such as gravel beds and clay stanks, to minimise the disruption to groundwater flow paths from the presence of the pipeline.

3.2.3.2 Option C

The Option C Gate 2 Level 2 WFD assessment has been completed for the remaining eight waterbodies that were screened in. The Level 2 assessment considers that the scheme will have a direct impact on WFD supporting conditions as part of the scheme in one waterbody (River Test Chalk). The findings indicate that there are potential WFD compliance risks associated with the operation of the scheme, due to the works taking place adjacent to and potentially within the River Test SSSI & GWDTE, East Aston Common SSSI & GWDTE and Bere Mill Meadows SSSI & GWDTE. Further design detail and mitigation is required to ensure

[3] The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017

that there is no risk of WFD deterioration to the waterbodies due to the construction and presence of the scheme. Mitigation might include returning groundwater abstracted during temporary construction dewatering back into the ground to help maintain groundwater levels, or additional measures, such as gravel beds and clay stanks, to minimise the disruption to groundwater flow paths from the presence of the pipeline.

3.2.4 Further work and mitigation

This Water Framework Directive Assessment, undertaken at plan level, finds that if mitigation measures suggested are followed that no adverse, permanent impacts on the water environment will occur as a result of the implementation of Option B and Option C. A distinguishing factor between the two options is the number of expected crossings of rivers, and roads within 500m of sensitive groundwater features (for example Option C has an additional crossing of the River Test and is located close to an additional GWDTE, Bere Mill Meadows SSSI).

A WFD cumulative effects assessment was undertaken on both route options B and C. The assessment found that cumulative WFD effects were likely during operation from other SROs (SESRO and STT), but cumulative effects during construction were unlikely. These effects were identified given the potential for changes in flow and water quality in the River Thames, from SESRO, STT and T2ST. Since T2ST cannot be considered as an option without the use of either SESRO or STT, the in-combination assessment in the River Thames water body is integrated into this assessment. No construction cumulative effects were identified. T2ST is not identified to have any construction or operational related cumulative effects with other water company schemes, or other projects under Local Development Frameworks and Planning Applications.

Further WFD assessment will be required for further work on the design beyond Gate 2 and for future planning/consent applications, to improve the confidence and certainty of WFD risks outlined in the Gate 2 WFD Level 2 assessments.

Areas for further assessment include:

- Hydroecological risk assessments into the impact of construction dewatering on groundwater levels, and potential implications on watercourses and GWDTE of Kennet and Lambourn Floodplains SSSI, Kennet Valley Alderwoods SSSI, River Test SSSI, East Aston Common SSSI and Bere Mill Meadows SSSI;
- If dewatering is discharged to surface watercourses to help maintain flow, there is the potential for short term impacts on water quality. Water quality analysis is required to understand the relative quality of groundwater and surface water in these areas and identify the significance of any changes in water quality in the watercourses;
- Detailed hydrological assessment of the impacts of changes in groundwater levels due to construction dewatering on flow in the Chalk streams and GWDTE which it supports;
- Consideration of pipejack or micro tunnel crossings for the more sensitive ordinary watercourses; and
- Additional groundwater investigation to understand groundwater levels across the route and how they interact with the pipeline during operation of the scheme. Further investigation should consider where groundwater levels are likely to be intersect with the pipeline, calculation of whether the pipeline could form a barrier to groundwater flow (and potential to increase flood risk), and identification of additional mitigation if required.

Proposed mitigation measures for reducing option impact have also been included as part of the WFD assessment and the implementation of this mitigation will determine the overall WFD assessment result. Mitigation measures should also include standard best practice dewatering methods and standard best practice water pollution control measures. Consideration of

mitigation measures will be subject to further developments in the optioneering for the routes. Examples of mitigation measures include:

- Standard best practice dewatering methods;
- Standard best practice water pollution control measures; and
- River intake: fish and eel screening at new intake.

3.3 Strategic Environmental Assessment

A SEA level assessment was applied to the options for the Gate 2 T2ST pipeline route options. The findings of the SEA level assessment are presented in Annex B4. It should be noted that the T2ST SEA is not a formal SEA under The Environmental Assessment of Plans and Programmes Regulations 2004 as it is a project not a plan/programme and is therefore, outside the scope of the SEA Regulations[4]. The SEA has been carried out as best practice and to help inform the regional planning and WRMP24 SEAs. The T2ST SEA Annex B4 document is not an Environmental Report under the Regulations and therefore, doesn't contain all of the information as set out in Schedule 2. A compliant Environmental Report will be produced for the WRMP24.

The approach to the SEA is aligned with the Water Resources South East (WRSE) regional plan environmental assessment process as presented in the WRSE SEA Scoping Report (Mott MacDonald, 2020) and Environmental Assessment Methodology Guidance (Revision D). This SEA has involved the identification of potential effects for each SEA objective at both the construction and operational phases, pre and post mitigation, with each SEA objective scored against an eight-point scale. The SEA objectives are presented in the table below.

Table 3.1: T2ST SEA Objectives

SEA Topic	SEA Objective
Biodiversity, flora and fauna	Protect and enhance biodiversity, priority species, vulnerable habitats and habitat connectivity (no loss and improve connectivity where possible)
Soil	Protect and enhance the functionality, quantity and quality of soils
Water	Increase resilience and reduce flood risk
	Protect and enhance the quality of the water environment and water resources
	Deliver reliable and resilient water supplies
Air	Reduce and minimise air emissions
Climatic Factors	Reduce embodied and operational carbon emissions
	Reduce vulnerability to climate change risks and hazards
Landscape	Conserve, protect and enhance landscape, townscape and seascape character and visual amenity
Historic Environment	Conserve, protect and enhance the historic environment, including archaeology
Population and Human Health	Maintain and enhance the health and wellbeing of the local community, including economic and social wellbeing
	Maintain and enhance tourism and recreation
Material Assets	Minimise resource use and waste production
	Avoid negative effects on built assets and infrastructure

Given both options (Route B and Route C) follow a very similar route, the SEA identified similar effects for each of the SEA objectives with both options scoring the same against each objective.

[4] UK Government (2004). The Environmental Assessment of Plans and Programmes Regulations 2004. Available at: https://www.legislation.gov.uk/uksi/2004/1633/contents/made [accessed April 2022]

Major positive effects (pre mitigation and post mitigation) have been identified for both options (Route B and Route C) for the SEA objective on delivering reliable and resilient water supplies given both the options improve the transfer of water across regions. WFD Level 1 Assessments were undertaken for both options (Route B and Route C) and triggered the requirement for WFD Level 2 Assessments. The WFD Level 2 Assessments (see Annex B3) for both options (Route B and Route C) identified that there are potential effects associated with the construction and operational phases, however these effects can be mitigated and further WFD assessment is therefore not required. Minor positive effects (pre mitigation and post mitigation) have been identified for both options (Route B and Route C) in relation to climate resilience given the options contribute to efficient use of water resources, providing protection against future drought scenarios (and potentially avoids abstractions in more vulnerable areas).

Carbon will be generated as a result of construction as well as during operation of both options (Route B and Route C). For both options (Route B and Route C), the SEA identified minor negative effects (pre mitigation and post mitigation) associated with carbon emissions during the construction phase and major negative effects (pre mitigation and post mitigation) during the operational phase.

Major negative effects were identified for biodiversity, flora and fauna (pre-mitigation) as a result of both of the options (Route B and Route C) intersecting international (Natura 2000 sites) and nationally designated sites. Route B is identified to have potential effects on Bere Mill Meadows SSSI whereas Route C does not. Both of the options (Route B and Route C) have the potential to result in impacts on priority habitats and Ancient Woodland. Ancient woodland is classed as ‘irreplaceable habitat’ and both options (Route B and Route C) intersect an area of Ancient Woodland. However, Route C is within close proximity (within 15m) to a greater number of Ancient Woodlands compared to Route B. A HRA Stage 1 Screening and Stage 2 Appropriate Assessment has been undertaken (see Annex B2) which identified that with appropriate mitigation, no likely significant effects are identified for Natura 2000 sites, or the UK National Site Network, for both options (Route B and Route C). The route corridors of both options (Route B and Route C) bisect a Local Wildlife Site and several SSSIs (some of which are GWDTE). Therefore, having potential for direct impact from habitat loss and disturbance. Assuming the routes can be re-routed to avoid these sites and the Ancient Woodland then residual effects are likely to be reduced, however moderate effects are identified post mitigation given uncertainty in baseline data and potential mitigation measures required.

The options (Route B and Route C) both pass through the North Wessex Downs AONB and the above ground assets are also located within the AONB, as such moderate negative effects were identified for landscape for the construction and operational phases (pre-mitigation). With careful design and screening residual effects (post mitigation) are likely to be minor. Moderate negative effects were also identified for the construction phase for the SEA objective on soil (pre-mitigation) given both options (Route B and Route C) have the potential for disturbance on agricultural land (Grade 2 – 5) and there is potential for both of the options (Route B and Route C) to disturb contaminants given they intersect or are within close proximity to historic and authorised landfill sites. Cliffeville landfill site is within the option corridor for Route B, however it is not within Route C. Given that land will be reinstated, soil management procedures are recommended and best practice to reduce contamination risk is recommended, the residual effects (post mitigation) are likely to be minor. The construction phase of both options (Route B and Route C) also have the potential to cause disruption to built assets and infrastructure therefore moderate negative effects are identified pre-mitigation. Use of pipejack or micro tunnel crossings under major roads and motorways and implementation of a Construction Traffic Management Plan (CTMP) will help reduce effects and therefore to minor negative effects are identified for both options (Route B and Route C) post mitigation. Minor negative or neutral effects were identified for the remaining SEA objectives.

Mitigation measures to prevent, reduce or off-set adverse environmental effects have been identified as part of the SEA.

A cumulative effects assessment was undertaken on both route options B and C, as per the cumulative effects assessment methodology. The assessment found that cumulative effects were likely to result during construction from other SROs (SESRO and STT), but cumulative effects during operation were unlikely. Cumulative effects may result during construction of some projects under Local Development Frameworks and Planning Applications, but cumulative effects during operation were unlikely to occur.

A number of recommendations for further work beyond Gate 2 are suggested.

4 Environmental Appraisal

4.1 Purpose and scope of environmental appraisal

This section presents the outcomes of desk-based assessments undertaken to identify potential impacts on the environment from the pipeline corridors and above ground infrastructure required as part of the T2ST SRO. The desk based assessments have been undertaken to meet the requirements for the RAPID Gate 2 guidance[1] and to address the RAPID Gate 1 T2ST Final Decision Actions, which included a requirement to "Fully identify and assess the impacts of pipeline routes and construction on the environment, particularly on designated sites and river crossings".

An assessment was undertaken for each of the topics as listed below:

- Biodiversity, flora and fauna
- Soils
- Water
- Air Quality
- Climatic factors
- Landscape
- Historic environment
- Population and human health
- Material assets
- Arboriculture
- Noise

The findings are discussed separately for Option B and Option C, with a summary for each topic.

The objectives of the assessments are further detailed in the below sections, but primarily they were to:

- establish the baseline associated with the T2ST options;
- analyse and evaluate the constraints and opportunities; and
- identify the impacts that require further investigation, and develop any required mitigation or opportunities for enhancement.

4.2 Limitations, uncertainties and data gaps

The environmental assessments undertaken at Gate 2 were completed using the available data but the following uncertainties and data gaps are noted. These uncertainties should be further explored beyond Gate 2.

- This assessment has been undertaken as a desk based assessment only due to the early stage of development of the T2ST scheme. The conclusions and recommendations made in this assessment would need to be confirmed upon the completion of in-person site visits and should not be considered final. Protected species surveys and other investigations will be undertaken after Gate 2, as per recommendations in Section 9.2.
- OS Master Map data was not available for the assessment. This data would be beneficial to the Biodiversity assessment to provide an overview of the habitats present within the Zone of Influence (ZOI) of the proposed pipeline routes. This information will aid in scoping on-site

surveys at the next stage of design. Additionally, biological and protected species records may also prove to be beneficial however are not considered data gap at this stage due to their fickle nature.

- AddressBase data was not available for the assessment. This data would be beneficial to the air quality assessment, the population and health assessment and the noise assessment as residential dwellings would have been identified. Assumptions were made in order to progress the assessments.
- Air quality data and traffic data within 1km of the routes was not available. Assumptions were therefore made on the vehicle flows and likely air quality.
- An abstraction licence list from the Environment Agency would be beneficial for the next stage of design to further the water assessment.
- Utility infrastructure data would be beneficial for the next stage of design to further the material assets assessment to provide a more in depth overview of services along both Options B and C.

4.3 Biodiversity, flora and fauna

4.3.1 Introduction

A desk-based assessment was undertaken to identify potential impacts on Biodiversity, Flora and Fauna from the transfer corridors and above ground infrastructure required as part of the T2ST SRO. The objectives of the desk-based assessment were to establish the biodiversity baseline regarding protected species and habitat associated with the preferred T2ST options, identify constraints and opportunities, and identify the issues that require further investigation.

The need to consider biodiversity, flora and fauna is driven by legislation, including the Conservation of Habitats and Species Regulations 2017, Wildlife and Countryside Act 1981 and Natural Environment and Rural Communities Act 2006) and national planning policy including the draft National Policy Statement (NPS) for Water Resource Infrastructure[5] (Section 3.3, Habitats Regulations Assessment and Section 4.3, Biodiversity and nature conservation), and the National Planning Policy Framework (NPPF)[6] (Section 15, Conserving and enhancing the natural environment, paragraphs 174-175, 179-182).

The desk-based assessment identified the following:

- key ecological features associated with the preferred T2ST options;
- constraints and opportunities associated with the preferred T2ST options; and
- issues and features that require further investigation.

4.3.2 Study area and sources of information

The desk-based assessment focused on the transfer route corridors, location of associated infrastructure and the surrounding area within a 2km area for statutory designated sites 1km study area for non-statutory sites and habitats. Where it was recognised that impacts could extend beyond the proposed study areas due to potential indirect impacts of the proposed scheme, assessment boundaries were extended accordingly to address the geographic extent of the potential impacts.

[5] Available at: https://consult.defra.gov.uk/water/draft-national-policy-statement/supporting_documents/draftnpswaterresourcesinfrastructure.pdf [accessed April 2022]

[6] Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2 [accessed April 2022]

The following table outlines the data sources that were collated and considered in the desk-based assessment.

Table 4.1: Sources of information for the Biodiversity, flora and fauna assessment

Data collected	Source
Greenspace sites; open map local roads; surface water; woodland	OS Open Data
Land cover data from Multi Agency Geographic Information for the Countryside (MAGIC) including statutory designated sites, ancient woodland and priority habitat inventory.	Natural England
Descriptions/ citations of Statutory Sites (and candidate designated sites)	Natural England/Joint Nature Conservation Committee (JNCC)
Important Bird Areas	Royal Society for Protection of Birds (RSPB)
Copernicus land cover data corresponding to broad EU recognised habitat-types	CORINE 2018 land cover
Biodiversity Action Plan (BAP) priority habitats and species	UK Government - MAGIC Maps Website[7] / the National Biodiversity Network (NBN) Atlas[8] / local authority information on BAP priority habitats and species.
Non-statutory Site Data	Local Biological Record Centres (BRCs) for Oxfordshire, Berkshire and Hampshire

4.3.3 Common baseline

Options B and C run along the same alignment for the majority of the route (Section 1, 2 and 4), and therefore the following baseline is common to both options. Baselines specific to each option (i.e. Section 3) are discussed in Section 4.3.4 for Option B and Section 4.3.5 for Option C along with impacts and potential mitigation for the whole option.

Designations adjacent to the corridors have not been listed below, however these have been considered in this section, along with any site where there is potential for an impact pathway.

The corridors bisect the designations listed below (note adjacent designations are not listed in this summary):

- Benhem Park and Speen Moor Local Wildlife Site (LWS);
- River Lambourn SAC & SSSI;
- Kennet Valley Alderwoods SAC & SSSI (also a GWDTE);
- River Kennet SSSI;
- River Test SSSI (also a GWDTE); and
- East Aston Common SSSI (also a GWDTE).

The corridors cross the following rivers and their associated designations:

- River Lambourn SAC and SSSI;
- River Kennet SAC and SSSI;
- River Enborne (not designated);
- River Test SSSI; and
- Bourne Rivulet (not designated).

[7] Available online at http://www.magic.gov.uk/ [accessed April 2022]

[8] Available at https://nbnatlas.org/ [accessed April 2022]. Please note that data from the NBN Atlas may have restricted use for commercial purposes where sensitive species are involved. Only NBN data that is licenced for commercial use will be used in this assessment

The corridors bisect one area of Ancient & Semi-Natural Woodland.

The corridor bisect several areas of priority habitat, notably including the following:

- habitat deciduous woodland, adjacent to the A34 close to the proposed BS2/CS2 BPT; and
- lowland calcareous grassland adjacent to the existing Yew Hill WSR.

An informal HRA and Stage 2 AA has been undertaken at plan level for Options B and C and is presented in Annex B2. The informal HRA and Stage 2 AA found that no adverse effects resulting from the implementation of Option B (alone and in-combination), or Option C (alone and in-combination) are reasonably foreseeable on the integrity of the Habitats Sites, if the suggested mitigation measures are observed. This biodiversity appraisal supplements the outcomes of the HRA and Stage 2 AA and should be read in conjunction with the recommendations made in that report.

4.3.4 Option B

Baseline for Option B, Section 3

The Option B corridor crosses the Bourne Rivulet (not designated) in addition to the common baseline.

The Option B corridor bisects several areas of priority habitat in addition to the common baseline, notably including the following:

- floodplain grazing marsh close to the proposed crossing of the River Enborne,
- several areas of deciduous woodland and areas of lowland calcareous grassland around the village of Crux Easton; and
- area of lowland calcareous grassland, bisected by the pipeline route to BS5 BPT.

Option B Evaluation

The Option B corridor and above ground infrastructure has the potential to impact protected species along its length during construction. Notable species with a potential to be present include but may not be limited to badgers, bats, Hazel Dormice, reptiles, Great Crested Newts and breeding birds. Direct impacts are likely to result from habitat loss, such as from loss of shelter, foraging and commuting opportunities, severance of routes through the landscape and further fragmentation of habitat. There are also likely to be indirect effects associated with construction, due to disturbance from construction plant and machinery, the presence of people, lighting and creation of dust. It should be noted that the proposed protected species suggested as being present are likely to be amended upon the completion of in-person site visits and should not be considered final. It should also be noted that the programme for construction works has not been confirmed at Gate 2 and therefore impact on the life cycle stage of protected species has not been assessed. This should be included in further assessment at the appropriate stage in the in the SRO development.

Other protected species with the potential to be present along the pipeline route include Otter, Water Vole and White-clawed Crayfish. These species have the potential to be present at the river crossing locations. Trenchless drilling is proposed to cross the main watercourses, which is likely to reduce impacts during construction. However, initial ground investigations are likely be required, and as such, potential negative impacts via disturbance and local habitat loss may occur if these species are present. Crossings for ordinary watercourses will be installed using open cut methods and temporary culverts and therefore will require further investigation and mitigation to reduce any potential negative impacts via disturbance and local habitat loss if these species are present.

Option B is likely to negatively impact Benhem Park and Speen Moor LWS, and adjacent River Lambourn SAC & SSSI and River Kennett SAC & SSSI. These areas are individually designated, but it must be noted that that the combination of these habitats results in mosaics of floodplain grassland, chalk streams, blocks of deciduous woodland and open grown trees which are likely to support a high density of protected species. These are likely to be negatively impacted by construction works, including during access for construction, however specifics of impacts are only likely to be confirmed through site visits recommended to be completed at the next stage of design.

The pipeline route crosses the River Lambourn SAC & SSSI, the River Kennet SSSI, and the River Test SSSI and runs adjacent to Kennet Valley Alderwoods SAC, SSSI & GWDTE. These sites are highly sensitive to changes in hydrology. Pipejack or micro tunnel crossings are likely to be used to minimise surface impacts from construction works, however initial ground investigations are still likely be required, which have the potential to impact qualifying features present and affect hydrology.

The proposed route of pipeline bisects Benhem Park and Speen Moor LWS. Trenchless crossing is not proposed within Benhem Park and Speen Moor LWS. Instead open cut excavation is proposed through the LWS, bisecting several priority habitats including good quality semi-improved grassland, floodplain grazing marsh and deciduous woodland, which all have the potential to be negatively impacted by construction works.

The proposed pipeline route bisects several areas of priority habitat which has the potential to be adversely affected during the construction phase of the pipeline. Key areas of priority habitat are: the deciduous woodland adjacent to the A34 close to the proposed BS2 BPT; floodplain grazing marsh close to the proposed crossing of the River Enborne, several areas of deciduous woodland and areas of lowland calcareous; and lowland calcareous grassland adjacent to the existing Yew Hill WSR. These habitats are likely to be negatively impacted during construction works by direct damage to chalk grassland flora during open cut excavation pipe installation, and indirectly via trampling from use of heavy machinery. Calcareous grasslands are low-nutrient sites that are likely to also be indirectly impacted from NO_x from heavy plant. The impacts may cause long term effects as these habitats can be difficult to restore.

An area of ancient woodland is likely to be bisected on the planned spur to Andover and could be negatively impacted by construction works resulting in ancient woodland habitat loss.

During operation, impacts upon habitats and protected species are likely to be low. The water to be transferred is proposed to be of potable standard, and therefore any potential leaks are unlikely to lead to transfer of INNS to sensitive habitats within, or hydrologically connected to, the pipeline route. The above ground assets will be newly-constructed facilities, and therefore are unlikely to result in significant leaks that would alter the groundwater levels to such an extent that habitats are impacted. Planned maintenance or replacement of pipeline sections have the potential to impact habitats and protected species, however impacts are likely to be highly localised and likely to be sufficiently mitigated by Ecological Method Statements and ecological supervision.

Option B Mitigation and enhancement

In order to mitigate potential issues arising from the SRO on biodiversity, the pipeline should be re-routed to avoid priority habitats, ancient woodlands and SSSIs. If this cannot be accommodated, pipejack or micro tunnel crossing should be employed. Mitigation and enhancement should also be considered for European sites, supporting habitat and priority species affected by the pipeline during construction and operation (including review of access routes). The potential change in hydrology should be investigated as part of a hydrogeological risk assessment as there is potential for long term impacts on GWTDE (including SSSIs) from changes to hydrology (see the Water assessment in Section 4.5). Investigation into the impact

of construction dewatering on groundwater levels, and potential implications on GWDTE is required. Mitigation and enhancement with respect to potential effects on GWDTE should be considered further.

4.3.5 Option C

Baseline for Option C, Section 3

The Option C corridor bisects the below designations in addition to those noted in the common baseline:

- Burghclere Beacon SSSI (also a GWDTE);
- Additional crossing of the River Test SSSI; and
- Bere Mill Meadows SSSI (also a GWDTE).

The Option C corridor includes a crossing of the River Test which is in addition to the common baseline.

The Option C corridor bisects several areas of priority habitat in addition to the common baseline, notably including the following:

- Deciduous woodland adjacent to B4640 and the A34 north of Burghclere;
- priority habitats where the pipeline crosses the River Test east of Whitchurch;
- areas classified as 'no main habitat but additional habitats present' south of Whitway; and
- deciduous woodland and lowland calcareous grassland directly adjacent to Burghclere Beacon SSSI

Option C Evaluation

The Option C corridor and above ground infrastructure has the potential to impact protected species along its length during construction. Notable species with a potential to be present include (but may not be limited to) badgers, bats, Hazel Dormice, reptiles, Great Crested Newts and breeding birds. Direct impacts are likely to result from habitat loss, such as from loss of shelter, foraging and commuting opportunities, severance of routes through the landscape and further fragmentation of habitat. There are also likely to be indirect effects associated with construction, due to disturbance from construction plant and machinery, the presence of people, lighting and creation of dust. It should be noted that the proposed protected species suggested as being present are likely to be amended upon the completion of in-person site visits and should not be considered final. It should also be noted that the programme for construction works has not been confirmed at Gate 2 and therefore impact on the life cycle stage of protected species has not been assessed. This should be included in further assessment at the appropriate stage in the in the SRO development.

Other protected species with the potential to be present along pipeline route include Otter, Water Vole and White-clawed Crayfish. These species have the potential to be present at the river crossing locations. Trenchless drilling is proposed to cross the main watercourses, which is likely to reduce impacts during construction. However, initial ground investigations are likely be required, and as such, potential negative impacts via disturbance and local habitat loss may occur if these species are present. Crossings for ordinary watercourses will be installed using open cut methods and temporary culverts and therefore will require further investigation and mitigation to reduce any potential negative impacts via disturbance and local habitat loss if these species are present.

Option C is likely to negatively impact Benhem Park and Speen Moor LWS, and adjacent River Lambourn SAC & SSSI and River Kennett SAC & SSSI. These areas are individually designated, but it must be noted that that the combination of these habitats results in mosaics of

floodplain grassland, chalk streams, blocks of deciduous woodland and open grown trees which are likely to support a high density of protected species. These are likely to be negatively impacted by construction works, including during access for construction, however specifics of impacts are only likely to be confirmed through site visits recommended to be completed at the next stage of design.

The pipeline route crosses the River Lambourn SAC & SSSI, the River Kennet SSSI, and the River Test SSSI and runs adjacent to Kennet Valley Alderwoods SAC, SSSI & GWDTE and Bere Mill Meadows SSSI & GWDTE. These sites are highly sensitive to changes in hydrology. Pipejack or micro tunnel crossings are likely to be used to minimise surface impacts from construction works, however initial ground investigations are still likely be required, which have the potential to impact qualifying features present and affect hydrology.

The proposed route of pipeline bisects Benhem Park and Speen Moor LWS. Trenchless crossing is not proposed within Benhem Park and Speen Moor LWS. Instead open cut excavation is proposed through the LWS, bisecting several priority habitats including good quality semi-improved grassland, floodplain grazing marsh and deciduous woodland, which all have the potential to be negatively impacted by construction works.

Burghclere Beacon SSSI is immediately adjacent to the Option C pipeline route. Burghclere Beacon is a low nutrient site, highly sensitive to changes in nutrients levels. The chalk grassland flora and fauna have the potential to be negatively impacted by construction works via potential spillage of construction materials and NO_x from heavy plant.

The proposed pipeline route bisects several areas of priority habitat which has the potential to be adversely affected during the construction phase of the pipeline. Key areas of priority habitat are: the deciduous woodland adjacent to the A34 close to the proposed CS2 BPT; and lowland calcareous grassland adjacent to the existing Yew Hill WSR. These habitats are likely to be negatively impacted during construction works by direct damage to chalk grassland flora during open cut excavation pipe installation, and indirectly via trampling from use of heavy machinery. Calcareous grasslands are low-nutrient sites that are likely to also be indirectly impacted from NO_x from heavy plant. The impacts may cause long term effects as these habitats can be difficult to restore.

The proposed pipeline is to use trenchless drilling under sections of priority habitat including: deciduous woodland adjacent to B4640 and the A34 north of Burghclere and through priority habitats where the pipeline crosses the River Test east of Whitchurch; areas classified as ‘no main habitat but additional habitats present’ south of Whitway; deciduous woodland and lowland calcareous grassland directly adjacent to Burghclere Beacon SSSI and deciduous woodland immediately adjacent to the A34. All priority habitats have the potential to be negatively impacted by construction works.

An area of ancient woodland is likely to be bisected on the planned spur to Andover and could be negatively impacted by construction works resulting in ancient woodland habitat loss.

During operation, impacts upon habitats and protected species are likely to be low. The water to be transferred is proposed to be of potable standard, and therefore any potential leaks are unlikely to lead to transfer of INNS to sensitive habitats within, or hydrologically connected to, the pipeline route. The above ground assets will be newly-constructed facilities, and therefore are unlikely to result in significant leaks that would alter the groundwater levels to such an extent that habitats are impacted. Planned maintenance or replacement of pipeline sections have the potential to impact habitats and protected species, however impacts are likely to be highly localised and likely to be sufficiently mitigated by Ecological Method Statements and ecological supervision.

Option C Mitigation and enhancement

The mitigation for Option C is as per Option B.

4.3.6 Summary

Option B has the potential to adversely affect floodplain grazing marsh close to the proposed crossing of the River Enborne and several areas of deciduous woodland and areas of lowland calcareous grassland around the village of Crux Easton. Option C does not affect these priority habitats.

Option C is located immediately adjacent to Burghclere Beacon SSSI and therefore has the potential to adversely affect this area during construction. Option B does not affect this SSSI.

The corridors for both Option B and Option C cross SSSIs that are also designated as GWDTE. Investigation into the impact of construction dewatering on groundwater levels, and potential implications on GWTDE (including SSSIs) from changes to hydrology is required. Mitigation and enhancement with respect to potential effects on GWDTE should be considered further through a hydrogeological risk assessment.

Option C has the potential to adversely affect deciduous woodland adjacent to B4640 and the A34 north of Burghclere; priority habitats where the pipeline crosses the River Test east of Whitchurch; additional habitats south of Whitway; deciduous woodland and lowland calcareous grassland directly adjacent to Burghclere Beacon SSSI; and deciduous woodland immediately adjacent to the A34. Option B does not affect these priority habitats.

At this stage, Option B and Option C both have similar effects in terms of biodiversity.

4.4 Soils

4.4.1 Introduction

A desk-based assessment was undertaken to identify potential impacts on soil resources from the transfer corridors and above ground infrastructure required as part of the T2ST SRO. The objectives of the desk-based assessment were to present the soils baseline associated with the preferred T2ST options, identify potential constraints and opportunities, and identify the issues that require further investigation.

The need to consider soils and land quality is driven by national planning policy, including the draft NPS for Water Resource Infrastructure[5] (Section 4.10, Land use including open space, green infrastructure and Green Belt) and the NPPF[6] (Section 15, Conserving and enhancing the natural environment, paragraphs 174 and 183-184).

The desk-based assessment identified the following:

- The anticipated properties and characteristics of soils likely to be impacted by the preferred T2ST options;
- The likely nature and scale of the effects of construction on soils;
- Potential impacts on quality and function of soil as a resource;
- Effect on agricultural land classified as BMV3;
- Potential issues requiring further assessment and the methods to be applied; and
- Potential options that will have the least impact on higher quality agricultural land.

The impact to food production from the creation or removal of agricultural land required as part of the T2ST SRO has been assessed as part of the Natural Capital assessment, which is presented in Section 6.

4.4.2 Study area and sources of information

The desk-based assessment focused on the transfer route corridors and the location of associated surface assets. A 200m buffer zone was incorporated around the preferred T2ST options to comprehensively assess the baseline conditions. At this stage, it was assumed that construction would require a 30m easement along the pipeline route and topsoil/subsoil would be stripped to accommodate for excavations, site haul roads and other construction features.

The following table outlines the data sources that were collated and considered in the desk-based assessment.

Table 4.2: Sources of information for the Soils assessment

Data collected	Source
Land use	MAGIC Maps Website[7]
Geology	British Geological Survey (BGS) Onshore GeoIndex[9]
Climatological data	Climatological Data for Agricultural Land Classification (ALC) handbook (1989)[10]
Flood risk	Flood map for planning[11]
Soil properties	Soilscapes viewer, Land Information System (LandIS)[12] BGS Onshore GeoIndex – borehole data Cranfield University, UK[13]
Agricultural land classification	Provisional ALC data (open data)[14] Post-1988 publicly available ALC data (open data)[15] Predictive Best Most Versitile (BMV) Land Maps[16]

4.4.3 Common baseline

Options B and C run along the same alignment for the majority of the route (Section 1, 2 and 4), and therefore the following baseline is common to both options. Baselines specific to each option (i.e. Section 3) are discussed in Section 4.4.4 for Option B and Section 4.4.5 for Option C along with impacts and potential mitigation for the whole option.

Both route options and above ground assets are predominantly located in agricultural fields in a landscape dispersed with woodland blocks. The routes cross multiple roads including: A417; B4494; B4000; A4; B3048; A303; A30; A272; B3049; and A3090. The routes cross several railway lines including Great Western Main Line; the Reading to Taunton railway line; and the Basingstoke and Exeter railway line. The routes cross multiple surface watercourses including:

[9] British Geological Survey. (2022) *GeoIndex Onshore*. Available at: GeoIndex - British Geological Survey (bgs.ac.uk) [accessed April 2022]

[10] The Meteorological Office. (1989) *Climatological Data for Agricultural Land Classification*

[11] Environment Agency. (2022) *Flood map for planning*. Available at: https://flood-map-for-planning.service.gov.uk/ [accessed April 2022]

[12] Cranfield Soil and AgriFood Institute. *Soilscapes*. Available at: Soilscapes soil types viewer - National Soil Resources Institute. Cranfield University (landis.org.uk) [accessed April 2022]

[13] Cranfield University. Soil Data. Available at: Soil Data - Cranfield Mapshop (blueskymapshop.com) [accessed April 2022]

[14] Natural England. (2020) *Provisional Agricultural Land Classification (ALC)*. Available at: Provisional Agricultural Land Classification (ALC) - data.gov.uk [accessed April 2022]

[15] Natural England. (2021) *Agricultural Land Classification (ALC) Grades - Post 1988 Survey (polygons)*. Available at: Agricultural Land Classification (ALC) Grades - Post 1988 Survey (polygons) - data.gov.uk [accessed April 2022]

[16] Natural England. (2017) *Likelihood of Best and Most Versatile Agricultural Land*. Available at: Natural England Access to Evidence - Likelihood of Best and Most Versatile Agricultural Land [accessed April 2022]

West Hendred Brook; River Lambourn; River Kennet; Kennet and Avon Canal; River Enborne; River Test; and River Dever.

The superficial geology along the route option sections and at surface assets includes Alluvium deposits, Clay with Flints, River Terrace Deposits (undifferentiated), and Sand and Gravel of uncertain age and origin.

The bedrock geology along the route option sections and at surface assets includes Gault Formation and Upper Greensand Formation (undifferentiated), Grey Chalk Subgroup, Lambeth Group, Thames Group, West Walton Formation, Ampthill Clay Formation and Kimmeridge Clay Formation (undifferentiated), and White Chalk Subgroup.

Digitised soil data was obtained from Cranfield University to identify the soil associations present for the area along the route option sections and at surface asset locations.

Digitised average soil organic carbon data was obtained from Cranfield University, which presented carbon (%) at depths of 0-30cm, 30-100cm and 100-150cm for the area along the route option sections and at surface asset locations.

Provisional ALC data and detailed ALC records (from soil surveys undertaken post-1988) were reviewed for the area along the route option sections and at surface assets. The route options and surface assets are situated in agricultural land predominantly classified as ALC Grade 3 (provisional), with localised areas of Grade 2, 4 and 5 or in non-agricultural land and urban land. It should be noted that the provisional ALC data does not subdivide Grade 3 land into Grade 3a (representing BMV land) and Grade 3b (not presenting BMV land). However where detailed ALC survey is available, localised areas of agricultural land potentially affected by the development has been classified as Grade 3a and Grade 3b.

There are four historic landfill sites within the study area for both Option B and Option C these are East Hendred, Chalk Pit, Skinners Green Lane and Bushfield Farm.

4.4.4 Option B

Baseline for Option B, Section 3

A high-level assessment of anticipated land-take for Option B, based on provisional ALC mapping shows the route (assuming a 30m easement) to go through land classified as listed below:

- Grade 2 = 12.7km representing 14.8% of agricultural land-take;
- Grade 3 = 67.2km representing 78.5% of agricultural land-take;
- Grade 3a = 1.1km representing 1.3% of agricultural land-take;
- Grade 3b = 0.7km representing 0.8% of agricultural land-take;
- Grade 4 = 3.2km representing 3.7% of agricultural land-take;
- Grade 5 = 0.7km representing 0.8% of agricultural land-take; and
- Non-agricultural or urban = 1.4km.

There is permanent land take required for the option given new assets are required as part of the option. The current locations of these are within agricultural land classed as Grade 3.

In addition to the common baseline, Option B crosses the A343 and the B3400, and the Bourne Rivulet.

In addition to the common baseline, Cliffeville Ltd authorised landfill site is located within the study area for Option B Section 3.

Option B Evaluation

Ground disturbance in the form of topsoil/subsoil stripping can adversely affect soil quality during the construction process through inappropriate handling during stripping, stockpiling and reinstatement. These can impact soil function which will ultimately affect crop/vegetation growth.

For temporary works it is anticipated that the majority of stripped topsoil/subsoil resource will be reinstated. A volume of subsoil may be permanently lost from the volume of strip that is associated with space occupied by underground pipelines. These soils will be appropriately stockpiled and managed prior to reinstatement upon the completion of pipe installation for a particular section.

For permanent land-take, topsoil/subsoil strip is anticipated to precede construction works and will present a permanent loss of topsoil/subsoil resource (where present) from the stripped area.

Soil resource from areas where reinstatement is not possible should firstly be considered for reuse within the SRO. If this is not viable and/or there is excess soil quantities, topsoil/subsoil may be sold for use in other construction projects or industries. It should be stated that landfilling of soil resource should be the last resort, as this will represent the permanent loss of stripped topsoil/subsoil resource from the SRO.

An existing operational landfill site is within the option corridor, Cliffeville Landfill. There is scope to avoid Cliffeville Landfill during further route design stages, however, there is potential that the pipeline excavation could disturb contaminants within this landfill site.

Option B runs through four historic landfills. There is potential that the pipeline excavation could disturb contaminants within the historic landfill sites. It should be ensured that pipeline excavations do not compromise the structure and safety of the historic landfill site. Potential impacts of the mobilisation of contaminants within a historic landfill include potential groundwater, surface water and soil contamination, should a source - pathway - receptor linkage be established.

Option B Mitigation and enhancement

The measures to mitigate potential issues arising from the SRO to soils are as follows:

- A detailed soil survey (soil resource survey and/or ALC survey) should be undertaken to confirm the soil resources present, map the distribution of soil types, establish the land grade (if ALC survey is chosen), and inform on a soil management plan. This would likely require auger boreholes at appropriate points along the route.
- The stripping, stockpiling, maintenance, reinstatement and aftercare of soil resources should be undertaken in accordance with Defra[17] and British Standards[18,19] soil guidance.
- Produce a soil management plan to detail the above guidance and provisions for stripping, stockpiling, maintenance, reinstatement and after care of soil resources.
- During construction activities, it is recommended that a qualified soil scientist undertake on-site monitoring visits to ensure the best practice and guidance as stated in the soil management plan is followed.

Further assessment of Cliffeville Landfill operational landfill is required at the next stage of design with a possible requirement for a Phase 1 contaminated land desk study and intrusive investigations to determine risks and construction approaches. The pipeline route should be

[17] Department for Environment, Food & Rural Affairs. (2009) *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites.* London: Defra.

[18] British Standards Institution. (2015) *BS 3882:2015 Specification for topsoil*. London: BSI Standards Limited.

[19] British Standards Institution. (2013) *BS 8601:2013 Specification for subsoil and requirements for use*. London: BSI Standards Limited.

reviewed during further route design stages in order to avoid the landfill. Best practice construction methods should be implemented for working within proximity to landfill sites to minimise disturbance of contaminants.

4.4.5 Option C

Baseline for Option C, Section 3

A high-level assessment of anticipated land-take for Option C, based on provisional ALC mapping shows the route (assuming a 30m easement) to go through land classified as:

- Grade 2 = 12.7km representing 14.8% of agricultural land-take;
- Grade 3 = 64.3km representing 75.1% of agricultural land-take;
- Grade 3a = 1.3km representing 1.5% of agricultural land-take;
- Grade 3b = 1.7km representing 2.0% of agricultural land-take;
- Grade 4 = 4.9km representing 5.7% of agricultural land-take;
- Grade 5 = 0.7km representing 0.8% of agricultural land-take; and
- Non-agricultural or urban = 1.4km.

There is permanent land take required for the option given new assets are required as part of the option. The current locations of these are within agricultural land classed as Grade 3 and 4.

Option C is predominantly located in agricultural fields with a section located to the east of the A34 highway. In addition to the common baseline, Option C crosses the A34 twice and crosses the B4640.

Option C affects the Southampton soil association in addition to the associations in the common baseline.

Option C Evaluation

Ground disturbance in the form of topsoil/subsoil stripping can adversely affect soil quality during the construction process through inappropriate handling during stripping, stockpiling and reinstatement. These can impact soil function which will ultimately affect crop/vegetation growth.

For temporary works it is anticipated that the majority of stripped topsoil/subsoil resource will be reinstated. A volume of subsoil may be permanently lost from the volume of strip that is associated with space occupied by underground pipelines. These soils will be appropriately stockpiled and managed prior to reinstatement upon the completion of pipe installation for a particular section.

For permanent land-take, topsoil/subsoil strip is anticipated to precede construction works and will present a permanent loss of topsoil/subsoil resource (where present) from the stripped area.

Soil resource from areas where reinstatement is not possible should firstly be considered for reuse within the SRO. If this is not viable and/or there is excess soil quantities, topsoil/subsoil may be sold for use in other construction projects or industries. It should be stated that landfilling of soil resource should be the last resort, as this will represent the permanent loss of stripped topsoil/subsoil resource from the SRO.

Option C runs through four historic landfills. There is potential that the pipeline excavation could disturb contaminants within the historic landfill sites. It should be ensured that pipeline excavations do not compromise the structure and safety of the adjacent historic landfill site. Potential impacts of the mobilisation of contaminants within a historic landfill include potential groundwater, surface water and soil contamination, should a source - pathway - receptor linkage be established.

Option C Mitigation and enhancement

Mitigation suggested for Option C is as per Option B.

4.4.6 Summary

Both options are assessed to potentially affect land classified as ALC Grade 3, 4 and 5, as well as Grade 3a and 3b where detailed ALC survey was available. Option B is assessed to potentially affect a greater area of provisional ALC Grade 3 land than Option C. However, Option C is anticipated to affect a slightly greater of area of Grade 3a land than Option B, where detailed ALC survey was available.

Ground disturbance in the form of topsoil/subsoil stripping can adversely affect soil quality during the construction process, which can impact soil function and ultimately affect crop/vegetation growth. It is recommended that a detailed soil survey be undertaken along the route to confirm soil resources present, with the findings help inform a soil management plan which will provide guidance to reduce and minimise adverse effect to soil quality.

Option B is likely to affect Cliffeville Landfill, an operational landfill site is located within the option corridor. Landfills are considered as a high risk of potential contamination. Further assessment of the landfill is required at the next stage of design with a possible requirement for a Phase 1 contaminated land desk study and intrusive investigations to determine risks and construction approaches. The pipeline route should be reviewed during further route design stages in order to avoid the landfill.

4.5 Water

4.5.1 Introduction

A desk-based assessment was undertaken to identify potential water resources and flood risk impacts on sensitive receptors from the construction and operation of the transfer corridors and above ground infrastructure required as part of T2ST SRO. The objectives of the desk-based assessment were to establish the baseline water resources and flood risk impacts associated with the preferred T2ST options, identify constraints and opportunities, and identify the issues and features that require further investigation.

The need to consider water is driven by national planning policy, including the draft NPS for Water Resource Infrastructure[5] (Section 4.15, Water quality and resources and 4.8, Flood Risk), the NPPF[6] (Section 14, Meeting the challenge of climate change, flooding and coastal change, paragraphs 159-169, and Section 15, Conserving and enhancing the natural environment, paragraph 174), and the Water Framework Directive (The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017).

The desk-based assessment identified the following:

- Flood risk from all sources i.e. fluvial, groundwater and surface water for the T2ST options;
- Groundwater features which could be impacted by T2ST;
- Constraints and opportunities associated with the T2ST options; and
- Issues requiring further investigation.

The following elements were excluded from this desk-based assessment:

- Water quality as this is covered in Annex C: Drinking Water Assessment; and
- Water Framework Directive assessment as this is covered in Annex B3: WFD and in Section 3.2.

4.5.2 Study area and sources of information

The desk-based assessment focused on the transfer route corridors and the location of associated surface assets.

The following table outlines the data sources that were collated and considered in the desk-based assessment.

Table 4.3: Sources of information for the Water assessment

Water Environment	Data collected	Source
Groundwater	Geology of bedrock and superficial deposits	British Geological Society (BGS)
	Groundwater level and flow direction	BGS, Environment Agency and Thames Water/Southern Water
	Aquifer properties	BGS
	Groundwater level data	Environment Agency and Thames Water/Southern Water
	Groundwater dependent terrestrial ecosystems	Environment Agency and Natural England
Surface water	WFD waterbodies	Environment Agency
	designations	Environment Agency
	Surface water flow	FEH
Flood risk	Flood map for planning	Environment Agency
	Historical flooding incidents	Lead local flood authorities, EA, Thames Water/Affinity Water
	Long term flood risk information (surface water, river flooding)	Environment Agency
	Flood risk from reservoirs	Environment Agency
	Flood protection infrastructure/measures	Environment Agency
	Abingdon flood scheme – River Ock modelling report	CH2M (2017)
Topography	LiDAR data	Environment Agency

4.5.3 Common baseline

Options B and C run along the same alignment for the majority of the route (Section 1, 2 and 4), and therefore the following baseline is common to both options. Baselines specific to each option (i.e. Section 3) are discussed in Section 4.5.4 for Option B and Section 4.5.5 for Option C along with impacts and potential mitigation for the whole option.

Groundwater

Bedrock geology and superficial deposits were similar for both options, affecting Principal, Secondary A, Secondary B and Unproductive aquifers. Details of the groundwater bodies are set out in the WFD assessment (see Annex B3).

Source Protection Zones (SPZ) are defined by the Environment Agency around large groundwater abstractions. They are zones which show the level of risk to the source from contamination, from any activity in these areas. Construction within SPZs requires additional assessment and potentially mitigation to ensure no adverse impacts on public water supplies. Prior to construction a hydrogeological risk assessment will be required for works within SPZ1 or 2. The routes pass through areas defined as SPZ1 and SPZ2.

Groundwater Dependent Terrestrial Ecosystems (GWDTE), like wetlands, flushes and fens are environments reliant upon groundwater for their continued success and health. This makes

them particularly sensitive to hydrological and ecological changes caused as a result of new developments that disrupt existing groundwater flow, such as pipelines. The option corridors bisect Kennet Valley Alderwoods SSSI, Burghclere Beacon SSSI, River Test SSSI, and East Aston SSSI which are also GWDTE and may be impacted by them.

Wells and springs are groundwater fed and as a result are groundwater dependent features. 15 wells have been identified within 250m that are common to both options. Four springs have been identified within 500m that are common to both options.

Surface water

The proposed scheme will cross a number of watercourses and could have direct or indirect (through impacts on groundwater flow) implications for surface water flow.

Both routes cross 5 main rivers as well numerous ordinary watercourses and the Kennet and Avon Canal. Details of the surface water bodies crossed by the scheme are set out in more detail in the WFD assessment (see Annex B3).

Flood Risk

The proposed assets in Section 1 of both options show no risk of fluvial flooding from the Environment Agency's Flood Zones. the northern border of the new WTW at the intake location is recorded in both Flood Zone 3 and 2.

For surface water flooding, the locations for the pressure tanks and pumping stations are signified as "Very low" flood risk (<0.1% of surface water flooding). The location for the WTW at the intake location is situated in an area of "High risk" (>3.3% surface water flooding).

The WTW at the intake location is situated in an area at "low risk" of groundwater flooding. However, both the BS2/CS2 BPT and the BS3/CS3 PS and BPT locations are in a "High risk" area of groundwater flooding.

Artificial flooding results from artificial or man-made flood sources such as raised channels, canals, or storage features such as ponds and reservoirs. The WTW at the intake location is assessed to be unaffected from artificial flooding. Both the BS2/CS2 BPT and the BS3/CS3 PS and BPT locations are shown to be unaffected from artificial flooding with no artificial sources close to their vicinity.

There are no new above ground assets required in Sections 2 and 4 and therefore these sections do not require a flood risk assessment.

4.5.4 Option B

4.5.4.1 Baseline for Option B, Section 3

Groundwater

Option B passes through the SPZ for numerous sources, with approximately half of the route within SPZ3. Option B passes through five SPZ1 and five SPZ2.

Three wells have been identified within 250m of the Option B corridor in addition to those in the common baseline. No additional springs have been identified within 250m of Option B.

Surface water

Option B crosses 19 surface water catchment, with direct crossings of six main rivers: River Lambourn, River Kennet/Kennet and Avon Canal, River Enborne, Bourne Rivulet, River Test and River Dever. Numerous smaller channels are also crossed.

Flood risk

The assets within Section 3 of Option B are not within the Environment Agency's Flood Zones and they are within areas listed as "Very low risk" (<0.1% of surface water flooding). The options for BS4 PS and BPT, BS5 BPT and BS6 PS are all situated in a "high risk" of groundwater flooding. None of the sites in section 3 are at risk of reservoir or artificial flooding.

4.5.4.2 Option B Evaluation

Groundwater

The impacts on designated groundwater bodies are assessed in the WFD assessment (see Annex B3). SPZ1 are defined by the shortest travel time from any pollution below the water table to the source in question, there is potential for impact on the groundwater as a result of construction of the option pipelines interfering with the natural groundwater flow and quality. This could result in disruption of supply from these sources.

The implications associated with interfering with SPZ2 are less severe than with SPZ1, thesev zones are still defined by a 400-day travel time from any pollution below the water table to the source in question. Therefore, intersection of these zones, could still lead to interference of the groundwater flow and quality leading to further implications at the abstraction sources.

Four GWDTE were identified as likely to impact Option B or be impacted by Option B. As all of these are classed as SSSIs, disturbing the groundwater flow and quality could lead to a loss of a protected or threatened habitat or species. These impacts and any requirement for mitigation would be considered under biodiversity (see Section 4.3).

While most of the identified wells and springs have been classed as 'unlikely to cause or be at risk', 11 have been identified as potentially impacted by the construction of Option B. Most of these features are wells within the option corridors, while others are features estimated to be at a lower elevation than the SRO at its nearest point and within 100m of the corridors.

The pipeline is likely to be lain at a maximum depth of 3m along the route, except where the pipeline has to pass beneath major roads, railway or rivers. Therefore, it is unlikely that the construction will directly affect groundwater flow, where groundwater is at a depth of greater than 5m. The groundwater depth contour data has been reviewed and areas where the Option B corridor intersects with shallow groundwater have been identified. For Option B, four areas have been identified as potentially impacting groundwater up to 10m in depth below ground level. Where groundwater could be shallow, it is possible that the presence of the pipe could lead to the creation of a preferential pathway for the flow of groundwater.

Surface water

Impacts on surface water bodies are set out in detail in the WFD assessment (see Annex B3), along with the appropriate mitigation measures required.

Main watercourse crossings will be carried out using pipejack or micro tunnel crossings. In order to facilitate this, it is likely that shallow shafts will be required on either side of the watercourse. In the construction of the shafts dewatering may be required and could lead to temporary localised impacts on groundwater flow and therefore to surface water flows.

The presence of the pipe could lead to the creation of a preferential pathway for the flow of groundwater, which could indirectly affect surface water flow.

Flood risk

Modelled water levels from the River Ock at the new WTW at the intake location have been reviewed. These levels provide an 'Annual Exceedance Probability' (AEP) which is the probability that a flood of a given (or larger) magnitude will occur within a period of one year. For

example, a 1% AEP Flood means you have a 1-in-100 chance that a flood of that size (or larger) could occur in any one year. The review has shown that the new WTW at the intake location experiences flooding as early as the 5%AEP (54.78mAOD) in the east corner of the site. Though only a small portion of the location is affected from flooding this would classify the new WTW location as a Flood Zone 3b (active flood plain) under the Environment Agency's Flood Risk vulnerability table. A water treatment works is defined by the Environment Agency as "Less Vulnerable" if it can operate during times of flooding. The new WTW in this case would not be permitted for construction in the Flood Zone 3b location and an alternative location would be required. It is suggested that the new WTW should be placed outside of Flood Zone 3b on a ground level that exceeds 54.78mAOD.

If the WTW is to be placed within an area of 1% AEP (54.84mAOD) it would result in flood displacement of 1650.46m³ and a suitable level for level compensation area would be required. Compensation areas are not required for development in the 0.1%AEP flood extent (NPPF 2022).

New developments have the potential to cause an increase in downstream flood risk due to increased runoff rates and volumes from the site. Most asset locations are in "Very low" risk of surface water flooding (<0.1% of surface water flooding). Only the WTW at the intake location (high risk) is at risk from surface water flooding.

The WTW at the intake location will require the use of a suitable drainage system to capture the displacement of surface water flooding at the asset location. It is recommended that a closed loop system be put into place to capture any potential contaminants from the treatment process.

Chalk aquifers have a slow response time to intense rainfall, however once the groundwater level has reached the surface, flooding can be pro longed.

It is recommended that ground water flooding is taken into consideration of the development of assets and that appropriate flood proofing measures and/or the rising of entry thresholds are incorporated to mitigate possible damages.

There is a risk of flooding during the construction phase of the option corridor near any watercourse and it is recommended that watercourse crossings and works within the river during forecasts of wet weather or issued flood warnings should be avoided. Therefore, construction timings should be considered in greater detail during the design development stage.

Preparation should be taken during the receipt of a flood alert to secure all construction locations and the equipment from the possibility of severe flooding. On site personnel should be made aware of the flood risks and an evacuation plan directing staff away from areas where there is an identified flood risk should be implemented on receipt of a flood alert or warning.

4.5.4.3 Option B Mitigation and enhancement

Groundwater

Prior to construction a hydrogeological risk assessment will be required for works within SPZ1 or 2. This risk assessment will need to consider the potential impacts upon groundwater flow routes and any impact upon flood risk and nearby receptors such as existing buildings, roads and service infrastructure. It may also be prudent to consider local plans and future development areas. If the risk assessment identifies the potential for an impact on the public water supply (either in yield or in water quality), then additional mitigation will be required and must be agreed with the water company and the Environment Agency. Mitigation could range from the provision of temporary water quality treatment at a source, the temporary closure of a source, or in some cases the complete replacement of a source (including new boreholes, treatment, pipe network etc).

The hydrogeological risk assessment should also consider the potential for long term impacts on GWTDE (including SSSIs) from changes to hydrology. Further investigation into the impact of construction dewatering on groundwater levels is required, and potential implications on GWDTE. Mitigation with respect to potential effects on GWDTE will be considered further in the biodiversity and aquatic environment sections (see Section 4.3).

Where potential effects on wells and springs have been highlighted, further investigation should be carried out to assess whether these wells are in use, assess the value of the wells and springs and investigate the magnitude of likely effects. For features that could be lost or where a significant adverse effect on the feature is likely, mitigation may be required. This could consist of replacement wells, connection of well user to mains supply and relocation of springs.

In any areas where groundwater could be shallow, it is possible that the presence of the pipe could lead to the creation of a preferential pathway for the flow of groundwater. Where shallow groundwater is likely to be encountered the use of clay stanks will be required in order to minimise the groundwater flow along the pipe trench.

Good practice pollution control measures will be implemented to minimise the risk of groundwater contamination at all construction sites.

Surface water

Crossings of main rivers will be carried out by pipejack or micro tunnel crossings. This will minimise the impact of the scheme on river flows and ecology.

In order to minimise the impact on surface water flow during construction, dewatering shall be kept to a minimum and any extracted water returned to the local environment (either to nearby watercourses or where possible back into the ground, through recharge trenches).

The presence of the pipe could lead to the creation of a preferential pathway for the flow of groundwater. Where shallow groundwater is likely to be encountered the use of clay stanks will be required in order to minimise the groundwater flow along the pipe trench.

Good practice pollution control measures will be implemented to minimise the risk of surface water contamination at all construction sites.

Flood risk: Fluvial flood risk during construction and operation

Careful consideration should be taken when a flood alert is issued by the Environment Agency. Only the WTW at the intake location is covered by both flood alerts and flood warning areas. The definitions for both are as follows

- The Environment Agency define a Flood Warning Area as “Geographical areas where we expect flooding to occur and where a flood warning service is provided”.
- The Environment Agency have described an Alert through the system to “warn of the possibility of flooding and make the necessary preparations, though the alert is less confident than a Flood Warning”.

It is recommended during the construction and operation phase that any personnel working at the asset locations should be made aware of the flood risk and an evacuation procedure should be put in place instructing personnel to evacuate to a place of safety. The asset locations should also be signed up to Environment Agency Flood Alerts and Warnings. Likewise, during the construction phase care must be taken to ensure stockpiled materials are not washed into local drains, causing blockages which could lead to localised flooding.

Preparation should be taken during the receipt of a flood alert or warning to secure the all-asset locations and the equipment from the possibility of severe flooding. On site personnel should be

made aware of the flood risks and an evacuation plan directing staff away from areas where there is a flood risk should be implemented on receipt of a flood alert or warning.

Environmental permits will be required for construction in a flood risk area.

It is recommended that for all assets the operator signs up for the Environment Agency's flood alerts and that these notifications and site safety emergency plans are shared and coordinated.

It is recommended that the WTW at the intake location is placed outside of Flood Zone 3 as construction for "Less vulnerable" development is not permitted.

An exception test is not required for "Less vulnerable" development and construction in Flood Zone 3a is permitted. The construction of the WTW at the intake location would require a level for level compensation area to be developed to capture any displaced flood volumes as a result up to 1%AEP+70% climate change. It is recommended that the WTW at the intake location is constructed outside of Flood Zone 3a. Assessment of the area would suggest that space is available for the WTW and would meet the requirements of the sequential test. If siting within FZ3a is unavoidable compensatory flood storage volume will need to be provided on a level for level basis.

All flood risk assessments must include an appropriate allowance for climate change covering the developments expected lifespan.

Construction methods will need to be considered for each river crossing. At main watercourses (River Kennet), roads and rail crossings, it is recommended that pipeline should use a no-dig technique or micro tunnelling. For ordinary watercourse crossings an open cut method with a temporary flume is recommended. It is also recommended that construction areas take the necessary resilient measures when working next to watercourses.

Flood risk: Surface water flood risk during construction and operation

New developments have the potential to cause an increase in downstream flood risk due to increased runoff rates and volumes. In this instance the new WTW at the intake location in Section 1 will have an effect on surface water runoff patterns. The designation land change from agriculture to hardstanding machinery and impermeable surface will affect the displacement of surface flooding. The change in surface water will need to be assessed and, if appropriate, controlled.

Currently all asset locations in section 1 and 3 are green field sites and are primarily used for agricultural purposes. There are no hardstanding or storage facilities at the asset locations.

It is recommended that during the construction phase care is taken to ensure stockpiled materials are not washed into local drains, causing blockages which could lead to localised flooding.

In the Planning and Flood Risk section of the NPPF (2021), sub section 167, point C, the assets need to incorporate sustainable drainage systems, unless there is clear evidence that this would be inappropriate.

A suitable drainage system is still recommended due to the land use change in section 3 for any of the asset locations. The impermeable surface will increase surface water flooding and most likely exacerbate the existing surface water flooding.

The new WTW at the intake location will require the use of a suitable drainage system to capture the displacement of surface water flooding at the asset location. It is recommended that a closed loop system be put into place to capture any potential contaminants from the treatment process.

The associated risk from both the temporary and permanent works at these locations will need to be assessed in detail for any planning applications and/or Flood Risk Activity Permit, and Flood Defence Consent (LLFA) applications.

4.5.5 Option C

4.5.5.1 Baseline for Option C, Section 3

Groundwater

Option C passes through the SPZ for numerous sources, with approximately half of the route within SPZ3. Option C passes through five SPZ1 and six SPZ2.

In addition to the GWDTE noted in the common baseline, Bere Mill Meadows SSSI is likely to impact Option C or be impacted by Option C.

Four wells have been identified within 250m of the Option B corridor in addition to those in the common baseline. Two springs have been identified within 500m of the Option C corridor in addition to those in the common baseline.

Surface water

Option C crosses 19 surface water catchments, with direct crossings of five main rivers: River Lambourn, River Kennet/Kennet and Avon Canal, River Enborne, River Test and River Dever. Numerous smaller channels are also crossed.

Flood risk

Section 3 of Option C contains the following assets: CS4 PS and BPT and CS5 PS. These are listed as “Very low risk” (<0.1% of surface water flooding).

The options for CS4 PS and BPT and CS5 PS are all situated in a “high risk” of groundwater flooding. CS4 PS and BPT location has a recorded incident of groundwater flooding in 1995.

No areas at risk of flood from reservoirs has been identified at the locations of Option C assets.

4.5.5.2 Option C Evaluation

Groundwater

The evaluation for SPZ for Option C is as per Option B.

Five GWDTE were identified as likely to impact Option C or be impacted by Option C; the evaluation for GWDTE for Option C is as per Option B.

While most of the identified wells and springs have been classed as ‘unlikely to cause or be at risk’, 12 have been identified as potentially impacted by the construction of Option C. Most of these features are wells within the option corridors, while others are features estimated to be at a lower elevation than the SRO at its nearest point and within 100m of the corridors.

The pipeline is likely to be lain at a maximum depth of 3m along the route, except where the pipeline has to pass beneath major roads, railway or rivers. Therefore, it is unlikely that the construction will directly affect groundwater flow, where groundwater is at a depth of greater than 5m. The groundwater depth contour data has been reviewed and areas where the Option C corridor intersects with shallow groundwater have been identified. For Option C, three areas have been identified as potentially impacting groundwater up to 10m in depth below ground level.

Flood risk

Groundwater flooding has been highlighted as a source of flooding particularly at the location for CS4 PS and BPT which has a record of groundwater flooding in 1995. The majority of the underlying bedrock geology is chalk. The Newbury flood risk management scheme (2015) mentions several periods that ground water flooding has occurred (2007, 2013 & 2014).

In all other aspects, the evaluation for Option C is as per Option B.

4.5.5.3 Option C Mitigation and enhancement

Groundwater

The mitigation for Option C is as per Option B.

Surface water

The mitigation for Option C is as per Option B.

Flood risk

The mitigation for Option C is as per Option B.

4.5.6 Summary

Option B and C corridors intersect a large number of Source Protection Zones, with particular concern raised over the five SPZ1 crossed by the corridors (both options). Prior to construction a hydrogeological risk assessment will be required for works within SPZ 1 or 2. This risk assessment will need to consider the potential impacts upon groundwater flow routes and any impact upon flood risk and nearby receptors such as existing buildings, roads and service infrastructure. It may also be prudent to consider local plans and future development areas. If the risk assessment identifies the potential for an impact on the public water supply (either in yield or in water quality), then additional mitigation will be required and must be agreed with the water company and the Environment Agency. Mitigation could range from the provision of temporary water quality treatment at a source, the temporary closure of a source, or in some cases the complete replacement of a source (including new boreholes, treatment, pipe network etc).

The hydrogeological risk assessment should also consider the potential for long term impacts on GWTDE (including SSSIs) from changes to hydrology. Four GWDTE were identified as likely to impact Option B or be impacted by Option B. Five GWDTE were identified as likely to impact Option C or be impacted by Option C. As all of these are classed as SSSIs, disturbing the groundwater flow and quality could lead to a loss of a protected or threatened habitat or species. Investigation into the impact of construction dewatering on groundwater levels, and potential implications on GWDTE is required.

The northern border of the new WTW at the intake location is recorded in both Flood Zone 3 and 2. It is recommended that new WTW at the intake location remains under review as the design evolves and construction activity takes place outside of Flood Zones 3a and 3b. Development in Flood Zone 3a would require a compensation area to be developed to capture any displaced flood volumes. Development in Flood Zone 3b for “Less vulnerable” development is not permitted. If siting within FZ3a is unavoidable compensatory flood storage volume will need to be provided on a level for level basis.

Groundwater flooding has been highlighted as a source of flooding particularly CS4 PS and BPT which has a record of groundwater flooding in 1995. It is recommended that ground water flooding is taken into consideration for the development of all assets and that appropriate flood proofing measures and/or the rising of entry thresholds are incorporated to mitigate possible damages.

At this stage, both Option B and Option C have similar effects in terms of water resources.

4.6 Air Quality

4.6.1 Introduction

A desk-based assessment was undertaken to identify potential air quality impacts on sensitive receptors associated with the construction and operation of the transfer corridors, and above ground infrastructure, required as part of the T2ST SRO. The objectives of the desk-based assessment were to establish the baseline air quality associated with the preferred T2ST options, identify constraints and opportunities, and identify the issues and features that require further investigation.

The need to consider air quality is driven by legislation, including the Air Quality Standards Regulations 2010[20] and national planning policy, including the draft NPS for Water Resource Infrastructure[5] (Section 4.2, Air Quality) and the NPPF[6] (Section 15, Conserving and enhancing the natural environment, paragraph 186).

The desk-based assessment comprised the following elements:

- Review of the baseline air quality conditions in the area surrounding preferred T2ST options using existing publicly available air quality data from Defra and relevant local authorities.
- Identification of whether baseline air quality conditions are exceeding or close to exceeding the national air quality limit values/objectives in the study area.
- Identification of nearby sensitive receptors. This included consideration of human health receptors, dust soiling receptors and ecological receptors (relevant nature conservation sites).
- Identification of the possible extent of dust generating activities during construction and identification of high-level construction phase mitigation measures in line with Institute of Air Quality Management's (IAQM) 'Guidance on the assessment of dust from demolition and construction.'[3] Note, there was not enough information available at this stage to undertake a formal construction dust assessment (following the methodology outlined in the IAQM guidance) to determine dust risk for the T2ST options.

The following elements were excluded:

- Demolition impacts – as no demolition work is understood to be taking place as part of the site activities.
- Identification of potential construction traffic and operational traffic effects as result of the T2ST options – as information on vehicle numbers or access routes are not available at this stage. However, based on the nature of the scheme, the impacts on air quality associated from vehicles associated with T2ST are unlikely to be significant. This is because Environmental Protection UK (EPUK)/IAQM[4] guidance indicates that an assessment of traffic emissions is only likely to be required where a development generates an additional annual average flow of greater than 100 HDVs per day or greater than 500 LDVs per day. Considering the nature of the scheme and the number of operational staff required, it is unlikely that either the LDV or the HDV flows will exceed these thresholds during the construction or operation phase. However, this should be reconsidered at future assessment stages when information on traffic is available.

[20] Air Quality Standards Regulations 2010, Air Quality Standards (amendment) Regulations 2016, Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019 Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020, Air Quality (England) Regulations 2000, Air Quality (England) (Amendment) Regulations 2002, Environment Act 1995 (Part IV), Environment Act 2021 (Schedule 11), Environmental Protection Act 1990 (section 79(1)(d))

- Identification of potential operational effects associated with standby generators required for the associated infrastructure (BS1 WTW, BS2/CS2 BPT and BS3/CS3 PS and BPT) – as these would not result in significant air quality impacts during normal operation since the generators would only be used for emergencies (i.e. during periods when mains electricity supply to the respective sites (WTW, BPTs PSs) was disrupted). If an emergency were to occur, the generators would likely operate for a short period of time until the power supply to the respective sites was restored. Outside emergency operation, the standby generators would only operate during maintenance/testing, which would have a duration of less than 50 hours a year. Therefore, given the limited number of operating hours associated with the standby generators during normal operation, the impacts on air quality would not be significant so has not been considered in this appraisal. However, this should be reviewed once the location and design of the associated infrastructure for T2ST has been finalised.

4.6.2 Study area and sources of information

For possible dust generating activities during construction, the desk-based assessment focused on the area surrounding the route corridors up to a distance of 350m and identified the number of sensitive receptors within this study area. This is in line with the IAQM construction dust guidance.

The review of baseline conditions considered representative air quality data within 3km of the transfer routes, due to there being no publicly available data within 1km.

The following table outlines the data sources that were collated and considered in the desk-based assessment.

Table 4.4: Sources of information for the Air Quality assessment

Data collected	Source
Locations of Air Quality Management Areas (AQMA) and Clear Air Zones (CAZ)	Local authority and MAGIC Maps Website[7]
Publicly available air quality data (air quality monitoring data, Defra background maps, PCM model)	Local authority monitoring data (published in Annual Status Reports) Defra PCM model and background maps
Human health, dust soiling and ecological receptor locations within 350m of transfer route corridors, anticipated construction works areas and associated infrastructure	OS OpenMap data (Functional Sites, Local Buildings) Natural England mapping

4.6.3 Common Baseline

Options B and C run along the same alignment for the majority of the route (Section 1, 2 and 4), and therefore the following baseline is common to both options. Baselines specific to each option (i.e. Section 3) are discussed in Section 4.6.4 for Option B and Section 4.6.5 for Option C along with impacts and potential mitigation for the whole option.

This assessment has used a qualitative approach to appraise the preferred T2ST options to identify where there is potential for air quality impacts. This included consideration of existing pollutant concentrations (from publicly available sources) in the vicinity of the options as well as the proximity of the options to:

- Air Quality Management Areas (AQMAs) and Clean Air Zones (CAZs)
- Sensitive human health receptors comprising residential receptors
- Sensitive dust soiling receptors
- Sensitive ecological receptors (SAC, SPA, Ramsar, SSSI, National Nature Reserves (NNR), Local Nature Reserves (LNR), LWS, Priority Habitats and Ancient woodland)

No AQMAs within 1km – closest AQMA to the Option is Winchester Town Centre AQMA (1.9km from both Option B and C).

No CAZs within any of the local authority administrative areas that the SRO passes through.

No local authority monitoring sites within 1km – the representative monitoring sites in rural/urban background locations across the wider area (up to 3km from the Option) monitored NO_2 concentrations well below the annual mean objective. However, NO_2 concentrations exceeding or close to exceeding the annual mean objective were recorded at two roadside monitoring sites located 2.8km-3.0km from the northern end of Options B and C on the approach to Abingdon AQMA, near to where the new WTW at the intake location is proposed.

PM concentrations recorded at monitoring sites within 3km of the Options were below the annual mean PM_{10} and $PM_{2.5}$ and 24-hour PM_{10} objectives, despite them being located within an AQMA. PM_{10} and $PM_{2.5}$ concentrations along the Option, which is not located in an AQMA, are expected to be lower.

Department for Environment, Food and Rural Affairs (Defra) background mapping suggests background concentrations across the 1km grid squares that contain the Options B and C are well below the NO_2, PM_{10} and $PM_{2.5}$ objectives.

Pollution Climate Mapping links located within 1km of both Options recorded a 2022 annual mean NO_2 concentration well below the objective.

Within 350m of Section 1 of Option B and C, there are over 100 residential properties, two primary schools and three places of worship, which are high sensitivity receptors. There are also medium sensitivity receptors, which include a play space and public garden/park, and low sensitivity receptors, which include farm buildings and three playing fields within 350m. There is also one area of ancient woodland (William's Wood) located within 350m.

Within 350m of Section 2 of Option B and C, there are between 10 and 100 residential properties and two places of worship, which are high sensitivity receptors. There is also a golf course, which is a medium sensitivity receptor, and farm buildings, which are low sensitivity receptors. There are also 18 areas of ancient woodland located within 350m of this Section, two of which are located within 20m (Back Wood and Borne Copse). There is a SAC (the River Lambourn) that intersects with this Section and a further two SACs (Kennet and Lambourn Floodplain and Kennet Valley Alderwoods) are located within 350m. These three SACs have also been designated as SSSI while an additional SSSIs (the River Kennet) intersects with this Section.

Within 350m of Section 4 of Option B and C, there are between 10 and 100 residential properties, a hospice and place of worship, which are all high sensitivity receptors. There is also a golf course located within 350m of the section, which is of medium sensitivity, and farm buildings, which are of low sensitivity. There are also two areas of ancient woodland located within 350m of this Section, Worthy Copse and Long Wood, in addition to the River Test SSSI that intersects with this Section.

4.6.4 Option B

Baseline for Option B, Section 3

In addition to the common baseline, within 350m of Section 3 for Option B, there are over 100 residential properties and one place of worship which are high sensitivity receptors. There are also medium sensitivity receptors, which include two play spaces and an allotment/community growing space, and low sensitivity receptors, which include farm buildings and a playing field.

There are also 33 areas of ancient woodland located within 350m of Section 3.

There are three SSSIs located within 350m of this Section, two of which (East Ashton Common and River Test) intersects with this Section.

Option B Evaluation

The assessment indicates that the NO_2, PM_{10} and $PM_{2.5}$ objectives are likely to be met in the vicinity of the SRO. NO_2 concentrations that exceeded or were close to exceeding the annual mean objective were recorded close to the proposed new WTW at the intake location, however this was recorded approximately 3km away from the SRO in the vicinity of an AQMA. There have been no other exceedances of the annual mean NO_2 objective and no exceedances at all of the PM_{10} and $PM_{2.5}$ objectives within 3km of the SRO. There are also no AQMAs or CAZs in the vicinity of the SRO either.

The appraisal outcomes indicate that there are sensitive human health, dust soiling and ecological receptors within 350m of both T2ST options which could be impacted as a result of construction activities. Therefore, a number of construction dust mitigation measures have been recommended in accordance with the IAQM guidance. A dust risk assessment will need to be undertaken at a later stage once more information is available to determine the construction dust risk at these sensitive receptors and whether additional construction dust mitigation is required.

The air quality impacts associated with vehicle traffic during the construction and operation phases and the impacts from the standby generators should also be assessed once further details of these activities are available. If significant effects are predicted as result of these activities, additional mitigation may be required.

Option B Mitigation and enhancement

The air quality impacts associated with vehicle traffic during the construction and operation phases and the impacts from the standby generators should be assessed once further details of these activities are available. If significant effects are predicted as result of these activities, additional mitigation may be required. It has been assumed that the impact on air quality will be mitigated within the design. Specifically, it is assumed that the generators would be designed to optimise dispersion of pollutants. For example, the generators should be designed with a sufficient stack height and should not have rain caps or cowls attached, which could impede the exhaust flow.

Generic mitigation measures during construction should be implemented for both Options as a minimum to reduce adverse impacts on air quality associated with construction dust. Mitigation measures should be based on highly recommended measures for low-risk sites in the IAQM guidance[21]. More stringent mitigation measures may be proposed at a later stage once a more detailed air quality assessment has been undertaken.

4.6.5 Option C

Baseline for Option C, Section 3

In addition to the common baseline, within 350m of Section 3 for Option C, there are over 100 residential properties and one place of worship, which are high sensitivity receptors. There is also a play space and an allotment/community growing space located within 350m of the section, which is of medium sensitivity, and a playing field and farm buildings, which are of low sensitivity.

There are also 22 areas of ancient woodland located within 350m of this Section.

[21] IAQM (2014). Guidance on the assessment of dust from demolition and construction, Retrieved from: www.iaqm.co.uk/ text/guidance/construction-dust-2014.pdf. [accessed April 2022]

There are five SSSIs located within 350m of this Section. One SSSI (Bere Mill Meadow) is located within 50m and three SSSIs (Burghclere Beacon, East Aston Common and the River Test) intersect with this Section.

Option C Evaluation

The evaluation for Option C is as per Option B.

Option C Mitigation and enhancement

The mitigation for Option C is as per Option B.

4.6.6 Summary

There are no Air Quality Management Areas within 1km of the proposed route. Clean Air Zones within any of the local authority administrative areas that the SRO passes through. Both Options B and C have similar effects; it is anticipated that best practice construction techniques will be applied, and no significant air quality issues are identified at this stage.

4.7 Climatic Factors

4.7.1 Introduction

A desk-based assessment was undertaken to identify potential climatic risks on sensitive receptors from the construction and operation of the transfer corridors and above ground infrastructure required as part of the T2ST SRO. The objectives of the desk-based assessment were to establish the baseline climatic factors associated with the preferred T2ST options, identify constraints and opportunities, and identify the issues and features that require further investigation.

The need to consider climatic factors is driven by legislation, including the Paris Agreement 2015 and Climate Change Act 2008, and national planning policy, including the draft NPS for Water Resource Infrastructure[5] (Section 3.7, Climate change adaptation) and the NPPF[6] (Section 14, Meeting the challenge of climate change, flooding and coastal change).

The desk-based assessment comprised the following elements:

- Review current climate of the region surrounding the route corridor using available data from the Met Office.
- Identification of projected changes to the climate to 2100 in south east England using the Met Office UKCP18 projections.
- Review vulnerability of assets to climate change, considering the location of T2ST infrastructure – pipeline and above ground assets.
- Review whether creating the infrastructure increases or decreases the risk associated with climate change to surrounding communities / land.
- Review whether a changing climate will exacerbate or ameliorate the risks that have been identified by other topics on environmental / social receptors.

Following Environment Agency guidance on undertaking climate change risk assessments[22], the desk-based assessment used a qualitative approach to appraise the preferred T2ST options and identify where there is potential for climate risks. The method is based on the Environment Agency Climate Change Risk Assessments[23] for permitting purposes and has been used for

[22] Available here: https://www.gov.uk/guidance/adapting-to-climate-change-risk-assessment-for-your-environmental-permit [accessed April 2022]

[23] Available at: Adapting to climate change: risk assessment for your environmental permit - GOV.UK (www.gov.uk) [accessed April 2022]

schemes similar to T2ST. It is a sound approach to risk assessment and is good practice. Consideration of future climate conditions in the area surrounding the options up to 2100 has been included.

4.7.2 Study area and sources of information

The desk-based assessment focused on the area surrounding the route corridors and associated infrastructure for the entire project. Current and future climate data describes the south east England region where the route corridor is located.

The following table outlines the data sources that were collated and considered in the desk-based assessment.

Table 4.5: Sources of information for the Climatic Factors assessment

Data collected	Source
Current climate conditions	Met Office observed data and regional climate summary for southern England
Future climate projections (temperature and precipitation)	Met Office UKCP18 user interface

4.7.3 Baseline

The route corridor is located in the south east region of England which is subject to continental weather influences that bring cold spells in winter and hot, humid weather in summer. High level climate observations for this region over a 30-year period between 1981-2010[24] are presented in Table 4.6.

Table 4.6: Observed climate conditions

Climate variables	Climate observations
Temperature	Mean annual temperatures in the region vary between 9.5°C and 11.5°C. Extreme minimum temperatures typically occur in December or January. January is the coldest month with mean daily minimum temperature between 0.5°C to 3°C. July is the warmest month with mean daily temperature of between 21°C and 23.5°C across the region. Extreme maximum temperatures typically occur in July or August and are usually associated with heat waves lasting several days.
Rainfall	The wettest areas are the South Downs and the higher parts of Dorset with an average of over 950mm per year. In contrast, the Thames Valley, London and north Kent receive less than 650mm of rain per year and less than 550m around the Thames Estuary. Rainfall is well-distributed throughout the year but with an autumn/early winter maximum that is more pronounced in counties bordering the English Channel. Further north in London and the Thames Valley, there are also significant amounts in the summer associated with showery, convective rainfall. In winter, there are 35 to 40 wet days (number of days with rainfall totals of 1mm or more) over the Downs and less than 30 wet days around the Thames Estuary. In summer, there are 25 wet days with the North Downs and western areas being more prone. The region can be subject to dry periods that place demands on water supplies and require conservation measures.
Wind	The region is one of the more sheltered parts of the UK with mean wind speeds strongest in the winter half of the year, especially from December to February. On average, gale force winds occur around 1-2 days per year over most inland areas of the region but exposed places along the South Coast experience 10 gales in an average year. Coastal areas experience sea breezes from late spring through the summer and will often reach London.
Sunshine	In general, December is the dullest month and June the sunniest. The region includes the sunniest places in mainland UK. On the coast, average annual sunshine durations can exceed 1800 hours but 1550-1600 hours is typical of most of the region with a decrease towards the north.

[24] Met Office (2016) Southern England: Climate. Available at: southern-england -climate---met-office.pdf (metoffice.gov.uk). [accessed April 2022]

Climate variables	Climate observations
Snowfall	On average, the number of days with snowfall is 12-15 per year over the lower lying areas but 20 days over the higher grounds of the Chilterns, North downs and Weald. The least snow-prone places are those close to the English Channel with less than 10 days.

The UKCP18 dataset developed by the Met office Hadley Centre has been used to obtain future climate projections for south east England. A baseline period of 1981-2000 has been used and RCP8.5 and RCP6 emission scenarios have been selected based on a precautionary approach. The central estimate, representing 'as likely as not' probability of change (50th percentile), has been selected.

As the project is anticipated to be operational from the 2040s, projections for the end of century, covering the period 2080-2099, are presented. Climate projections for south east England are presented in Table 4.7.

Table 4.7: Climate projections for south east England

Climate variables	Baseline (1981-2000)	Projected change 2080-2099 (RCP6, 50th percentile)	Projected change 2080-2099 (RCP8.5, 50th percentile)
Mean annual temperature (^{o}C)	10.1	+3.1	+4.3
Mean summer temperature (^{o}C)	16.1	+4.2	+5.8
Mean winter temperature (^{o}C)	4.6	+2.5	+3.6
Mean summer precipitation (mm)	150.5	-30%	-41%
Mean winter precipitation (mm)	206.7	+21%	+27%

The UKCP18 projections indicate that in the period 2080-2099, temperatures in south east England are projected to increase across the year. Precipitation is projected to vary seasonally, with an increase in winter and decrease in summer. Although summers are projected to become drier overall, more intense rainfall events are anticipated. These projections are generally aligned to those identified across the UK where summers are projected to be hotter and drier, and winters wetter and warmer.

The construction phase has not been assessed because construction will take place in the short-term in the 2030s. Any risks arising due to extreme weather events should be considered and addressed by measures in the CEMP.

4.7.4 Option B

Option B Evaluation

This scheme contributes to the efficient use of water resources, providing protection against future drought scenarios (and potentially avoids abstractions in more vulnerable areas).

Impacts of higher summer temperatures include the potential that pipe / cabling material will be exposed to increased solar radiation (UV) and may deteriorate at a faster rate, cracking, strength loss and more rapid deterioration of concrete due to high temperatures. Additionally, chemical and mechanical processes/equipment may exceed their operational temperature limit resulting in shut down and brake pressure tank capacity not able to cope with increased demand in the future due to increases in temperature.

Impacts of extreme low-pressure events include the potential that pipe and cabling material will be exposed to air frost and extreme cold temperatures/ice leading to deterioration of materials.

Higher annual and winter rainfall and more extreme rainfall events throughout the year may impact the SRO as high rainfall levels can cause swelling of the ground surrounding the pipe and lead to instability, risk of corrosion of pipe and cable materials. The pipeline along Option B section 1 passes through areas of existing Flood Zone 2 & 3, in Drayton and Steventon. Along Option B section 2 it passes through areas of existing Flood Zone 2 & 3 at the River Kennet crossing, to the west of Newbury. Along Option B section 3 is passes through areas of existing Flood Zone 2 & 3, in Stoke and the area around River Test and in Option B section 4 is passes through of existing Flood Zone 2 & 3 at the River Dever. Flood risk in this area is likely to be exacerbated with higher winter rainfall and more extreme rainfall events throughout the year and may cause ground instability and issues with access to the pipes. Flood water may seep into pipe and contaminate supply, however low risk as it is a buried pipe.

Drier summers can impact soil, drought may have an impact on the stability/properties. There is a risk of ground cracking/shrinkage due to drought and can cause instability issues. Shrinkage and desiccation of ground leading to cracks, strength loss and instability. Foundations may be affected.

The main climatic factors risk include:

- Areas of flooding being exacerbated by climate change and negatively impacting the pipeline.
- The ground being subjected to high temperatures and drought, leading to desiccation, loss of strength and damage to WTW/pumping station foundations and pipeline bedding.
- WTW/pumping stations operational temperature limits exceeded leading to shut downs.

Option B Mitigation and enhancement

It is recommended that mitigation measures are implemented considering the changes in climate in the designs of the pipeline and assets. This includes; higher range of thermal variation, flooding and ground movement.

Construction related mitigation measures can be implemented to reduce the impact of the SRO on the climate such as:

- Structural elements will be designed to include thermal expansion and greater thermal variation specification to account for climate change;
- Pipe design and choice of materials to consider temperature variation;
- Materials selection and specification to consider future temperatures. Monitor and adjust the curing process of the concrete accordingly in order to minimise the risk of high temperatures on the deterioration rate of the structure.
- Consider nature based solutions to provide shade and reduce temperature.
- Locate pipeline access points in areas where there is low risk of flooding. Ensure pipe design and cover is enough to withstand seepage from flooding into the pipes.
- Ensure that ground movements are monitored and repaired when necessary to avoid further damage. Consider the changes in soil moisture in the pipe bedding material specification.
- Additional protective measures will be implemented to ensure that the pipes and cabling are sufficiently protected to reduce the corrosion rates. Selection of materials to consider future rainfall regime.
- Ensure that drainage capacity is designed to limit the flooding at the structure and account for future increased rainfall. Ensure that the foundations are not susceptible to seepage due to poor drainage.

4.7.5 Option C

Option C Evaluation

This scheme contributes to efficient use of water resources, providing protection against future drought scenarios (and potentially avoids abstractions in more vulnerable areas).

Impacts of higher summer temperatures include the potential that Pipe / cabling material will be exposed to increased solar radiation (UV) and may deteriorate at a faster rate, cracking, strength loss and more rapid deterioration of concrete due to high temperatures. Additionally, chemical and mechanical processes/equipment may exceed their operational temperature limit resulting in shut down and brake pressure tank capacity not able to cope with increased demand in the future due to increases in temperature.

Impacts of extreme low-pressure events include the potential that pipe and cabling material will be exposed to air frost and extreme cold temperatures/ice leading to deterioration of materials.

Higher annual and winter rainfall and more extreme rainfall events throughout the year may impact the SRO as high rainfall levels can cause swelling of the ground surrounding the pipe and lead to instability, risk of corrosion of pipe and cable materials. The pipeline along Option C section 1 passes through areas of existing Flood Zone 2 & 3, in Drayton and Steventon. Along Option C section 2 it passes through areas of existing Flood Zone 2 & 3 at the River Kennet crossing, to the west of Newbury. Along Option C section 3 is passes through areas of existing Flood Zone 2 & 3, in the areas around River Enbourne and the River Test, and in Option C section 4 is passes through of existing Flood Zone 2 & 3 at the River Dever. Flood risk in this area is likely to be exacerbated with higher winter rainfall and more extreme rainfall events throughout the year and may cause ground instability and issues with access to the pipes. Flood water may seep into pipe and contaminate supply, however low risk as it is a buried pipe.

Drier summers can impact soil, drought may have an impact on the stability/properties. There is a risk of ground cracking/shrinkage due to drought and can cause instability issues. Shrinkage and desiccation of ground leading to cracks, strength loss and instability. Foundations may be affected.

Option C Mitigation and enhancement

The mitigation for Option C is as per Option B.

4.7.6 Summary

Both Options B and C have similar effects. The main risks for both options include:

- Areas of flooding being exacerbated by climate change and negatively impacting the pipeline;
- The ground being subjected to high temperatures and drought, leading to desiccation, loss of strength and damage to new permanent structure foundations and pipeline bedding; and
- New WTW/pumping stations operational temperature limits exceeded leading to shut downs.

4.8 Landscape

4.8.1 Introduction

A desk-based assessment was undertaken to identify potential impacts on landscape from the transfer corridors and above ground infrastructure required as part of the T2ST SRO. The objectives of the desk-based assessment are to establish the landscape baseline associated with the preferred T2ST options, identify constraints and opportunities, and identify the issues that require further investigation.

The need to consider landscape is driven by legislation, including the European Landscape Convention Feb 2008 and the Town and Country Planning Act 1990, and national planning policy including the draft NPS for Water Resource Infrastructure[5] (Section 4.9, Landscape and visual impacts) and the NPPF[6] (Section 15, Conserving and enhancing the natural environment, paragraphs 174 and 180).

The objectives of the landscape initial baseline assessment are to:

- Set out the landscape character areas associated with the preferred T2ST options;
- Identify the key landscape assets associated with the preferred T2ST options;
- Identify sensitivities and opportunities in relation to landscape associated with the preferred T2ST options; and
- Identify the areas that require further investigation.

The assessment does not identify sensitive visual receptors or the impact on their views because this would require more detailed design information and confirmation on site.

The risk-based approach identified sensitive landscapes and receptors that may be affected by the preferred T2ST options in order to inform the route selection, infrastructure siting and refinement process with the aim of avoiding, reducing and mitigating potential impacts on landscape features and visual amenity where possible to:

- Avoid potentially significant effects that could be scoped into an EIA.
- Avoid attracting onerous planning conditions and delays to achieving planning consents.
- Facilitate delivery to programme and achieve efficiencies.

4.8.2 Study area and sources of information

This desk-based assessment focused on the transfer route corridors, location of associated infrastructure and the surrounding area within a maximum 1km distance of the preferred T2ST options. This search radius was considered sufficient to produce a comprehensive landscape baseline.

The following table outlines the data sources that were collated and considered in the desk-based assessment.

Table 4.8: Sources of information for the Landscape assessment

Data collected	Source
Landscape designations including National Park, AONB, Ancient woodland, Agricultural land classifications, Areas of high landscape value	Natural England, Local Planning Authorities (Vale of White Horse, West Berkshire, Basingstoke and Deane, Test Valley, Winchester)
Historic environment including conservation areas, listed buildings, scheduled monuments, Registered Parks and Gardens Parks, Historic landscape characterisation historic hedgerows, historic field patterns	Information on the assets that are relevant to historic environment will be sourced from the Historic Environment assessment to ensure consistency. Information on assets not relevant to the Historic environment assessment will be sourced from aerial photography, historic maps, and published historic landscape character documentation.
PRoW including footpaths, bridleways, cycle paths	Local Planning Authorities, SUSTRANS, OS mapping
Published landscape and townscape character assessments and National Character Area Profiles	Local Planning Authorities, GOV.UK
Topography	LiDAR data from the Environment Agency database
Tranquillity and light pollution data	CPRE, the countryside charity
Planning policy	Local plans and Local Planning Authorities
Existing vegetation	Aerial photography, OS mapping

Data collected	Source
Green infrastructure including country parks, formal parks, areas of recreation green space	OS Mapping, Local plans and Local Planning Authorities

4.8.3 Common baseline

Options B and C run along the same alignment for the majority of the route (Section 1, 2 and 4), and therefore the following baseline is common to both options. Baselines specific to each option (i.e. Section 3) are discussed in Section 4.8.4 for Option B and Section 4.8.5 for Option C along with impacts and potential mitigation for the whole option.

Section 1 of both options partly lies within Upper Thames Clay Vales National Character Area (NCA). Sections 1 and 2 lie partially within Berkshire and Marlborough Downs NCA. Sections 2 and 3 for both Options B and C partially lie within Thames Basin Heaths NCA. Sections 3 and 4 for both Options B and C partially lie within Hampshire Downs NCA.

Section 1 of both options passes close to the footpath Ridgeway National Trail where it crosses the A34 and the cycle route, NCN 544. Part of Section 1 is located on the chalk scarp of the Chilterns and the Berkshire and Marlborough Downs.

Section 2 of both options passes close to Snelsmore Common Country Park, and close to footpaths and cycleways, including the Lambourn Valley way, Kennet and Avon Canal walk and NCN route 4. Part of Section 2 is located on the chalk scarp of the Berkshire and Marlborough Downs.

Section 4 of both options passes close to Lainston House Registered Park and Garden and close to footpaths and cycleways, including the Clarendon Way. Part of Section 4 is located on the chalk scarp of the Hampshire Downs (Thames Basin).

There are 9 Conservation Areas located within the route corridors or the 500m study area surrounding the route corridors. Construction of the proposed pipeline would result in a temporary change to land use and to the varied landforms of the existing rural landscape, due to large-scale excavation and stockpiling of materials within the working corridor.

In operation, the presence of substantial new infrastructure and associated fencing, lighting, hardstanding and access roads would potentially urbanise the rural landscape. There would also potentially be a permanent loss of vegetation within the pipeline corridor easements and within the footprint of new, permanent infrastructure.

Much of the northern sections of Option B and Option Care located in the North Wessex Downs AONB.

4.8.4 Option B

Baseline for Option B, Section 3

Section 3 of Option B passes next the Portway Roman Road at Middle Wyke, and close to footpaths and cycleways including the Wayfarers Walk, Brenda Parker Way, Test Way and NCN 246.Part of Section 3 of Option B is located on the chalk scarp of the Hampshire Downs (Thames Basin).

Section 3 of Option B passes near to East End and North End Conservation Area and through St Mary Bourne and Stoke Conservation Area.

Option B Evaluation

The temporary diversion or closure of footpaths and cycleways, including the Ridgeway National Trail, NCN 544, Lambourn Valley Way, Kennet and Avon Canal walk, NCN 4, Wayfarers Walk,

Brenda Park Way, Test Way, NCN 246 and Clarendon Way, would temporarily reduce recreational connectivity.

Construction activity, plant, lighting and the siting of compounds would reduce tranquillity within the North Wessex Downs AONB which is noted for its quiet rural character from views.

Construction activity within Section 2 has the potential to temporarily reduce tranquillity in areas close to Snelsmore Common Country Park.

Section 3 of Option B will likely require vegetation removal along the Portway Roman Road near Middle Wyke which will alter a feature that is a notable element contributing to the landscape character.

Section 3 of Option B passes near to East End Conservation Area and through St Mary Bourne and Stoke Conservation Area. Removal of vegetation within the conservation areas has the potential to alter the historic townscape character.

The presence of new infrastructure, hardstanding and access roads would potentially urbanise the rural landscape.

BS1 WTW and PS would be sited in an open arable landscape and would potentially affect the pattern of the landscape due to removal of vegetation and views.

BS2 BPT would be close to the Ridgeway National Trail. The structure and associated fencing and hardstanding would potentially affect the views from the trail and nearby Public Right of Way (PRoW).

BS3 PS and BPT would be adjacent to the A34 and screened by existing woodland from the east and west. Landscape mitigation would include new woodland planting to the north and south of the new structures, integrating new and existing woodlands.

BS4 PS and BPT would be close to the Brenda Parker Way. The structure and associated fencing, lighting and hardstanding would potentially affect the views from the trail and nearby PRoW.

BS5 BPT would be close to Highclere Park, although screened by existing woodland to the north and east, and has the potential to alter the setting of the park.

BS6 PS / CS5 PS would be sited adjacent to the existing Micheldever WSR, close to the urban edge of Andover, and screened by existing woodland along Micheldever Road.

Option B Mitigation and enhancement

Landform mitigation measures include:

- Work with the existing landform in the siting of above ground structures to reduce visibility and integrate them into the landscape.
- Avoid siting permanent structures at ridgelines
- Ensure that remedial works respect the existing contours and landform.
- Use manmade landforms e.g. bunds and extended earthworks to integrate any new structures into the local topography.

Land cover mitigation measures include:

- Locate construction compounds adjacent to existing infrastructure
- Design and locate fencing, hoardings and lighting required in construction and operation to reduce the urbanising the rural landscape.

- Avoid damage to sinuous tracks and boundaries by siting the pipeline and above ground structures away from them. Where this is not possible, narrow the working corridor to reduce the impact on these characteristic features of the landscape.
- Work with existing field patterns and access routes in the siting of compounds and permanent structures
- Restore land to former use following construction.
- Follow locally characteristic vegetation patterns in design of mitigation planting around permanent structures.
- Design structures and boundary treatments to be sympathetic to the local vernacular.

Vegetation and water mitigation measures include:

- Adjust the pipeline route to avoid removal of vegetation and avoid root protection zones where possible.
- Adjust the pipeline route to cross the watercourse where there is little or no vegetation.
- Avoid running parallel to watercourses for long stretches.
- Design of culverts to be sensitive to the rural location in terms of scale and materials.
- Replace all hedgerows and trees removed during construction.
- Narrow the working corridor where crossing vegetated areas in order to reduce vegetation loss.
- Look for opportunities to enhance nearby hedgerows, riparian vegetation and strengthen connections within the blue-green network.
- Link mitigation woodland and other screen planting to existing nearby woodland belts and vegetation to aid landscape integration.

Characteristic views mitigation measures include:

- Avoid removal of vegetation on the chalk scarps, as this would be highly visible.
- Avoid siting permanent structures on the rising scarps as this would be highly visible.
- Integrate above ground structures into the landscape using woodland and screen planting.

Perceptual and experiential qualities mitigation measures include:

- Locate construction compounds adjacent to existing infrastructure and away from sensitive landscapes (e.g. North Wessex Downs AONB)
- Minimise lighting in construction and operation to avoid introducing additional lighting into the dark countryside.

Landscape assets mitigation measures include:

- Provision of managed access or a diversion during construction.
- Avoid prolonged closure of footpaths.
- Site BS4 PS and BPT where it will be screened from the Brenda Parker Way trail by existing vegetation. Landscape mitigation would include new woodland and hedgerows to integrate the structure into the landscape. Retention of existing woodland blocks and established field boundaries would reduce the requirement for planting mitigation woodland
- Look for opportunities to enhance nearby sections of the Ridgeway National Trail in terms of planting, resurfacing, information boards, way markers and social enhancements.

4.8.5 Option C

Baseline for Option C, Section 3

Section 3 of Option C Portway crosses the Portway Roman Road between Litchfield and Cole Henley and close to footpaths and cycleways including the Wayfarers Walk, Brenda Parker Way and Test Way.

Section 3 of Option C passes through Laverstoke and Freefolk Conservation Area and near to Tufton Conservation Area.

CS4 PS and BPT would be close to the top of the scarp to the west of Great Litchfield Down and adjacent to the A34.

Option C Evaluation

The temporary diversion or closure of footpaths and cycleways, including the Ridgeway National Trail, NCN 544, Lambourn Valley Way, Kennet and Avon Canal walk, NCN 4, Wayfarers Walk, Brenda Park Way, Test Way, NCN 246 and Clarendon Way, would temporarily reduce recreational connectivity.

Construction and operational activity would reduce tranquillity within the North Wessex Downs AONB which is noted for its quiet rural character from views.

Construction activity within Section 2 has the potential to temporarily reduce tranquillity in areas close to Snelsmore Common Country Park.

Section 3 of Option C will likely require vegetation removal along the Portway Roman Road between Litchfield and Cole Henley which will alter a feature that is a notable element contributing to the landscape character.

Section 3 of Option C passes through to Laverstoke and Freefolk Conservation Area and Tufton Conservation Area. Removal of vegetation within the conservation areas has the potential to alter the historic townscape character.

CS1 WTW and PS would be sited in an open arable landscape and would potentially affect the pattern of the landscape due to removal of vegetation and views. Landscape mitigation would include new woodland belts to screen the structures. The scheme design should aim to fit within the existing field pattern.

CS2 BPT would be close to the Ridgeway National Trail. The structure and associated fencing and hardstanding would potentially affect the views from the trail and nearby PRoW.

CS3 PS and BPT would be adjacent to the A34 and screened by existing woodland from the east and west. Landscape mitigation would include new woodland planting to the north and south of the new structures, integrating new and existing woodlands.

CS4 PS and BPT would be close to Wayfarers Walk, multiple scheduled ancient monuments and historic features characteristic of the landscape and the top of the scarp to the west of Great Litchfield Down and adjacent to the A34. The structure and associated fencing and hardstanding would potentially affect the views from the long-distance footpath and nearby PRoW and be visible at the top of the scarp. The presence of the new PS and BPT has the potential to partially screen the archaeological remains and change the historic character of the landscape in this location.

CS5 PS would be sited adjacent to the existing Micheldever WSR, close to the urban edge of Andover, and screened by existing woodland along Micheldever Road. Landscape mitigation would include new woodland planting to the south and west of the new structures, integrated with existing roadside and boundary vegetation.

Option C Mitigation and enhancement

The mitigation for Option C is as per Option B, for all mitigation except for landscape assets mitigation as follows:

Landscape assets mitigation measures include:

- Site CS4 PS and BPT where it will be screened from Wayfarers Walk, multiple scheduled ancient monuments and historic features characteristic of the landscape by existing vegetation. Landscape mitigation would include new woodland and hedgerows to integrate the structure with existing areas of woodland. Retention of existing woodland blocks and established field boundaries would reduce the requirement for planting mitigation woodland.

4.8.6 Summary

The route of the pipeline construction corridor and location of above ground structures should be refined to reduce the likely loss of vegetation and impact to sensitive landscape features.

At this stage, both Option B and Option C have similar effects in terms of landscape.

4.9 Historic Environment

4.9.1 Introduction

A desk based assessment was undertaken to identify potential impacts on the Historic Environment from the transfer corridors and above ground infrastructure required as part of the T2ST SRO. The objectives of the desk-based assessment are to establish the historic and archaeological baseline associated with the preferred T2ST options, identify constraints and opportunities, and identify the issues that require further investigation.

The need to consider the historic environment is driven by legislation and national planning policy (draft National Policy Statement for Water Resource Infrastructure and National Planning Policy Framework).

The need to consider the historic environment is driven by legislation including the Ancient Monuments and Archaeological Areas Act 1979 and the Planning Act 1990 (Listed Buildings and Conservation Areas), planning policy, including the draft NPS for Water Resource Infrastructure[5] (Section 4.7, Historic Environment) and the NPPF[6] (Section 16, Conserving and enhancing the historic environment, paragraphs 189-208).

The objectives of the historic environment desk-based assessment were to:

- Set out the characteristics of the historic environment associated with the preferred T2ST options;
- Identify the key heritage assets associated with the preferred T2ST options;
- Identify constraints and opportunities associated with the preferred T2ST options; and
- Identify the issues and heritage assets that require further investigation.

4.9.2 Study area and sources of information

The desk-based assessment focused on the transfer route corridors, locations of associated infrastructure, and the surrounding area within 500m for designated heritage assets[25] and 200m

[25] Designated heritage asset defined by the NPPF as “A World Heritage Site, Scheduled Monument, Listed Building, Protected Wreck Site, Registered Park and Garden, Registered Battlefield or Conservation Area designated under the relevant legislation.” NPPF Annex 2: Glossary, National Planning Policy Framework, Ministry of Housing, Communities & Local Government, June 2019

for non-designated heritage assets[26]. This search radius was considered sufficient to produce a comprehensive baseline and allowed for an understanding of the archaeological potential and historic significance to be established, and subsequently for appropriate mitigation to be recommended for the scheme regarding the historic environment. Where heritage assets with the study areas are identified as being subject to potential impacts, consideration of those impacts will also include the impacts on 'setting', which may extend beyond the extent of the study areas described above.

The following table outlines the data sources that were collated and considered in the desk-based assessment.

Table 4.9: Sources of information for the Historic Environment assessment

Data collected	Source
Historic Environment – Designated Assets	
World Heritage Sites	National Heritage List for England (NHLE) data download[27]
Listed Buildings	NHLE data download
Scheduled Monuments	NHLE data download
Registered Parks and Gardens	NHLE data download
Registered Historic Battlefields	NHLE data download
Conservation Areas	NHLE data download
Historic Environment – Non-Designated Assets	
Locally Listed Buildings	Local Planning Authorities (Vale of White Horse, West Berkshire, Basingstoke and Deane, Winchester)
Non-designated heritage assets	Datasets held by the Oxfordshire (18/10/2021), West Berkshire (31/03/2022), Hampshire (18/10/2021) and Winchester City (18/10/2021) Historic Environment Record (HER). National Mapping Programme data Historic maps (National Library of Scotland and British Library) BGS

4.9.3 Common baseline

Options B and C run along the same alignment for the majority of the route (Section 1, 2 and 4), and therefore the following baseline is common to both options. Baselines specific to each option (i.e. Section 3) are discussed in Section 4.9.4 for Option B and Section 4.9.5 for Option C along with impacts and potential mitigation for the whole option.

There are 549 Listed Buildings located within the route corridors or within the 500m study area surrounding the route corridors. Those with a high heritage value include (but are not limited to) those listed below:

- Church of St Mary in East Ilsley, Grade I Listed Building.
- Kennet House, Grade II* Listed Building.
- Milestone located at SU 44910 18277, Grade II Listed Building.
- Church of St Nicholas in Beedon, Grade I Listed Building.
- Church of St. James in Winterbourne, Grade II* Listed Building.

[26] Non-designated heritage asset defined by National Planning Guidance as "buildings, monuments, sites, places, areas or landscapes identified by plan-making bodies as having a degree of heritage significance meriting consideration in planning decisions but which do not meet the criteria for designated heritage assets." https://www.gov.uk/guidance/conserving-and-enhancing-the-historic-environment, [accessed April 2022]

[27] Available at https://historicengland.org.uk/listing/the-list/data-downloads/ [accessed April 2022]

- In South Littleton, the Church of St Michael, Grade II* Listed Building
- Littleton Manor in Spelthorne, Grade II* Listed Building.
- Church of St Catherine in Littleton, Grade II* Listed Building.

There are 27 Scheduled Monuments located within the route corridors or the 500m study area surrounding the route corridors, including the following high value sites in close proximity:

- The ‘Barrow north of Ridgeway’
- ‘Long barrow on Sheep Down, 1km north of East Ilsley’
- Four Scheduled Monuments associated with surviving sections of Grim’s Ditch
- Goldbury Hill Anglo-Saxon Cemetery
- Bussock Camp
- ‘cross dyke and bowl barrow on the northern spur of Beacon Hill’
- the large univallate hillfort at Beacon Hill associated with the Iron Age cross dyke above
- the Old Pound Corpse earthwork
- ‘earthwork 1/2 mile (810m) NW of Larkwhistle Farm’ A ‘Bowl barrow 630m NNE of Littleton House’
- ‘Three round barrows 500m WNW of Flowerdown House’

There are four Registered Parks and Gardens located within the route corridors or the 500m study area surrounding Option B and Option C, of which two are of high heritage value:

- Highclere Park, Grade I Registered Park and Garden
- Lainston House, Grade II* Registered Park and Garden

There is one Registered Historic Battlefield located within the route corridors or the 500m study area surrounding the route corridors, namely the Battle of Newbury 1643.

There are 9 Conservation Areas located within the route corridors or the 500m study area surrounding the route corridors.

There are over 1000 non-designated heritage assets within the route corridors or the 500m study area surrounding the route corridors.

There are no World Heritage Sites located within the route corridors or the 500m study area surrounding the route corridors.

A historical narrative was identified from the designated and non-designated assets appraised, alongside documentary research within or up to 500m surrounding the route corridors, allowing an assessment of the potential for archaeology on the routes. Areas of below-ground archaeological remains are difficult to predict; however, there is a higher potential for below-ground archaeological remains to survive in areas where there has been minimal redevelopment. Therefore, as much of the Scheme is located within agricultural fields that have seen little disturbance there is a higher potential for below-ground archaeology within these areas.

4.9.4 Option B

Baseline for Option B, Section 3

In addition to the listed buildings noted in the common baseline, there is one Grade II Listed Building which will be directly impacted by the Section 3 route. This is a Milestone on A343 at NGR 431 581 (MM440) dated to the late 18th century that is an unusual example of this type. It is inscribed with ‘Sarum 28, Newbury 5, Andover 10. The Andover and Chilton Pond turnpike was opened in 1766 and this is one of a series of similar milestones on the turnpike’. There are

no Grade I or II* Listed Buildings located within the Option B, Section 3 corridor or within the 500m study area.

In addition to the scheduled monuments listed in the common baseline, there are five scheduled monuments located within the Option B Section 3 corridor, or within the 500m study area:

- Round barrow on Rabbit Warren
- Earthworks in Danegrove Copse
- Bowl barrow 610m east of Crux Easton Church
- Long barrow 580m south-west of Woodcott Church
- Bowl barrow 120m ESE of The Croft

In addition to the Registered Parks and Gardens listed in the common baseline, there is one located within Option B Section 3, or within the 500m study area, namely Hurstbourne Park which is of medium heritage value.

There are 5 Conservation Areas within the Option B Section 3 route corridor or the 500m study area surrounding the route corridors, with the SRO going directly through the St Mary Bourne and Stoke Conservation Area.

Option B Evaluation

The construction phase of the Scheme has the potential to cause temporary minor impacts to four Conservation Areas:

- West Hendred Conservation Area
- East Hendred Conservation Area.
- East End and North End Conservation Area
- St Mary Bourne and Stoke Conservation Area

Minor impacts may be anticipated during the construction phase on the Scheduled Monument of ‘Barrow N of ridgeway, Hodcott Down’ and Grim’s Ditch.

The setting of the following heritage items has the potential to face temporary impacts during construction:

- Ducksbridge Grade II Listed Building – minor impacts
- Gangbridge House Grade II Listed Building – minor impacts
- Grade II* Listed Park and Garden, Lainston House – moderate impacts

There is also the potential to have a minor impacts on a potential Roman villa identified at Enborne through aerial imagery; possible below ground remains of a Roman building as indicated by cropmarks and debris associated with a Romano-British building; prehistoric or possible medieval earthworks and enclosures at Sutton Scotney, Wonston, South Wonston, Worthy Grove, Lower Farm Cottages, Littleton, Lanham Down, and Down Farm; and probable remains of a Second World War heavy anti-aircraft battery at Vale Farm. However, this is largely dependent on the presence of any the below-ground remains of the structures.

There are potential earthworks and field systems identified on aerial imagery at the north of Section 1 which have the potential to contain below-ground remains which may lead to a minor, but permanent, impact on these assets during construction.

While areas of below-ground archaeological remains are difficult to predict, because much of the Scheme is located within agricultural fields that have seen little disturbance there is a higher potential for below-ground archaeology that may be impacted during construction of the Scheme.

Operation of the Scheme is unlikely to have any permanent impact on the identified assets.

Overall, the archaeological potential of the SRO ranges from low to high. There is a high-moderate potential for Prehistoric and post-Medieval remains, as well as a moderate-low potential for Roman, Medieval, and Modern remains. Therefore, it is predicted that the SRO would not impact built heritage and impacts to any potential below-ground archaeology would be moderate.

Option B Mitigation and enhancement

Part of the SRO may go through several Conservation Areas. It is recommended that mitigation measures should be considered such as minimising disruption during works, measures to avoid impacts upon key views, noise screening, and monitoring noise and vibration.

As a minimum it should be expected that archaeological monitoring will be required during construction phase. However, given the high importance of the heritage assets non-intrusive geophysical survey followed by trial trenching may be required by Historic England in advance of construction phase for any of the designated assets identified within the SRO, notable the Scheduled Monuments listed above.

It is also recommended that geophysical survey be conducted on any section of the route where earthworks have been identified from cropmarks and aerial photography prior to any intrusive works. Should this not be possible, it is recommended that the groundworks proposed in the undeveloped areas of the site are archaeologically monitored. This is to ensure that no remains are removed by the SRO without adequate record. Additional investigation may also be required, as determined through consultation with the relevant local authorities.

4.9.5 Option C

Baseline for Option C, Section 3

In addition to the listed buildings noted in the common baseline, there are the following listed buildings with a high heritage value located within the Option C, Section 3 corridor or within the 500m study area:

- Sandham Memorial Chapel in Burghclere, Grade I Listed Building.
- Church of All Saints, Grade I Listed Building.
- ‘Barn approximately 40 Metres south-west of Manor Farmhouse’, Grade I Listed Building.
- Manor House of Burghclere, Grade II* Listed Building.

No Grade II Listed Buildings will be directly impacted by the Option C, Section 3 route.

In addition to the scheduled monuments listed in the common baseline, there are nine scheduled monuments located within the Option C Section 3 corridor, or within the 500m study area, of which the following high value sites are in close proximity:

- a section of ‘linear earthwork south-west of Great Litchfield Down’
- three bowl barrows in a cemetery of ten Bronze Age round barrows, seven of which are upstanding, situated along the floor of a dry valley between Thorn Down and Great Litchfield Down

There are 4 Conservation Areas within the Option C Section 3 route corridor or the 500m study area surrounding the route corridors, with the SRO going directly through the Laverstoke and Freefolk Conservation Area.

Option C Evaluation

The construction phase of the Scheme has the potential to cause temporary minor impacts to four Conservation Areas:

- West Hendred Conservation Area
- East Hendred Conservation Area.
- Laverstoke and Freefolk Conservation Area

Minor impacts may be anticipated during the construction phase on the Scheduled Monument of 'Barrow N of ridgeway, Hodcott Down' and Grim's Ditch.

The setting of the following heritage items has the potential to face temporary impacts during construction:

- Ducksbridge Grade II Listed Building – minor impacts
- Gangbridge House Grade II Listed Building – minor impacts
- Grade II* Listed Park and Garden, Lainston House – moderate impacts

There is also the potential to have a minor impacts on a potential Roman villa identified at Enborne through aerial imagery; the remains of a possible ring ditch, prehistoric trackway and field system to the north-west of Tufton Warren; prehistoric or possible medieval earthworks and enclosures at Sutton Scotney, Wonston, South Wonston, Worthy Grove, Lower Farm Cottages, Littleton, Lanham Down, and Down Farm; and probable remains of a Second World War heavy anti-aircraft battery at Vale Farm. However, this is largely dependent on the presence of any the below-ground remains of the structures.

There are potential earthworks and field systems identified on aerial imagery at the north of Section 1 which have the potential to contain below-ground remains which may lead to a minor, but permanent, impact on these assets during construction.

Three non-designated heritage assets have the potential to be impacted by the construction of the Scheme. The first asset is a deserted settlement (1066 AD-1539 AD) at Old Burghclere which is evidenced through historic records and cropmarks. Any construction works in this area has the potential to moderately impact any possible below-ground remains relating to this site

While areas of below-ground archaeological remains are difficult to predict, because much of the Scheme is located within agricultural fields that have seen little disturbance there is a higher potential for below-ground archaeology that may be impacted during construction of the Scheme.

Operation of the Scheme is unlikely to have any permanent impact on the identified assets.

Overall, the archaeological potential of the SRO ranges from low to high. There is a high-moderate potential for Prehistoric and post-Medieval remains, as well as a moderate-low potential for Roman, Medieval, and Modern remains. Therefore, it is predicted that the SRO would not impact built heritage and impacts to any potential below-ground archaeology would be moderate.

Option C Mitigation and enhancement

The mitigation for Option C is per option B.

4.9.6 Summary

During construction, Option B, Section 3 has the potential to temporarily impact two Conservation Areas, one Grade II Listed Building and one Scheduled Monument, as well as several non-designated heritage assets.

During construction, Option C, Section 3 has the potential to temporarily impact one Conservation Area and several non-designated heritage assets.

Both options are likely to disturb areas of below-ground archaeological remains.

Operation of the Scheme is unlikely to have any permanent impact on the identified assets.

4.10 Population and Human Health

4.10.1 Introduction

A desk based assessment was undertaken to identify potential Population and Health impacts on sensitive receptors from construction and operation of the transfer corridors and above ground infrastructure required as T2ST SRO. The objectives of the desk-based assessment were to establish the Population and Health baseline associated with the preferred T2ST options, identify constraints and opportunities, and identify the issues and features that require further investigation.

The need to consider population and human health is driven by planning policy, including the draft NPS for Water Resource Infrastructure[5] (Section 4.10, Land use including open space, green infrastructure and Green Belt and 4.13, Socio-economic impacts) and the NPPF[6] (Section 8, Promoting healthy and safe communities, Section 12, Achieving well-designed places, Section 15, Conserving and enhancing the natural environment, paragraph 185).

The desk-based assessment comprised the following elements:

- Identification of the population and health baseline including local population receptors and resources in the study area.
- An assessment as to the potential for the T2ST options to affect the key receptors and resources.
- Identification of constraints and opportunities associated with the T2ST options.

4.10.2 Study area and sources of information

The desk-based assessment focused on the transfer route corridors, and the location of associated infrastructure. The study area for this topic is a 500m buffer around the route corridors and associated infrastructure. Where sensitive receptors (specifically education and healthcare facilities) or regional tourist attractions, lie outside of this study area, but are accessed by populations using routes within the study area (that may be disturbed as part of construction works within the route corridors), these facilities were identified.

The following table outlines the data sources that were collated and considered in the desk-based assessment.

Table 4.10: Sources of information for the Population and Health assessment

Data collected	Source
Housing and private property	Google Maps
Businesses	OS OpenMap and Google Maps
Community facilities, focusing on: Schools and education facilities Hospitals and medical facilities Care homes Places of worship	OS OpenMap
Open space and recreation, focusing on: National and regional trails	OS OpenMap

Data collected	Source
Recreational facilities Allotments Regional tourist attractions	
Population and health	English Indices of Multiple Deprivation (IMD) 2019 – for the measurement and comparison of relative levels of deprivation (poverty – total IMD and individual domains for Health, Employment and Living Environment Public Health England data sets Office for National Statistics (ONS) data sets on demography

4.10.3 Common baseline

Options B and C run along the same alignment for the majority of the route (Section 1, 2 and 4), and therefore the following baseline is common to both options. Baselines specific to each option (i.e. Section 3) are discussed in Section 4.10.4 for Option B and Section 4.10.5 for Option C along with impacts and potential mitigation for the whole option.

The baseline of the population and human health assessment identified population and human health receptors and resources within 500m buffer layer of the proposed pipelines and the environmental corridors.

The following elements were included:

- Housing and private property
- Businesses
- Community facilities
- Open space and recreational areas

Both proposed pipeline routes pass through agricultural land, with settlements located within 500m containing housing and private property, businesses, community facilities and areas of open space and recreation. Health indicators were also analysed for the population within the five local authority areas in which the proposed pipeline options are located. Life expectancy (for both genders) is slightly higher across all areas in which the corridors are located, compared to the England average. The under-75 mortality rates (from all causes, cardiovascular diseases and cancer) for all the local authorities are also less than the national rates. A large proportion of residents living within 500m of the proposed pipeline options live in the least or fourth most deprived quintiles in the country.

4.10.4 Option B

Baseline for Option B, Section 3

The majority for the land affected by Option B is agricultural which may have an impact (both permanent and temporary) on the operation of businesses that carry out this function.

Option B Evaluation

The potential impacts on housing and private property, businesses, community facilities and open space and recreation were considered as part of the evaluation. For each option and section, a summary of the main findings is provided.

Section 1 - For the majority of the environmental corridors, the proposed pipeline and above ground assets do not bisect any housing or private property, businesses, community facilities or open space and recreational areas. There is the potential for temporary land requirements that may affect population and human health receptors. The majority of temporary land required is likely to be agricultural land. The proposed above ground BS2 BPT is located directly adjacent

to a PRoW. This may temporarily obstruct the PRoW during construction or may require permanent diversion.

Depending on the construction methodology, there may be a change in environmental conditions at some population and human health receptors because of a combination of noise, air quality, visual impacts or presence of HGV vehicles.

Section 2 –There is the potential for temporary impacts, as a result of land requirements, on housing or private property. The majority of land in this section is agricultural which may have an impact (both permanent and temporary) on the operation of businesses that carry out this function. The pipeline bisects a number of roads, so there may be temporary disruption for communities which use these routes to travel between communities and to access facilities.

Depending on the construction methodology, there may be a change in environmental conditions at some population and human health receptors because of a combination of noise, air quality, visual impacts or presence of HGV vehicles.

Section 3 – There is the potential for temporary impacts, as a result of land requirements, on housing or private property . The majority of land in this section is agricultural which may have an impact (both permanent and temporary) on the operation of businesses that carry out this function.

The pipeline bisects a number of roads, so there may be temporary disruption for communities which use these routes to travel between communities and to access facilities. Communities that are most likely to be impacted are East Woodhay, East End, Binley, Stoke, St Mary Bourne, Whitchurch and Longparish. The proposed pipeline bisects a number of PRoW to the west of Highclere, in Lower Wyke and within Longparish.

Depending on the construction methodology, there may be a change in environmental conditions at some population and human health receptors because of a combination of noise, air quality, visual impacts or presence of HGV vehicles.

Section 4 – There is the potential for temporary impacts on population and human health receptors. This includes potential impacts on private property and housing and community receptors, particularly in Crawley and Sparshott, north west of Winchester. The majority of land in this section is agricultural which may have an impact (both permanent and temporary) on the operation of businesses that carry out this function.

The pipeline bisects a number of roads, so there may be temporary disruption for communities which use these routes to travel between communities and to access facilities. Communities that are most likely to be impacted are Barton Stacey, Crawley, Sparshott, Flowerdom and Pitt. The proposed pipeline bisects a number of PRoW in this section near to Longparish, Lower Bullington and Littleton.

Depending on the construction methodology, there may be a change in environmental conditions at some population and human health receptors because of a combination of noise, air quality, visual impacts or presence of HGV vehicles.

During operation, potential impacts are likely to be minimal given the pipeline will be below ground and the land which was utilised during construction reinstated. However, the operation of the above ground assets is likely to change the amenity for nearby population and human health receptors due to potential noise, air quality and visual impacts. The communities most likely to be impacted are in Drayton due to the operation of the new WTW at the intake location. Given the distance between all other above ground assets and communities, no other impacts are anticipated.

Option B Mitigation and enhancement

To avoid or mitigate potential disruption and disturbance to communities during construction and operation of the T2ST scheme, best practice mitigation should be implemented during construction. This includes:

- Setting out how engagement with local communities will be undertaken during construction.
- Implementation of specific measures in relation to air quality and noise to reduce impacts on neighbouring residents communities, particularly for sensitive community resources such as educational facilities, health facilities and care homes.
- Developing mitigation for local road closures and diversions when details are known regarding timing and duration of closure.
- Developing mitigation for temporary trainline closures and disruption to trainline services when details are known regarding timing and duration of closure, in order to reduce direct impacts from travel disruption.
- The above ground assets should have landscaping, air quality and noise mitigation included in their design, in order to limit the potential indirect impacts from noise and air pollution on properties and businesses and open spaces.
- 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.

4.10.5 Option C

Baseline for Option C, Section 3

As for Option B, the majority for the land affected by Option C is agricultural which may have an impact (both permanent and temporary) on the operation of businesses that carry out this function.

Option C Evaluation

Section 1, 2 and 4 as per Option B as the pipeline routes and environmental corridor is the same.

The majority of Section 3 of Option C is located on land which is currently used for agricultural purposes. Due to temporary land requirements during construction, there is likely to be an impact (both temporary and permanent) on the operation of businesses that carry out this function in the areas of land affected. The proposed pipeline and above ground assets do not bisect any housing or private property, businesses (other than agricultural), community facilities or areas of open space and recreation.

The pipeline bisects a number of roads, so there may be temporary disruption for communities which use these routes to travel between communities and to access facilities. Communities that are most likely to be impacted are Burghclere, Old Burghclere, Cole Henley, Whitchurch and Freefolk. The proposed pipeline bisects a number of PRoW in this section near to Burghclere, Whitway, Litchfield and Longparish.

Depending on the construction methodology, there may be a change in environmental conditions at some population and human health receptors because of a combination of noise, air quality, visual impacts or presence of HGV vehicles.

During operation, potential impacts are likely to be minimal given the pipeline will be below ground and the land which was utilised during construction reinstated. However, the operation of the above ground assets may change the amenity for nearby population and human health

receptors due to potential noise, air quality and visual impacts. Drayton is most likely to be impacted due to the operation of the new WTW at the intake location. Given the distance between all other above ground assets and communities, no other impacts are anticipated.

Option C Mitigation and enhancement

The mitigation for Option C is as per Option B.

4.10.6 Summary

At this stage, Option B and Option C both have similar effects in terms of population and human health.

4.11 Material Assets

4.11.1 Introduction

A desk based assessment was undertaken to identify potential impacts on material assets from the transfer corridors and above ground infrastructure required as part of the T2ST SRO. The objectives of the desk-based assessment were to establish the baseline material asset impacts associated with the preferred T2ST options, identify constraints and opportunities, and identify the issues and features that require further investigation.

There is no specific legislation for the assessment of impacts on material assets. The need to consider material assets is driven by national planning policy (draft National Policy Statement for Water Resource Infrastructure and National Planning Policy Framework).

The need to consider material assets is driven by planning policy, including the draft NPS for Water Resource Infrastructure[5] (Section 4.10, Land use including open space, green infrastructure and Green Belt and 4.14, Traffic and Transport) and the NPPF[6] (Section 9, Sustainable transport, Section 10, High quality communications, Section 17, Sustainable use of materials). The desk-based assessment comprised the following elements:

- A desk-based mapping exercise identifying key material assets present in the study area (including infrastructure relating to energy and heat generation and distribution, water and wastewater, transport, waste management, minerals).
- An assessment as to the potential for the T2ST options to affect material assets.
- Constraints and opportunities associated with the T2ST options will be identified, and any requirements for further survey or investigation highlighted.

4.11.2 Study area and sources of information

For construction, the desk-based assessment focused on the transfer route corridors, location of the associated infrastructure and surrounding area within 200m.

The following table outlines the data sources that were collated and considered in the desk-based assessment.

Table 4.11: Sources of information for the Material Assets assessment

Data collected (Theme based upon SEPA guidance on materials assets for SEA)	Asset	Source
	Power lines	National Grid powerlines[28]

[28] National Grid powerlines available at: https://www.nationalgrid.com/uk/electricity-transmission/network-and-infrastructure/network-route-maps [accessed April 2022]

Data collected (Theme based upon SEPA guidance on materials assets for SEA)	Asset	Source
Infrastructure relating to energy and heat generation and distribution	Power plants (coal, nuclear, Energy from Waste (EfW))	Data platform open data[29]
	Large-scale renewables - wind farms, solar farms, hydroelectric	Data platform open data[30]
Existing water / wastewater infrastructure	Treatment works/reuse plants Reservoirs (including service reservoirs)	Thames Water and Southern Water
Transport	Motorways, A-roads, roads	Ordnance Survey Open data GIS data from Local Planning Authorities (Hampshire County Council, West Berkshire Council, Oxfordshire County Council)
	Railways / Tramlines	
	Navigable waterways	
	PRoW and National cycle paths	
	Airports / Airfields and Aviation Safeguarding Zones	
Waste Management	Landfill sites - historic and authorised (type)	Environment Agency Open Data
	Waste management facilities including recycling centres, energy from waste plants, incinerators	Mineral and Waste Plans / Aerial mapping GIS data from Local Planning Authorities (Hampshire County Council, West Berkshire Council, Oxfordshire County Council)
Minerals	Quarries	Onshore Geoindex available at: http://mapapps2.bgs.ac.uk/geoindex/home.html
	Mineral Safeguarding Areas / Mineral Allocation Sites	Local Authority data – Mineral and Waste Plans GIS data from Local Planning Authorities (Hampshire County Council, West Berkshire Council, Oxfordshire County Council)

4.11.3 Common baseline

Options B and C run along the same alignment for the majority of the route (Section 1, 2 and 4), and therefore the following baseline is common to both options. Baselines specific to each option (i.e. Section 3) are discussed in Section 4.11.4 for Option B and Section 4.11.5 for Option C along with impacts and potential mitigation for the whole option.

There are ten motorway, A-road and other road assets within the study area for both Option B and Option C. These are the A34, Reading Road, M4, A4, A343, B3400, A303, B3049, B3420 and A3090.

There are five Power Line assets present across the sections within the study area for Option B and Option C.

There are no Power plants (coal, nuclear, Energy from Waste (EfW)) within the study area for Option B and Option C.

There are three large scale renewable assets within the study area of Option B and Option C providing photovoltaics solar energy these are Hill Farm Solar Park, Owls Lodge Farm, Owls Lodge Farm extension.

[29] Information on conventional power plants available at: https://data.open-power-system-data.org/conventional_power_plants/2020-10-01 [accessed April 2022]

[30] Information on renewable energy power plants available at: https://data.open-power-system-data.org/renewable_power_plants/2020-08-25 [accessed April 2022]

There are three relevant water treatment work/reuse plant assets within the study area for Option B and Option C, namely Barton Stacey WTW, Winterbourne Sewage Treatment Works (STW) and Chieveley STW.

There are four reservoir assets within the study area for Option B and Option C these are Micheldever WSR, Beacon Hill WSR, Crabwood WSR and Yew Hill WSR.

There are two railway line assets within the study area for Option B and Option C these comprise of Steventon Track and Newbury Track.

There is one navigable waterway asset within the study area for Option B and Option C comprising of Kennet and Avon Canal.

There are two National Cycle Path assets within the study area for both Option B and Option C, namely Gringe Path and Newbury Path.

There are no airports or airfields and aviation safeguarding zones within the study area for Option B and Option C.

There are four historic landfill sites within the study area for both Option B and Option C these are East Hendred, Chalk Pit, Skinners Green Lane and Bushfield Farm.

The County Council Mineral and Waste Plans were reviewed and identified two waste management facility assets within the study area for both Option B and Option C, namely the A30 Recycling Facility (Barton Stacey) and Chilton Recycling Facility.

There are two quarry assets within the study area for both Option B and Option C, namely Chilton Recycling Facility and Folly Farm Wellsite.

The County Council Mineral and Waste Plans were reviewed and identified six mineral safeguarding area/ mineral allocation site assets within the study area for Option B and Option C.

4.11.4 Option B

Baseline for Option B, Section 3

In addition to the common baseline, Cliffeville Ltd authorised landfill site is located within the study area for Option B Section 3.

An additional National Cycle Path asset is located within the study area for Option B, namely Middle Wyke Path.

Option B Evaluation

The pipeline will require excavation and depending on the height of machinery required to excavate, there may be impacts on the power lines present within the study area. There are five Power Line assets present across the sections within the study area for Option B. This may present potential safety hazards which may result in a power outage and damaged cables.

There is the potential for temporary disruption to motorways, A-roads and roads due to pipeline excavation on the roadworks if required. This may result in road closures temporary traffic diversion and traffic build up. It is assumed that pipejack or micro tunnel crossings would be used under major roads such as motorways to reduce disruption.

There is potential for disruption of railway line sections if excavation is required for the pipeline. Option B may potentially impact two railway line assets. However, it is assumed that pipejack or micro tunnel crossings would be used under railways to minimise disruption.

There is potential for disturbance to water transport routes. However, it is assumed that if the route crosses a canal, pipejack or micro tunnel crossings would be used to reduce effects.

There is potential for disruption to PRoW paths and National Cycle Paths due to temporary closures or diversions of public footpaths, bridleways and public cycling routes. If access along the PRoW or National Cycle Paths cannot be maintained throughout the works, then consultation with the local authority in which its situated will be required for the diversion or closure.

An existing operational landfill site is within the option corridor, Cliffeville Landfill. There is potential that the pipeline excavation could disturb contaminants within this landfill site.

Option B runs through four historic landfills. There is potential that the pipeline excavation could disturb contaminants within the historic landfill sites. It should be ensured that pipeline excavations do not compromise the structure and safety of the historic landfill site. Potential impacts of the mobilisation of contaminants within a historic landfill include potential groundwater, surface water and soil contamination, should a source - pathway - receptor linkage be established.

There are two waste management facilities locates within the Option B corridor; however, it is assumed that pipeline routing would go around these assets, therefore, no effects are anticipated.

Strategic areas for minerals are located along the SRO pipeline which may be affected by pipeline construction.

Option B Mitigation and enhancement

In order to mitigate potential issues arising from the SRO on material assets, mitigation measures should be implemented such as selection of appropriate machinery for the pipeline excavation in proximity to any power lines and use of covers such as netting below power lines to reduce potential power outages.

Appropriate diversions should be implemented where possible which minimise the length of any necessary closures along any roads, national cycle paths, and PRoW.

Pipejack or micro tunnel crossings should be used under railways and major roads if possible.

The design of the pipeline should ensure avoidance of existing operational assets such as landfills, quarries, waste facilities and solar parks.

Cliffeville Landfill operational landfill site is located within the option corridor. Landfills are considered as a high risk of potential contamination. Further assessment of the landfill is required with a possible requirement for a Phase 1 contaminated land desk study and intrusive investigations to determine risks and construction approaches. The pipeline route should be reviewed during further route design stages in order to avoid the landfill. Best practice construction methods should be implemented for working within proximity to landfill sites to minimise disturbance of contaminants.

4.11.5 Option C

Baseline for Option C, Section 3

In addition to the common baseline, there is one further road asset within the study area for Option C. This is the B4640.

The County Council Mineral and Waste Plans were reviewed and identified and additional waste management facility assets within the study area for Option C Section 3 comprising of Ivory Farm, Burghclere.

Whitchurch Track railway line runs along Option C section 3.

Option C Evaluation

The pipeline will require excavation and depending on the height of machinery required to excavate, there may be impacts on the power lines present within the study area. There are five Power Line assets present across the sections within the study area for Option C. This may present potential safety hazards which may result in a power outage and damaged cables.

There is the potential for temporary disruption to motorways, A-roads and roads due to pipeline excavation on the roadworks if required. This may result in road closures temporary traffic diversion and traffic build up. It is assumed that pipejack or micro tunnel crossings would be used under major roads such as motorways to reduce disruption. The impacts are the same for Options B and C however Option C runs through an additional road (B4640).

There is potential for disruption of railway line sections if excavation is required for the pipeline. Option C has the potential to impact three railway line assets. However, it is assumed that pipejack or micro tunnel crossings would be used under railways to minimise disruption.

There is potential for disturbance to water transport routes However, it is assumed that if the route crosses a canal, pipejack or micro tunnel crossings would be used to reduce effects.

There is potential for disruption to PRoW paths and National Cycle Paths due to temporary closures or diversions of public footpaths, bridleways and public cycling routes. If access along the PRoW or National Cycle Paths cannot be maintained throughout the works, then consultation with the local authority in which its situated will be required for the diversion or closure.

Option C runs through four historic landfills. There is potential that the pipeline excavation could disturb contaminants within the historic landfill sites. It should be ensured that pipeline excavations do not compromise the structure and safety of the adjacent historic landfill site. Potential impacts of the mobilisation of contaminants within a historic landfill include potential groundwater, surface water and soil contamination, should a source - pathway - receptor linkage be established.

There are two waste management facilities locates within the Option C corridor; however, it is assumed that pipeline routing would go around these assets, therefore, no effects are anticipated.

Option C includes strategic areas for minerals along the SRO which may be affected by pipeline construction.

Option C Mitigation and enhancement

Mitigation is as per Option B.

4.11.6 Summary

At this stage, both Option B and Option C have similar effects in terms of material assets.

Option B is likely to affect Cliffeville Landfill, an operational landfill site is located within the option corridor. Landfills are considered as a high risk of potential contamination. Further assessment of the landfill is required with a possible requirement for a Phase 1 contaminated land desk study and intrusive investigations to determine risks and construction approaches.

The pipeline route should be reviewed during further route design stages in order to avoid the landfill.

4.12 Arboriculture

4.12.1 Introduction

A desk based assessment was undertaken to identify potential impacts on Arboriculture from the transfer corridors and above ground infrastructure required as part of the T2ST SRO. The objectives of the desk-based assessment are to establish the Arboriculture baseline associated with the preferred T2ST options, identify constraints and opportunities, and identify the issues that require further investigation.

The need to consider arboriculture is driven by legislation including the Town and Country Planning Act 1990, and national planning policy, including the draft NPS for Water Resource Infrastructure[5] (Section 4.3, Biodiversity and nature conservation, paragraph 4.3.14) and the NPPF[6] (Section 15, Conserving and enhancing the natural environment, paragraphs 131 and 180).

The desk-based assessment comprised the following elements:

- Identification of the arboricultural baseline in the study area.
- An assessment as to the potential for the T2ST options to affect key arboricultural features.
- Identification of arboricultural constraints and opportunities associated with the T2ST options.
- Identification of mitigation measures to address constraints.

4.12.2 Study area and sources of information

The desk-based assessment focused on the transfer routes, location of associated infrastructure, and the surrounding area within 100m of the proposed pipeline route corridors. The recording of all the key arboricultural constraints within 100m of the proposed route corridors ensured the identification of all potential design conflicts with arboricultural features.

The following table outlines the data sources that were collated and considered in the desk-based assessment.

Table 4.12: Sources of information for the Arboriculture assessment

Data collected	Source
Ancient Woodland / Woodland	MAGIC Maps Website[7]
Ancient and Veteran Trees	Ancient Tree Inventory
Conservation Areas (CA)	Local Planning Authorities (Vale of White Horse, West Berkshire, Basingstoke and Deane, Test Valley, Winchester)
Tree Preservation Orders (TPOs)	Local Planning Authorities (Vale of White Horse, West Berkshire, Basingstoke and Deane, Test Valley, Winchester)

4.12.3 Common baseline

Options B and C run along the same alignment for the majority of the route (Section 1, 2 and 4), and therefore the following baseline is common to both options. Baselines specific to each option (i.e. Section 3) are discussed in Section 4.12.4 for Option B and Section 4.12.5 for Option C along with impacts and potential mitigation for the whole option.

Works will not directly impact upon Tree Preservation Orders (TPOs) in Section 1 or 4. Works will not directly impact upon TPOs in Section 2 but do pass in close proximity to TPO 201/21/0577.

Works will not directly impact upon Conservation Areas (CAs) in Section 1, 2 or 4.

Works will directly impact upon the following four areas of ancient woodland: Chapel Wood, Wick Wood; Back Wood and Cowdown Copse. Works are in close proximity to several areas of ancient woodland: Williams Wood, Park Copse, Bagnor Wood, Skews, Old Plantation (Enborne Wood Cottage), Borne Copse, Braylands Copse, Farm Copse, Middleton Green, Ridgeway Copse, Pond Copse, Burnt Lodge Copse, and Gas Gov.

Works will not directly impact upon Ancient or Veteran Trees in Section 1, 2 or 4.

4.12.4 Option B

Baseline for Option B, Section 3

The following items are identified in addition to those in the common baseline.

Works will directly impact one TPO (TPO,TVBC.0894) in Section 3, Option B.

Works will directly impact CAs in two areas in Section 3, Option B, namely St Mary Bourne Conservation Area and Longparish Conservation Area. In the areas where the pipeline enters the CA and any RPAs of trees within the CA, these areas should be physically inspected via a walkover assessment by a qualified arboriculturist to determine the level of impact, if any, to the trees. Due to the location of some of these trees, an inspection via satellite imagery would not be sufficient in identifying potential development proposal conflicts with arboricultural features.

Works are within close proximity to 7 areas of ancient woodland in Section 3: Buckhanger Copse, Grove Copse, Zeal House Copse, Grotto Copse and Biggs Copse, Easton Park Wood, Pauls Copse.

Works are within close proximity to 12 Veteran Trees in Section 3.

Option B Evaluation

The guidance on ancient woodland, ancient trees, and veteran trees (Advice for making planning decisions, from Natural England and the Forestry Commission, published January 2022) states that for ancient woodlands, ancient trees, and veteran trees the proposal should have a buffer zone of at least 15 metres from the boundary of the woodland to prevent significantly damaging the root system (known as the root protection area (RPA)). For ancient or veteran trees (including those on the woodland boundary), the buffer zone should be at least 15 times larger than the diameter of the tree. The buffer zone should be a minimum of 5 metres from the edge of a tree canopy if that area is larger than 15 times the diameter of the closest tree stem. Where assessment shows other impacts are likely to extend beyond this distance, the proposal is likely to need a larger buffer zone.

Ancient woodland, ancient trees, and veteran trees are irreplaceable and so the loss or deterioration resulting from the development is not currently considered an option. Therefore, proposed compensation measures are not considered as part of the assessment of the merits of the development proposal at this stage.

Option B has direct conflicts with CAs and ancient woodlands with the potential to negatively impact these areas during construction.

The Option B SRO is located near six TPO designations, either directly though or close to three conservation areas. The Option B SRO also is either in conflict or close proximity to 23 ancient woodlands. Option B route corridor is also in close proximity to four ancient veteran trees.

Option B Mitigation and enhancement

To support to the detailed design phase of the project, it is recommended that a full BS5837:2012 survey must be conducted, and an arboricultural impact assessment and tree protection plan produced. Where the route is not able to avoid sensitive sites, extra mitigation is likely to be required to minimise impacts during the construction phase.

In order to mitigate potential issues arising from the SRO on arboriculture, the pipeline should be re-routed to avoid TPOs, CAs, ancient woodlands and ancient and veteran trees. If this cannot be accommodated, further mitigation should be implemented including detailed assessment by a qualified arboriculturist and working using protective barriers.

4.12.5 Option C

Baseline for Option C, Section 3

The following items are identified in addition to those in the common baseline.

Works will directly impact one TPO (TPO,TVBC.0894) in Section 3, Option C.

Works will directly impact CAs in two areas Laverstoke and Freefolk Conservation Area and Longparish Conservation Area. In the areas where the pipeline enters the CA and any RPAs of trees within the CA, these areas should be physically inspected via a walkover assessment by a qualified arboriculturist to determine the level of impact, if any, to the trees. Due to the location of some of these trees, an inspection via satellite imagery would not be sufficient in identifying potential development proposal conflicts with arboricultural features.

Works are in close proximity to the following 3 ancient woodlands; Angledown Copse, Streetly Copse and 1x unnamed woodland.

Works will not directly impact upon Ancient or Veteran Trees in Section 3, Option C.

Option C Evaluation

Option C has direct conflicts with conservation areas (CAs) and ancient woodlands with the potential to negatively impact these areas during construction.

The Option C SRO is located near four TPO designations, either directly though or close to two conservation areas. The Option C SRO also is either in conflict or close proximity to 17 ancient woodlands. No ancient veteran trees are in proximity to Option C.

Option C Mitigation and enhancement

The mitigation for Option C is as per Option B.

4.12.6 Summary

Option B and C both have direct conflicts with conservation areas and ancient woodlands with the potential to negatively impact these areas during construction. Option C has less overall impact on trees.

4.13 Noise

4.13.1 Introduction

A desk based assessment was undertaken using a qualitative approach to appraise the preferred T2ST SRO options and identify where there was potential for noise impacts and the likely mitigation that would be required.

The need to consider noise is driven by legislation including the Environmental Protection Act 1990, and national planning policy, including the draft NPS for Water Resource Infrastructure[5] (Section 4.11, Noise and vibration) and the NPPF[6] (Section 8, Promoting healthy and safe communities).

The desk-based assessment comprised the following elements:

- Identification of the noise baseline in the study area.
- Identification of nearby noise sensitive receptors and an assessment as to the potential for the T2ST options to affect these receptors. The assessment considers noise sensitive receptors located within 300m of the proposed pipeline alignment along the route which may potentially be impacted.
- Identification of noise constraints and opportunities associated with the T2ST options.
- Identification of mitigation measures to address constraints

The desk-based assessment for operational noise was based on aims of the Department for Environment, Food and Rural Affairs (Defra) (2010), Noise Policy Statement for England, which are, *"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:*

- avoid significant adverse impacts on health and quality of life;
- mitigate and minimise adverse impacts on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life."

4.13.2 Study area and sources of information

The desk-based assessment focused on the transfer route corridors, location of associated infrastructure and the surrounding area within 300m where only daytime impacts are expected and 600m where night-time impacts may occur. Potential vibration impacts were considered to a distance of 50m.

The following table outlines the data sources that were collated and considered in the desk-based assessment.

Table 4.13: Sources of information for the Noise assessment

Data collected	Source
Baseline Noise Data	Extrium Defra Noise Mapping Website Extrium > England Noise and Air Quality Viewer
Publicly available baseline noise data	Previous publicly available planning applications for proposed sites near the preferred T2ST options.
Receptor locations within 600m of the pipeline and above ground infrastructure	OS mapping, publicly available satellite imagery
Construction Plant Noise Levels	British Standard 5228-1:2009+A1:2014 entitled 'Code of practice for noise and vibration control on construction and open sites – Part 1: Noise
Construction Plant Vibration Levels	British Standard 5228-1:2009+A1:2014 entitled 'Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration

Data collected	Source
Construction Methodology	Design Team, previous similar projects

4.13.3 Common baseline

Options B and C run along the same alignment for the majority of the route (Section 1, 2 and 4), and therefore the following baseline is common to both options. Baselines specific to each option (i.e. Section 3) are discussed in Section 4.13.4 for Option B and Section 4.13.5 for Option C along with impacts and potential mitigation for the whole option.

The majority of noise sensitive receptors along the route are residential premises. Other noise sensitive receptors present include schools, nurseries, churches, hospitals. Commercial receptors are also present but are considered less sensitive and have not been included in further assessment unless they also include residences such as farms or small family businesses.

The majority of the buried pipeline along the route will make no noise when installed and operational. The above ground assets will likely incorporate noise mitigation and therefore any potential adverse noise impacts can be designed out.

4.13.4 Option B

Baseline for Option B, Section 3

Temporary Noise impacts due to construction are likely to occur at a number of locations along the pipeline route. Temporary Noise impacts in Section 3, Option B due to pipeline construction are likely to occur at one residential receptor in addition to the common baseline, namely April Cottage and Big house, South-West of April Cottage.

Option B Evaluation

By careful design of the pipeline routes the noise impact of the pipeline can be minimised. The majority of the alignment can be chosen to be at least 85m from noise sensitive receptors (130m where pipejacking occurs) in order to minimise significant adverse noise impacts. However, in some areas this is unlikely to be achieved.

Option B traverses a largely rural landscape along Section 3 where the route may be chosen to remain at least 85m from dwellings (130m where pipe jacking is required). This appears unlikely to be achievable at only one location near April Cottage next to the Enbourne Rivulet.

Option B Mitigation and enhancement

Where significant adverse noise and/or vibration impacts are identified for works within the construction phase cannot be avoided, appropriate mitigation measures will be applied including the use of Best Practicable Means in accordance with BS5228-1&2:2009+A1:2014 guidance. Mitigation may comprise a number of measures including management of construction hours, selection of low noise and vibration construction plant, use of screening (enclosures, barriers, or bunds), noise and vibration monitoring.

Mitigation of construction traffic would include implementation of a Construction Management Plan.

Mitigation of operational noise would be applied through design to minimise potential adverse noise impacts at the nearest noise sensitive receptors. Measures may include selection of plant and equipment, location and orientation of fixed plant items and use of screening (e.g., acoustic enclosures, barriers or bunds).

4.13.5 Option C

Baseline for Option C, Section 3

Temporary Noise impacts due to construction are likely to occur at a large number of locations along the pipeline route, especially on the West Side of Burghclere where Option C traverses through a constrained area.

Option C Evaluation

By careful design of the pipeline routes the noise impact of the pipeline can be minimised. The majority of the alignment can be chosen to be at least 85m from noise sensitive receptors (130m where pipejacking occurs) in order to minimise significant adverse noise impacts. However, in some areas this is unlikely to be achieved.

Option C, Section 3 traverses through constrained areas near the A34 at Enborne Row where the route is unlikely to remain at least 85m from dwellings (130m where pipe jacking is required). Around 25 dwellings are likely to be impacted here and a further seven on Penwood Road/ Oakley Caravan Park.

On the West Side of Burghclere, Option C traverses through another constrained area, where the route is unlikely to be able to remain at least 85m from dwellings, resulting in potential temporary impacts on Tothill, Pound Lane, Harts Lane, Coopers Lane, Winchester Road, and West Street. Around 24 dwellings in this area are potentially impacted significantly.

Option C Mitigation and enhancement

The mitigation for Option C is as per Option B.

4.13.6 Summary

Temporary construction noise impacts from pipeline laying of Option B are likely to impact significantly fewer dwellings than Option C.

All operational noise impacts will be designed out for both options, however this will be a greater task for Option B than Option C since the above ground facilities for Option C are more isolated.

4.14 Mitigation and enhancement summary

Development of a CEMP should be considered at the appropriate stage in the SRO development that will include standard mitigation measures as well as any other specific measures identified following further environmental assessment.

The below table summarises the potential impacts from the T2ST pipeline identified as part of this Gate 2, desk based environmental appraisal, and proposes mitigation and enhancement that could be considered and put in place to minimise or avoid that impact.

Table 4.14: Mitigation and enhancement summary

Section	Phase	Potential impact	Mitigation/Enhancement
Biodiversity, flora and fauna			
Whole pipeline	Construction	Adverse impact to ordinary watercourses and surrounding priority habitats	Consider the use of pipejack or micro tunnel crossings for each ordinary watercourse crossing and crossings of priority habitat.
Whole pipeline	Construction	Loss of irreplaceable habitats	The pipeline route should be reviewed during further design stages in order to avoid irreplaceable habitats. Mitigation and enhancement options should be assessed for irreplaceable habitats such as Ancient Woodland

Section	Phase	Potential impact	Mitigation/Enhancement
Whole pipeline	Construction	Adverse impact on groundwater levels and potential implications on SSSI that are GWDTE	Consider undertaking investigation into the impact of construction dewatering on groundwater levels, and potential implications on SSSI that are GWDTE. Mitigation and enhancement with respect to potential effects on GWDTE should be considered further.
Option B and C Section 2	Construction	Adverse impact to River Lambourn and surrounding priority habitats.	Pipejack or micro tunnel crossings to be considered under all priority habitats close to River Lambourn including areas of lowland calcareous grassland and reedbed.
Option B and C Section 2	Construction	Adverse impact to River Kennet and surrounding priority habitats.	Pipejack or micro tunnel crossings to be considered under all priority habitats close to River Lambourn including areas of lowland calcareous grassland and reedbed.
Option B and C Section 2	Construction	Adverse impact to River Kennet and River Lambourn valley habitat mosaics during construction.	Consider undertaking further assessment of the potential impacts during construction when details are known (including review of construction access).
Option B and C Section 2	Construction	Adverse impact to priority habitats present within Benhem Park and Speen Moor LWS	Pipejack or micro tunnel crossings to be considered under all priority habitats present within Benhem Park and Speen Moor LWS as well as planned pipejack or micro tunnel crossing for River Kennet.
Option B Section 3	Construction	Adverse impact to River Enborne and surrounding priority habitats.	Consider extending the pipejack or micro tunnel crossing under River Enborne to include priority habitats either side of river.
Option B Section 3	Construction	Adverse impact to priority habitat close to BS2 BPT, BS5 BPT and the existing Yew Hill WSR.	Consider re-routing the pipeline to avoid priority habitats such as lowland calcareous grassland. Where this cannot be accommodated, pipejack or micro tunnel crossing should be considered
Option B Section 3	Construction	Adverse impact to Ancient Woodland	Pipejack or micro tunnel crossing to be considered under area of Ancient Woodland (Grid Ref: SU4173244296).
Option C Section 3	Construction	Adverse impact to Burghclere Beacon SSSI	Pipejack or micro tunnel crossing to be considered under Burghclere Beacon SSSI if pipeline encroaches designated area.
Option B and C Section 4	Construction	Adverse impact to River Test and surrounding priority habitats.	Pipejack or micro tunnel crossing to be considered for River Test and surrounding priority habitats.
Soils			
Whole pipeline	Pre-construction	Temporary and permanent loss of topsoil/subsoil	Consider undertaking a detailed soil survey (soil resource survey and/or ALC survey).
Whole pipeline	Pre-construction	Agricultural land take	Consider producing a soil management plan.
Whole pipeline	Construction	Soil quality	Consider employing a qualified soil scientist to undertake on-site monitoring visits to ensure the best practice and guidance as stated in the soil management plan is followed.
Option B Section 3	Pre-construction	Disturbance to contaminants in Cliffeville landfill site	Consider re-routing the pipeline to avoid the landfill. If this is not possible, further assessment of the landfill should be considered with a possible requirement for a Phase 1 contaminated land desk study and intrusive investigations to determine risks and construction approaches.
Water			
Whole pipeline	Pre-construction	Works within SPZ 1 or 2	Consider producing a hydrogeological risk assessment.

Section	Phase	Potential impact	Mitigation/Enhancement
Whole pipeline	Pre-construction	Impacts on wells and springs	Consider undertaking further investigation to assess whether the wells are in use, assess the value of the wells and springs and investigate the magnitude of likely effects. For features that could be lost or where a significant adverse effect on the feature is likely mitigation may be required. This could consist of replacement wells, connection of well user to mains supply and relocation of springs.
Whole pipeline	Construction	Adverse impact on groundwater levels and potential implications on GWDTE of Kennet and Lambourn Floodplains SSSI, River Test SSSI, East Aston Common SSSI and Bere Mill Meadows SSSI	Consider undertaking investigation into the impact of construction dewatering on groundwater levels, and potential implications on GWDTE required.
Intake WTW	Pre-construction	Fluvial flood risk	Consider placing the new WTW at the intake outside of Flood Zone 3b as construction for “Less vulnerable” development is not permitted. Consider also placing the new WTW at the intake outside of Flood Zone 3a. An exception test is not required for “Less vulnerable” development and construction in Flood Zone 3a is permitted. The construction of the new WTW at the intake location would require a level for level compensation area to be developed to capture any displaced flood volumes as a result up to 1%AEP+70%CC. If siting within FZ3a is unavoidable compensatory flood storage volume will need to be provided on a level for level basis.
Whole pipeline (areas at risk of flooding)	Construction	Fluvial flood risk	Consider undertaking preparation during the receipt of a flood alert or warning to secure the all-asset locations and the equipment from the possibility of severe flooding. On site personnel should be made aware of the flood risks and an evacuation plan directing staff away from areas where there is a flood risk should be implemented on receipt of a flood alert or warning. Environmental permits will be required for construction in a flood risk area It is recommended that for all assets the operator considers signing up for the Environment Agency’s flood alerts and that these notifications and site safety emergency plans are shared and coordinated.
Whole pipeline (areas at risk of flooding)	Construction	Surface water flood risk	It is recommended that during the construction phase care is taken to ensure stockpiled materials are not washed into local drains, causing blockages which could lead to localised flooding.
Intake WTW	Pre-construction	Surface water flood risk	Consider design of a suitable drainage system due to the land use change in section 3 for any of the asset locations. The impermeable surface will increase surface water flooding and most likely exacerbate the existing surface water flooding. The new WTW at the intake location will require the use of a suitable drainage system to capture the displacement of surface water flooding at the asset location. It is recommended that a closed loop system is considered to be put into place to capture any potential contaminants from the treatment process.
Air Quality			

Section	Phase	Potential impact	Mitigation/Enhancement
Whole pipeline	Construction	Impacts on sensitive human health, dust soiling and ecological receptors	Generic mitigation measures relating to communication and site management, monitoring, preparing and maintaining the site operations should be considered. Construction dust mitigation measures have been recommended in accordance with the IAQM guidance. A dust risk assessment should be considered, to be undertaken at a later stage once more information is available to determine the construction dust risk at these sensitive receptors and whether additional construction dust mitigation is required.
Climatic factors			
Whole pipeline	Pre-construction	Potential impact on the pipeline as a result of potential changing climate.	Consider designing structural elements to include thermal expansion and greater thermal variation specification to account for climate change. Pipe design and choice of materials to consider temperature variation. Materials selection and specification to consider future temperatures. Consider monitoring and adjusting the curing process of the concrete accordingly in order to minimise the risk of high temperatures on the deterioration rate of the structure. Consider nature based solutions to provide shade and reduce temperature.
Whole pipeline	Pre-construction	Potential impact on the pipeline as a result of potential changing climate – increased flood risk	Consider locating pipeline access points in areas where there is low risk of flooding. Consider ensuring pipe design and cover is enough to withstand seepage from flooding into the pipes. Consider ensuring that drainage capacity is designed to limit the flooding at the structure and account for future increased rainfall. Consider ensuring that the foundations are not susceptible to seepage due to poor drainage. Consider implementing additional protective measures to ensure that the pipes and cabling are sufficiently protected to reduce the corrosion rates. Consider selecting materials which consider future rainfall regime.
Whole pipeline	Pre-construction	Potential impact on the pipeline as a result of potential changing climate-ground movement	Consider ensuring that ground movements are monitored and repaired when necessary to avoid further damage. Consider the changes in soil moisture in the pipe bedding material specification.
Landscape			
Whole pipeline	Pre-construction	Effects on landscape character within NCA's	Consider working with the existing landform in the design and siting of above ground structures to reduce visibility and integrate them into the landscape. During design, consider using manmade landforms e.g. bunds and extended earthworks to integrate any new structures into the local topography.
Whole pipeline	Pre-construction	Temporary changes to land use and rural character of the landscape.	Consider designing and locating fencing, hoardings and lighting required in construction and operation to reduce the urbanising the rural landscape. Consider locating construction compounds adjacent to existing infrastructure. Consider designs that avoid damage to sinuous tracks and boundaries by siting the pipeline and

Section	Phase	Potential impact	Mitigation/Enhancement
			above ground structures away from them. Where this is not possible, consider narrowing the working corridor to reduce the impact on these characteristic features of the landscape. Consider working with existing field patterns and access routes in the siting of compounds and permanent structures Consider restoring land to former use following construction. Consider following locally characteristic vegetation patterns in design of mitigation planting around permanent structures. Consider designing structures and boundary treatments to be sympathetic to the local vernacular.
Whole pipeline	Pre-construction	Impact on vegetation and water.	Consider adjusting the pipeline route to avoid removal of vegetation and avoid root protection zones where possible. Consider adjusting the pipeline route to cross watercourses where there is little or no vegetation. Consider avoiding running parallel to watercourses for long stretches. Consider designing culverts to be sensitive to the rural location in terms of scale and materials. Consider replacing all hedgerows and trees removed during construction. Consider narrowing the working corridor where crossing vegetated areas in order to reduce vegetation loss. Consider looking for opportunities to enhance nearby hedgerows, riparian vegetation and strengthen connections within the blue-green network. Consider linking mitigation woodland and other screen planting to existing nearby woodland belts and vegetation to aid landscape integration.
Whole pipeline	Pre-construction	Reduction of tranquillity in the vicinity of the construction work	Consider locating construction compounds adjacent to existing infrastructure and away from sensitive landscapes (e.g. North Wessex Downs AONB) Consider minimising lighting in construction and operation to avoid introducing additional lighting into the dark countryside.
Whole pipeline	Pre-construction	Potential temporary diversion or closure of footpaths and cycleways that intersect with the proposed corridor.	Provision of managed access or a diversion to be considered during construction. Consider designs that avoid prolonged closure of footpaths.
Options B and C Section 1	Pre-construction	Potential loss of vegetation alongside footpaths and cycleways, in particular adjacent to Ridgeway National Trail where it crosses the A34.	Consider designs that avoid removal of vegetation along the Ridgeway National Trail. Consider siting the BS2 BPT where it will be screened from the trail by existing vegetation. Consider looking for opportunities to enhance nearby sections of the trail in terms of planting, resurfacing, information boards, way markers and social enhancements.
Options B and C Section 2	Pre-construction	Construction activity has the potential to temporarily reduce tranquillity in the vicinity of the construction work, including areas close to Snelsmore Common Country Park.	Consider locating construction compounds adjacent to existing infrastructure and away from sensitive landscapes (e.g. North Wessex Downs AONB, Lambourne river corridor, Kennet and Avon Canal

Section	Phase	Potential impact	Mitigation/Enhancement
Options B and C Section 2	Pre-construction	Potential temporary closure of footpaths and cycleways that intersect with the proposed corridor, including Kennet and Avon Canal, NCN route 4 and Lambourne Valley Way leisure routes.	Provision of managed access or a diversion during construction to be considered. Consider designs that avoid prolonged closure of footpaths. Consider designs that avoid removal of vegetation along the Kennet and Avon Canal and Lambourne Valley. Consider looking for opportunities to enhance nearby sections of footpaths and cycleways in terms of planting, resurfacing, information boards, way markers and social enhancements.
Options B Section 3	Pre-construction	There is potential requirement for road widening to allow for construction traffic along narrow lanes that are characteristic of the area. Construction activity has the potential to affect the setting of the villages along the lower Test valley, including, Hurstbourne Priors and Longparish	Consider avoiding narrow lanes for construction traffic routes to minimise vegetation loss due to road widening. Consider avoiding siting the pipeline and above ground structures where they will disrupt irregular field patterns or require alterations to narrow roads, ancient droving road and trackways that are characteristic of the area. Where this is not possible, consider narrowing the working corridor to reduce the impact on these characteristic elements of the landscape.
Options B Section 3	Pre-construction	Potential removal of waterside vegetation resulting in a change to the character of the watercourses, including River Enborne, Bourn Rivulet and River Test.	Consider designs that avoid running parallel to the watercourse for long stretches.
Options B Section 3	Pre-construction	Construction activity on the rising scarp has the potential to temporarily alter the characteristic views south from the Thames Basin within the AONB towards the prominent scarp of the Hampshire Downs. Construction activity in the Thames Basin has the potential to temporarily alter views north from the elevated scarp top within the AONB north.	Consider designs that avoid removal of vegetation on the chalk scarp of the Hampshire Downs (Thames Basin)where it is highly visible. Consider designs that avoid siting permanent structures on the rising scarp Consider integrating the above ground structures into the landscape using woodland screening planting.
Options B Section 3	Pre-construction	Removal of vegetation along the Portway Roman Road where the construction corridor passes next to Middle Wyke will alter a feature that is a notable element contributing to the landscape character.	Consider designs that avoid crossing the route of Portway Roman Road where it is lined with a woodland belt. Consider replacing vegetation removed during construction. Consider looking for opportunities to strengthen the vegetation along the Roman Road.
Options B Section 3	Pre-construction	There is potential for loss of vegetation within areas including: Woodland blocks to the west of East End Conservation Area Woodland blocks eastern boundary of Ashmansworth Conservation Area	Where possible consider designs that avoid crossing the conservation areas. Where crossing the conservation areas is unavoidable consider designs that avoid the removal of mature trees and hedgerows, reduce the working corridor and construction period. Consider replacing all hedgerows and trees removed during construction.

Section	Phase	Potential impact	Mitigation/Enhancement
		Riparian vegetation along Bourne Rivulet and garden vegetation between Stoke and St Mary Bourne. Woodland and standard trees within landscaped parkland/gardens ain Longparish and along the River Test	Consider looking for opportunities to enhance the setting of the conservation areas.
Options C Section 3	Pre-construction	Potential removal of waterside vegetation resulting in a change to the character of the watercourses, including River Enborne and River Test (crossing in two locations; both east of Whitchurch and South of Hurstbourne Priors).	Consider adjusting the pipeline route to cross the watercourse where there is little or no vegetation. Consider designs that avoid running parallel to the watercourse for long stretches.
Options C Section 3	Pre-construction	Removal of vegetation along the Portway Roman Road where the construction corridor crosses the Portway Roman Road between Litchfield and Cole Henley will alter a feature that is a notable element contributing to the landscape character.	Consider aligning the route with existing breaks in the tree lined Portway Roman Road. Cosider replacing vegetation removed during construction. Consider looking for opportunities to strengthen the vegetation along the Roman Road.
Options C Section 3	Pre-construction	Impact on conservation areas comprising well vegetated field boundaries and wooded corridor of the River Trent within the Laverstoke and Freefolk Conservation Area. Woodland blocks on the southern tip of Tufton Conservation Area	Where possible consider designs that avoid crossing the conservation areas. Where crossing the conservation areas is unavoidable consider designs that avoid the removal of mature trees and hedgerows, reduce the working corridor and construction period. Cosider replacing all hedgerows and trees removed during construction. Consider looking for opportunities to enhance the setting of the conservation areas.
Options B and C Section 4	Pre-construction	Potential loss of woodland vegetation, and hedgerows removed from the working corridor during construction. Potential removal of vegetation within a wide belt of waterside vegetation along the River Dever at Tidbury Common resulting in a change to the character of the watercourse.	Consider adjusting the pipeline route to avoid removal of vegetation and avoid root protection zones where possible. Cosider adjusting the pipeline route to cross the watercourse where there is little or no vegetation. Consider designs that avoid running parallel to the watercourse for long stretches Consider designing culverts to be sensitive to the rural location in terms of scale and materials. Consider replacing all hedgerows and trees removed during construction. Consider narrowing the working corridor where crossing vegetated areas in order to reduce vegetation loss. Consider looking for opportunities to enhance vegetation
Options B and C Section 4	Pre-construction	Removal of woodland within the construction corridor on the eastern edge of Lainston House Registered Park and Garden along Stockbridge Road (B3049).	Consider narrowing the working corridor at this location to avoid loss of vegetation. Consider replacing all vegetation removed during construction lost. Consider looking for opportunities to restore the setting of the garden.
Historic environment			

Section	Phase	Potential impact	Mitigation/Enhancement
Whole pipeline	Pre-construction	Below-ground remains	Consider undertaking a geophysical survey at various sections along the pipeline to confirm if below-ground remains associated with earthworks identified from aerial imagery. With the potential for additional targeted investigation where necessary. Particular points of interest include the location of the potential Roman villa (SU 44252 66329) in Section 2
Option B Section 3	Pre-construction	Minimising disruption during works, measures to avoid impacts upon key views, noise screening, and monitoring noise and vibration.	When working in a Conservation Area as such St Mary Bourne and Stoke, East End and North End, and Laverstoke and Freefolk, consider mitigation measures which may include minimising disruption during works, measures to avoid impacts upon key views, noise screening, and monitoring noise and vibration.
Option C Section 3	Pre-construction	Below-ground remains	Consider undertaking a geophysical survey at the location of the deserted settlement centred on SU 46600 58050 and the potential prehistoric earthworks centred on SU 45888 45227 to confirm presence of below-ground remains before work begins.
Options B and C Section 4	Construction and Operation	Impact on The Registered Park and Garden of Laiston House	Provided that the route does not go any closer to The Registered Park and Garden of Laiston House and no permanent adverse impacts are anticipated then no mitigation measures are advised; however, access routes may have the potential to impact this asset during construction as such they should ideally be based to the east of the route.
Population and human health			
Whole Pipeline	Construction	Impacts from travel disruption and air and noise pollution.	Consider developing mitigation for local road closures and diversions when details are known regarding timing and duration of closure, in order to reduce direct impacts from travel disruption and air and noise pollution.
Whole Pipeline	Construction	Travel disruption to trainlines	Consider developing mitigation for temporary trainline closures and disruption to trainline services when details are known regarding timing and duration of closure, in order to reduce direct impacts from travel disruption.
Whole Pipeline	Construction	Travel disruption to connecting footpaths	Consider developing mitigation such as temporary diversions for footpaths connected to local amenities such as schools, churches ect when details are known regarding timing and duration of closure, in order to reduce direct impacts from travel disruption.
Whole Pipeline	Construction	Travel disruption to PRoWs	Consider developing mitigation for PRoW closures and diversions when details are known regarding timing and duration of closure, in order to reduce direct impacts from travel disruption and air and noise pollution.
Whole Pipeline	Construction	Indirect impacts from air and noise pollution	Consider implementing standard construction mitigation during construction of the pipeline and above ground assets within 500m of properties, businesses, community facilities and open spaces, in order to reduce indirect impacts from air and noise pollution.
Whole Pipeline	Operation	Indirect impacts from noise and air pollution on properties and businesses and open spaces.	Consider including landscaping, air quality and noise mitigation in the design of the above ground assets, in order to limit the potential indirect impacts from noise and air pollution on properties and businesses and open spaces.

Section	Phase	Potential impact	Mitigation/Enhancement
Options B and C Section 3	Construction	Indirect impacts from air and noise pollution	Consider implementing standard construction mitigation during construction of the pipeline and above ground assets within 500m of properties, businesses, community facilities and open spaces, in order to reduce indirect impacts from air and noise pollution **particularly near the village of Longparish**
Material assets			
Whole pipeline	Construction	Potential power outages caused by construction	Consider selecting appropriate machinery for the pipeline excavation in proximity to any power lines and covers such as netting below power lines to be used to reduce potential power outages.
Whole pipeline	Construction	PRoW and road closures/diversions	For any PRoW or road closures; consider implementing appropriate diversions where possible and minimising length of closure as necessary.
Whole pipeline	Construction	Railway and road closure/diversion	Consider using pipejack or micro tunnel crossing under railways and major roads if possible.
Options B and C Section 1	Pre-construction	Disruption to existing assets	Consider desiging the pipeline to avoid existing operational assets including the Chilton Recycling Facility and Hill Farm Solar Park.
Option B Section 3	Pre-construction	Disturbance to contaminants in landfill sites	Cliffeville Landfill an operational landfill site is located within the option corridor. Landfills are considered as a high risk of potential contamination. Consider undertaking further assessment of the landfill with a possible requirement for a Phase 1 contaminated land desk study and intrusive investigations to determine risks and construction approaches. Consider re-routing the pipeline to avoid the landfill.
Option B Section 3	Construction	Disturbance to contaminants in landfill sites	Consider implementing best practice construction methods for working within proximity to operational landfill sites (Cliffeville Landfill) to minimise disturbance of contaminants
Option C Section 3	Pre-construction	Disruption to existing assets	Consider desiging the pipeline to ensure route avoids existing operational assets including Ivory Farm, Burghclere waste facility.
Whole pipeline	Construction	Disruption to existing strategic areas of minerals	Consider liasing with Minerals and Waste Authority on sections of the route that go through strategic areas of minerals
Options B and C Section 4	Pre-construction	Disruption to existing assets	Consider desiging the pipeline to ensure route avoids existing operational assets including the A303 Recycling Facility, Barton Stacey and Owls Lodge Farm solar park.
Arboriculture			
Whole pipeline	Pre-construction	Temporary and permanent impact upon arboriculture	Consider conducting a full BS5837:2012 survey and an arboricultural impact assessment. Consider producing a tree protection plan to support the detailed design phase of the project.
Various locations throughout pipeline length	Pre-construction/ Construction	Direct conflict with conservation areas and ancient woodlands	Consider re-routing the pipeline to avoid direct conflict with conservation areas and ancient woodlands.
Various locations throughout pipeline length	Pre-construction/ Construction	Proximity to TPOs	Consider re-routing the pipeline to avoid works close to TPOs.

Section	Phase	Potential impact	Mitigation/Enhancement
Various locations throughout pipeline length	Construction	Proximity to ancient woodland	Where ancient woodlands are in close proximity to the works footprint, consider creating buffer zones around them which cannot be entered.
Option B Section 3	Construction	Proximity to ancient and veteran trees (Option B)	Where veteran trees are in close proximity to the works footprint, consider creating buffer zones around them which cannot be entered.
Noise			
Whole pipeline	Pre-Construction	Nose impacting residential receptors	Consider designing the pipeline alignment to be at least 85m from dwellings and pipe jacking to be at least 130m from dwellings.
Whole pipeline	Construction	Nose impacting residential receptors	Consider using any excess excavated material to construct temporary or permanent noise bunds where noise impacts are predicted.
Whole pipeline	Construction	Nose impacting residential receptors	Consider undertaking regular communication with nearby residents. The effects of construction noise and vibration can be mitigated by good public relations and community liaison. Residents who are kept aware of the reasons for construction works, the expected duration of elevated noise or vibration and the date at which it will stop are more accepting of it than if the noise commences without warning or explanation and appears to be continuing for an indefinite period.
Whole pipeline	Construction	Nose impacting residential receptors	Consider undertaking good practice measures as set out in BS5228 parts 1 and 2. Best Practicable Means in terms of considerate working should be considered at all times. Consider a letter box drop, and dedicated site contact for the public with a complaints handling procedure.

4.15 Next steps

At Gate 2, the environmental appraisal was undertaken as a desk based assessment only. Walk-over surveys and investigations should be considered and undertaken in order to inform detailed mitigation.

The below table summarises the next steps identified by the desk based assessment that could be considered for the T2ST pipeline at the appropriate stage in the design.

Table 4.15: Next steps summary

Topic	Next steps
Biodiversity, flora and fauna	• Once the pipeline route and placement of associated infrastructure is finalised, it is recommended that OS Master Map is purchased for the whole route to enable accurate habitat mapping in the UKHabs methodology. This will subsequently allow a synergistic approach between Biodiversity and Natural Capital/BNG workflows to provide a first pass as to the Habitat Units baseline of the proposed Red Line Boundary, before any subsequent in person site visits to ground truth and complete habitat condition assessments of habitats present. • Local Environmental Records Centres should be contacted to gather protected species data and information on locally protected sites. • A suite of protected species is likely to be present across the proposed pipeline route. It is recommended that once pipeline route is finalised within route corridors B and C, that in person site visits be conducted to assess the likelihood of protected species and habitats being present. • It is recommended that a buffer is added to the proposed Red Line Boundary, which is proportionate to standard survey methodologies and scope of scheme for differing protected species and assemblages. For example, Great Crested Newts can travel 250m breeding ponds

Topic	Next steps
	and as such would require a 250m buffer, whereas any potential terrestrial invertebrate interest within the site highlighted by in person site visits is likely to be limited to the Red Line Boundary. • Timing of protected species survey vary upon the individual ecology of the protected species in question, as such optimum windows for differing protected species vary. It is recommended that in person site visits first be completed to ground truth findings of desk based UKHabs mapping before a survey programme for protected species/ habitats been constructed.
Soils	• Consider undertaking a detailed soil survey (soil resource survey and/or ALC survey) along the route to confirm soil resources present. Production of a soil management plan should be considered which will be informed by the findings of the soil survey and will provide guidance for stripping, stockpiling, maintenance, reinstatement and after care of soil resources. • Further assessment of likely effects to Cliffeville Landfill (operational landfill site) is required with a possible requirement for a Phase 1 contaminated land desk study and intrusive investigations to determine risks and construction approaches. The pipeline route should be reviewed during further route design stages in order to avoid the landfill.
Water	• Consider producing a hydrogeological and groundwater risk assessment, particularly for the elements of the scheme within areas defined as SPZ1 and SPZ2, and elements within Flood Zones. • Refine the design of the new WTW at the intake location to be sited outside of Flood Zone 3b and 3a. • It is recommended that ground water flooding is taken into consideration of the development of assets and that appropriate flood proofing measures and/or the rising of entry thresholds are incorporated to mitigate possible damages.
Air Quality	• A dust risk assessment will need to be undertaken at a later stage once more information is available to determine the construction dust risk at these sensitive receptors and whether additional construction dust mitigation is required. • The air quality impacts associated with vehicle traffic during the construction and operation phases and the impacts from the standby generators should be assessed once further details of these activities are available.
Climatic Factors	• Refine the Climate Change Risk Assessment following development of the T2ST design.
Landscape	• Refine the route of the pipeline construction corridor and location of above ground structures to reduce the likely loss of vegetation and impact to sensitive landscape features. • Once the location of above ground structures has been refined, production of ZTV to aid identification of possible visual receptors. • Site visits to be carried out along the refined route. • Design landscape mitigation to integrate the above ground structures into the landscape and replace any vegetation removed during construction within the working corridor.
Historic Environment	• Consider conducting ageophysical survey on any section of the route where earthworks have been identified from cropmarks and aerial photography prior to any intrusive works. Should this not be possible, it is recommended that the groundworks proposed in the undeveloped areas of the site are archaeologically monitored. This is to ensure that no remains are removed by the proposed scheme without adequate record. Additional investigation may also be required, as determined through consultation with the relevant local authorities.
Population and Health	• Depending on the construction methodology, there may be a change in environmental conditions at private property located within 500m of Options B and C as a result of a combination of noise, air quality, visual impacts or presence of HGV vehicles. This should be considered further at the next stage of assessment.
Material Assets	• The material assets identified need to be considered when finalising the design of the pipeline route to avoid the existing operational assets identified. • Liaise with Minerals and Waste Authority on sections of the route that go through strategic areas of minerals.
Arboriculture	• If works require working to TPO trees or tree groups, then consultation with the local planning authorities tree officer will be required.

Topic	Next steps
Noise	• Once the final alignment of the pipeline has been agreed, consider the areas where residual construction noise impacts may occur and consider the noise mitigation options to be included in a Construction Noise Management Plan. • Conduct baseline noise monitoring in order to set noise limits in accordance with BS4142: 2014 in the area of the Crabtree/Sparsholt BPT. Once the noise baseline has been established use the derived criteria as design constraints for these facilities.

4.16 Monitoring

It is suggested that on-site surveys be undertaken at the appropriate stage in the design to confirm the baseline is as per the desk based appraisal.

No monitoring is required beyond Gate 2, in addition to monitoring already being undertaken as part of other SROs including SESRO and STT.

Monitoring for environmental effects and efficacy of mitigation measures may be required following detailed design of the mitigation.

4.17 Cumulative assessment

An initial cumulative assessment has been undertaken as part of the SEA option update for the T2S2 Gate 2 submission (see Annex B4).

A full cumulative effects assessment, as would be reported in an EIA, is not appropriate for Gate 2 due to the conceptual design stage of the T2ST SRO, and other SROs. As such, the focus of this cumulative assessment has been on the identification of risks due to potential cumulative effects of SROs with other plans and projects that will need to be addressed at future gates and for which additional mitigation may be required.

It is understood that if T2ST is selected as an option in the WRSE Regional Plan as well as Thames Water WRMP24 and Southern Water WRMP24 it will be subject to further cumulative effects assessment with the other selected options, neighbouring water companies plans and neighbouring regional plans. Until the WRSE Best Value Regional Plan has been developed and agreed it is not known when the T2ST option would be implemented, and therefore, which other developments could act in-combination with it.

This cumulative effects assessment has been undertaken as per the cumulative effects assessment methodology.

The following plans, programmes and projects have been considered within this cumulative effects assessment:

- Other Strategic Resource Options (SROs);
- Other water company schemes;
- Local Development Frameworks;
- Relevant planning applications; and
- NSIP/DCOs (none identified as relevant within the study area).

It should be noted that the cumulative effects assessment applies to both route corridors B and C and effects are anticipated to be similar. Therefore, the assessment below covers both routes.

Due to uncertainties in design, planning and operation of the schemes reported in this cumulative assessment, an in-combination assessment of all identified plans, programmes and projects is not appropriate for this stage of assessment and will need to be addressed at future gates and for which additional mitigation may be required. It is expected that a in-combination assessment of SROs will be undertaken at a regional scale by WRSE.

As per the programme assumptions in Section 2.5, the draft WRSE regional plan has determined a need for a T2ST scheme of up to 120Ml/d by 2040-2053 depending on the scenario in the adaptive plan. Therefore, at this stage, it is envisaged the project will not be operational until at least 2040.

Table 4.16 summarises the results of the in-combination assessment.

Table 4.16: Summary of cumulative effects assessment for Options B and C

Project or plan	Cumulative construction effects	Cumulative operation effects
SESRO	Effects would arise from construction traffic, noise, dust and visual intrusion	Unlikely
STT	Effects would arise from construction traffic, noise, dust and visual intrusion	Unlikely
Southampton Link Main and Andover Link Main schemes (Southern Water)	No cumulative effects arising from construction are anticipated due to the timeline for construction being prior to T2ST	To be considered within the Southern Water WRMP24
Winchester District Local Plan Part 1 – Joint Core Strategy Policy WT2 - Strategic Housing Allocation – North Winchester	Potential for minor construction effects arising from noise, dust pollution and disruption to traffic if the construction of dwellings takes place before 2040	No operational in-combination effects are anticipated
Winchester District Local Plan Part 1 – Joint Core Strategy Policy WT3 - Bushfield Camp Employment Site	If construction periods overlap then there is the potential for minor construction effects arising from noise, dust pollution and disruption to traffic	No operational in-combination effects are anticipated
Vale of White Horse District Local Plan 2031 Part 2 Core Policy 15b: Harwell Campus - Harwell Campus Comprehensive Development Framework	Potential for minor temporary cumulative effects including noise, dust pollution and disruption to traffic and visual intrusion	No operational in-combination effects are anticipated
Test Valley Borough - The land is not currently allocated in the Local Plan but is being promoted for residential development	Potential effects including noise, dust pollution and disruption to traffic	No operational in-combination effects are anticipated
Vale of White Horse District Council (planning application: P22/V0599/O)	Potential for cumulative effects during construction on the A4185, resulting from congestion if construction timings were to coincide. However, it is likely that construction will be completed before construction of T2ST.	No operational in-combination effects are anticipated

In summary, it was identified that T2ST has the potential to result in cumulative effects with other SROs, local development frameworks and planning applications during the construction phase (prior to 2035, or 2049 depending on which scenario goes forward following the WRSE emerging plan). These effects were identified given there is potential for the timing of the construction phases of T2ST to overlap with the construction phase of these other plans, programmes and projects. No operational cumulative effects were identified. T2ST is not identified to have any construction or operational related cumulative effects with other water company schemes.

5 Invasive Non-Native Species Risk Assessment

5.1 Introduction

5.1.1 Background

The transfer of 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 functioning, 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[31]. Additionally, the presence of INNS in water company assets may compromise the supply of drinking water and the safe return of treated wastewater to the environment. It is therefore essential that water companies understand the key pathways of INNS spread between their assets and the wider environment in order to implement appropriate mitigation measures.

5.1.2 Assessment objectives

The overall aim of this report was to present an assessment of the potential increase in INNS risk arising from the T2ST SRO. This overall aim was underpinned by the following objectives:

- To establish if the scheme will introduce a hydrological connection between previously isolated catchments.
- To identify INNS within an appropriate study area to understand the current INNS distribution.
- To outline legislative context of INNS risk assessment.
- To use the SRO Aquatic INNS Risk Assessment Tool (SAI-RAT) developed by APEM Ltd on behalf of the Environment Agency (EA) to quantify the INNS risk associated with the scheme based on the conceptual design information currently available.
- To review potential biosecurity options for implementation by the client and other relevant stakeholders to mitigate the INNS risk associated with the scheme.

5.1.3 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

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

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 Water Framework Directive UK Technical Advisory Group (WFD-UKTAG, 2015).

5.2 Methodology

5.2.1 Study area

The T2ST SRO involves two options for the transfer of potable water from a new WTW at the intake location to the west of A34 near Drayton, Oxfordshire to the existing Yew Hill Water Supply Reservoir (WSR) near Winchester, Hampshire. The following water transfer route options are under review at Gate 2:

- **Option B:** Pipeline from the new WTW at the intake location to the west of A34 near Drayton, then continuing to the west of the A34 to Yew Hill WSR. Connects along the route to three existing assets – Beacon Hill WSR, Micheldever WSR and Crabwood WSR.
- **Option C:** Pipeline from the new WTW at the intake location to the west of A34 near Drayton, running to the east of the A34 between Newbury and Whitchurch, then continuing to west of A34 to Yew Hill WSR. Connects along the route to three existing assets – Beacon Hill WSR, Micheldever WSR and Crabwood WSR.

The EA guidance for SRO INNS risk assessments specifies that the study area should be a 1km buffer zone either side of the proposed water transfer route[32].

5.2.2 High level screening against EA guidance

The EA position statement *Managing the Risk of Spread of Invasive Non-Native Species Through Raw Water Transfers*[33] 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 SRO was screened to determine if it will create a link between isolated catchments, as mapped in the EA document Invasive Non-Native Species Isolated Catchment Mapping[34].

[32] APEM Ltd (2021). SRO Aquatic INNS Risk Assessment Tool (SAI-RAT) – User Guide. Produced on behalf of the Environment Agency.
[33] Environment Agency (2017). Managing the Risk of Spread of Invasive Non-Native Species Through Raw Water Transfers. Position 1321_16.
[34] Environment Agency (2018). Invasive Non-Native Species Isolated Catchment Mapping. Prepared by Wallingford HydroSolutions Ltd.

5.2.3 INNS records

Open-source macroinvertebrate, macrophyte and fish data for the period 1965 to 2020 were obtained for the study area (see Section 3.1) from the EA Ecology and Fish Data Explorer app[35] and the National Biodiversity Network (NBN) Atlas online records[36]. The data were screened against Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) and WFD-UKTAG guidance[37] to identify INNS present within the study area.

5.2.4 Water transfer risk assessment

5.2.4.1 Tool overview

The SRO Aquatic INNS Risk Assessment Tool (SAI-RAT) used for this investigation was developed by APEM Ltd on behalf of the EA. The tool builds upon other assessment tools such as the Northumbrian Water Group raw water transfer assessment tool and the Wessex Water asset assessment tool, to provide a standardised approach to quantifying the INNS risk associated with SROs.

Risk assessments are processes by which the level of risk presented by certain hazards can be assessed, where hazards are anything that can cause harm. The level of risk is typically the combination of the chance and extent of the harm which could be caused. In the case of this tool, the hazard is the potential movement of INNS along key pathways, and the risk is the chance of that movement occurring combined with the extent of the harm this could cause.

The tool takes a pragmatic pathway and source-pathway-receptor model approach to the assessment of INNS risk relating to assets and raw water transfers. An extended functional group mechanism has been included in the tool to account for future risks rather than only examining species known to be currently present within the vicinity of transfer routes and assets. These functional groups are listed in Appendix 0.

The risk assessment matrix tool takes the form of a Microsoft Excel spreadsheet, into which data and information about SRO water transfers and asset options are entered by the assessor to automatically generate a risk score. Risk scores are presented as a percentage of the highest potential score, with a higher score signifying an increased risk of introducing and transferring INNS. Risk scores are categorised as Low, Medium or High. as shown in Table 5.1. Detailed instructions for use of the tool are provided in the *SRO Aquatic INNS Risk Assessment Tool (SAI-RAT) – User Guide* (APEM Ltd, 2021).

Table 5.1: Risk score categories

Percentage (%)	Category
0 - 33	Low
34 - 66	Medium
67 - 100	High

5.2.4.2 Tool input data

The information and data entered into the water transfer INNS risk assessment tool for each of the two water transfer route options are detailed in Table 5.2.

[35] EA Ecology and Fish Data Explorer app available online at: https://environment.data.gov.uk/ecology/explorer/ [accessed April 2022]

[36] NBN Atlas available online at: https://nbnatlas.org/ [accessed April 2022]

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

Table 5.2: INNS risk assessment tool water transfer input data

Input variable	Option B	Option C
Source	Intake WTW	Intake WTW
Source easting	446455	446455
Source northing	194477	194477
Source management catchment	Gloucestershire and the Vale	Gloucestershire and the Vale
Source operational catchment	Ock	Ock
Source type	WTW	WTW
Number of raw water transfers into source	None	None
Pathway type	Pipeline	Pipeline
Receptor name	Yew Hill WSR	Yew Hill WSR
Receptor easting	445402	445402
Receptor northing	126429	126429
Receptor management catchment	Test and Itchen	Test and Itchen
Receptor operational catchment	Itchen	Itchen
Receptor type	Offline waterbody (WSR)	Offline waterbody (WSR)
Isolated receptor catchment	Yes	Yes
Volumetric rate of transfer (Ml/d)	101 to 150	101 to 150
Frequency of transfer	Year round - continuous variable flow	Year round - continuous variable flow
Distance of transfer (km)	>30	>30
Washout/maintenance points along route	>3	>3
Source navigable	No	No
Pathway navigable	No	No
Angling at source	No	No
Angling on pathway	No	No
Water sports at source	No	No
Water sports along pathway	No	No
High Impact INNS at source	Known to be present	Known to be present
High Impact INNS along pathway	Known to be present	Known to be present
Highest order site designation within 1km of receptor	International (River Itchen SAC)	International (River Itchen SAC)
Presence of priority habitats within 1km of pathway	Known to be present	Known to be present
Presence of priority habitats within 1km of receptor	Known to be present	Known to be present
Other existing connections present between source and receptor	0	0

The tool separates the INNS risk associated with water transfers from the INNS risk associated with assets. As the purpose of this assessment was to quantify the potential increase in INNS risk arising from the SRO, only the INNS risk associated with the new WTW at the intake location was assessed as all other assets included in the SRO are already in existence. The information and data entered into the asset INNS risk assessment tool for the new WTW at the intake location are detailed in Table 5.3. WTW operational details were limited at the time of assessment, therefore assumptions were made regarding the frequency of site visits and maintenance.

Table 5.3: Risk assessment tool new asset input data. * denotes assumptions in the tool input.

Input variable	Intake WTW
Asset type	WTW
Asset location	On existing agricultural land to the west of A34 near Drayton in Oxfordshire
Asset easting	446455
Asset northing	194477
Asset size (m^2)	45,000
Existing high impact INNS records on site/area of proposed site	Known to be present
Existing priority habitats on site	Not known to be present
Frequency of personnel site visits*	Daily
Frequency of personnel entering or in contact with raw water*	Daily
Frequency of road vehicles on site*	Daily
Frequency of maintenance operations not requiring personnel to enter water*	Daily
Frequency of maintenance operations requiring personnel to enter water*	Monthly

5.2.5 Biosecurity assessment

The INNS risk assessment tool includes a high-level, qualitative assessment of biosecurity measures. Following input of proposed water transfer and new asset details to the tool, various biosecurity measures are presented based on the identified pathways of INNS spread. Each of the presented biosecurity measures in the tool are assigned a confidence rating of either High, Medium or Low based on their overall robustness at reducing risk in relation to the corresponding pathway. Biosecurity measures included in the conceptual design for Option B and Option C were reviewed against the confidence ratings given in the tool.

5.3 Assumptions and limitations

Assumptions about WTW operational processes (e.g., frequency of personnel visits and maintenance) have been made and inputted to the risk assessment tool. The asset INNS risk score should be reviewed at a later stage when operational procedures have been developed for the new WTW at the intake location.

Construction risks have not been considered at Gate 2 as they are not used to differentiate between the risks of high-level SRO options, around which there is still a degree of uncertainty. The tool used in this assessment quantifies the risk associated with the operational phase of a water transfer option, rather than the construction phase. The SRO would involve the construction of a new pipeline, which 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., sediment and vegetation). As the conceptual design is further developed, construction-phase risks relating to INNS should also be considered.

The data and information entered into the INNS risk assessment tool were based on the latest available conceptual design. As the conceptual design is still in development, these details may be subject to change. The INNS risk assessment should be revised throughout the design process.

5.4 Results

5.4.1 High level screening against EA guidance

The transfer source, a new WTW at the intake location, falls within area 73 of the EA's *Invasive Non-Native Species Isolated Catchment Mapping v3* (EA, 2018). This area is classified as 'Canal – CRT', meaning that hydrological connections to areas beyond the catchment already exist through intersection of the river network with Canal and River Trust (CRT) navigable canals. Connecting watercourses listed include the Kennet and Avon Canal, Wiltshire and Berkshire Canal, Thames and Severn Canal, Oxford Canal and Grand Union Canal. The proposed pipeline routes for both Option B and Option C cross area 43 before reaching the receptor site, Yew Hill WSR, located in area 44. Both area 43 and 44 are classed as 'Isolated', meaning that they do not have existing hydrological connections to any other catchments.

The EA guidance for raw water transfers states: 'new schemes that create a hydrological connection between isolated catchments must have mitigation measures in place to ensure INNS cannot be spread by the new transfer' (EA, 2017). Although both Option B and Option C involve the transfer of water between catchments that are not currently connected, water will be treated at source and the receptor will be a WSR rather than an open waterbody. Consequently, there is no risk that INNS will be transferred between catchments. Both Option B and Option C are considered to meet EA criteria.

5.4.2 INNS records

A total of 20 invasive aquatic and riparian species were identified in the EA and NBN Atlas records for the study area (i.e., 1km buffer zone around the proposed transfer routes). Two invasive fish species were identified, including the High Impact common carp (*Cyprinus carpio*). Seven invasive macroinvertebrate species have been recorded in the study area, including the High Impact signal crayfish (*Pacifastacus leniusculus*). Eleven invasive aquatic plant species have been recorded, including five High Impact species.

The INNS identified in the records for the two transfer routes were the same, with the exception of Wautier's limpet (*Ferrissia wautieri*) which was identified in the EA records for survey sites within 1km of Option C but not Option B.

Further detail of the INNS records within 1km of the transfer routes is included in Appendix 0.

5.4.3 Risk assessment

The INNS risk scores derived from the EA tool for the two transfer options are summarised in Table 5.4.

Table 5.4: INNS risk assessment scores

T2ST Option	Water transfer risk score (%)	Water transfer risk score category	Asset risk score (%)	Asset risk score category
Option B	35.73	Medium	10.94	Low
Option C	35.73	Medium	10.94	Low

Water transfer Option B and Option C do not differ significantly in their conceptual design. The data and information input to the EA INNS risk assessment tool were identical for the two options and as such there was no difference in the resulting risk scores.

The Medium risk score of 35.73% is considered to be an overestimate of the INNS risk. Treatment of raw water at the new WTW at the intake location prior to transfer will eliminate any INNS at source, however the water transfer part of the tool does not account for water treatment

processes. Additionally, transfer via a pipeline rather than an open water course will prevent the introduction of INNS along the transfer route, for example via recreational activities, navigation or INNS migration. At no point during the normal operation of the T2ST transfer will raw or treated water be discharged to an open waterbody.

Treated water may occasionally be discharged to nearby water courses or waterbodies from washout or maintenance points along the pipeline route. As the water will be treated, there is no risk of INNS introduction to the receptor waterbodies. However, an increase in flow in a receptor waterbody as a result of pipeline washout could potentially facilitate the spread of INNS already present in the system to unimpacted areas further downstream. Further consideration should be given to the incorporation of INNS mitigation measures in the design and operation of washout and maintenance points along the pipeline route.

The INNS risk score associated with the new WTW at the intake location was calculated as 10.94%, which equates to a Low risk score. Generation of this asset risk score was largely based on assumptions about WTW operational processes (e.g., frequency of personnel visits and maintenance). Although the asset risk score was categorised as Low, it is thought that the most likely pathway of INNS spread associated with the SRO will be the movement of personnel and vehicles from the WTW following contact with untreated water. The asset INNS risk score should be reviewed at a later stage when operational procedures have been developed for the new WTW at the intake location.

5.4.4 Biosecurity assessment

The risk assessment tool identified a range of biosecurity measures to mitigate the risk associated with key pathways of INNS spread that will be introduced by the proposed water transfers and new assets. Of the biosecurity options presented in the tool, several High and Medium confidence measures have already been incorporated into the conceptual design, including the treatment of water at source by chlorination, OZONE and UV.

Potential biosecurity measures for mitigating INNS risk associated with the water transfer are shown in Table 5.5 and potential biosecurity measures for implementation at the new WTW at the intake location are shown in Table 5.6.

Table 5.5: Potential biosecurity measures for pipeline pathway

Biosecurity measure	Description	Included in conceptual design	Confidence
Biosecurity strategy	Biosecurity measures incorporated into water company standard operating procedure.	No	Medium
Chlorination	Chlorination of transferred water using hypochlorite, chlorine gas or chlorine dioxide. Suggested pipeline concentration of 1mg Cl/L over 10 days of continuous dosing.	Yes	High
Chemical treatment	Could include coagulation and flocculation, OZONE treatment, pH or salinity alteration, or application of an herbicide.	Yes – OZONE treatment	High
Anti-fouling paints	Paint applied to surfaces of pipeline to create toxic/unfavourable substrate for bio-fouling INNS.	No – not considered necessary as the transferred water will be treated at source.	Medium
UV treatment	UV is transmitted through water as it flows through a specialised chamber. The radiation damages cells and DNA and causes mortality in the exposed organisms.	Yes	Medium

Biosecurity measure	Description	Included in conceptual design	Confidence
Active filtration	Active filtration using screen filters, bed filters or other pumped filtration methods.	No	Medium
Passive filtration	Installation of fish screens, rundown screens or conveyor screens to prevent the passage of suspended matter and organisms.	No	Low

Table 5.6: Potential biosecurity measures for implementation at source WTW

Biosecurity measure	Description	Included in conceptual design	Confidence
Check, clean, dry (CCD)	Promotion of CCD protocol amongst WTW personnel.	No	Medium
Biosecurity strategy	Biosecurity strategy developed by water company.	No	Medium
Site-specific operational equipment	Provision of site-specific operational equipment (e.g., pontoons, buoys, vehicles) to reduce the inter-site movement of INNS.	No	High
Equipment and personal protective equipment (PPE) cleaning (dry)	Installation of waterless cleaning stations. May involve the use of brushes to decontaminate dirty equipment.	No	Low
Static water wash equipment and PPE (cold)	Water < 35°C to aid manual removal of INNS (ambient temperature water will not cause mortality of INNS). May involve use of dip tank.	No	Low
Static water wash equipment and PPE (hot)	A temperature of > 35°C for 15 minutes, or > 45°C for 1 second has been proven effective against many invasive invertebrate species. May involve use of dip tank.	No	Medium
Running water (cold)	Running water can be effective against invertebrate INNS. However, efficacy (mortality endpoint) is reduced in comparison to pressurised water. Efficacy is dependent on the method and effort of cleaning	No	Low
Running water (hot)	Running water can be effective against invertebrate INNS; however, efficacy (mortality endpoint) is reduced in comparison to pressurised water. Efficacy is dependent on the method and effort of cleaning	No	Medium
PPE cleaning (dry)	Boot brushing/cleaning stations are a simple approach to decontamination of footwear. Can be a simple brush or boot scraper. All waste should be treated as hazardous and disposed of accordingly.	No	Low
PPE cleaning (dip tank or sink, cold)	A dip tank or sink to allow total immersion of PPE. Brushes and cleaning tools would be a requirement. Ambient temperature water will not cause direct mortality in INNS (unless of much different salinity), so cleaning relies on manual action (scrubbing and drying). Wastewater would be contaminated, so appropriate disposal needed	No	Low
PPE cleaning (dip tank or sink, hot)	A dip tank or sink to allow total immersion of PPE. A temperature of >35°C for 15 minutes, or >45°C for 1 second has been proven effective against many INNS. The efficacy of hot water against INN plant species (mortality endpoint) is	No	Medium

Biosecurity measure	Description	Included in conceptual design	Confidence
	not as high as for invertebrates, so it is important that equipment is treated for sufficient time; immersion of equipment at 50°C for 5 minutes is recommended to achieve high INN plant mortality.		
Pressure wash (cold)	High-pressure cold water can be effective against invertebrate INNS. However, efficacy (mortality endpoint) is reduced in comparison to pressurised hot water. Efficacy is dependent on the method of application of the spray, regarding duration and distance from surface.	No	Low
Pressure wash (hot)	High-pressure, hot water can be very effective against invertebrate INNS. However, the efficacy is dependent on the method of application of the spray, regarding duration and distance from surface	No	Medium
Drying	Allowing equipment to completely dry ensures that hitchhiker INNS are rendered non-viable. Providing a drying room or other designated area on site for this purpose would allow PPE to be stored and dried at the same location.	No	High

5.5 Summary and next steps

5.5.1 Conclusions

The following conclusions have been drawn from the results of the INNS risk assessment:

- The INNS risk is the same for Option B and Option C as key aspects of their conceptual design are the same.
- The proposed transfers will introduce a new hydrological connection between previously isolated catchments. However, treated water will be transferred to an enclosed WSR rather than to an open waterbody, therefore there is no risk of INNS introduction to the receptor catchment.
- Although a number of aquatic INNS have been identified within the study area, including several High Impact species, there is no risk that the SRO will facilitate their spread as water transfer is via pipeline rather than open water course.
- The Medium risk score generated by the EA's risk assessment tool is considered to be an overestimate of the INNS risk as the tool does not account for water treatment processes at source. The SRO involves the transfer of treated water from a WTW to an enclosed WSR. At no point during the normal operation of the transfer will raw or treated water be discharged to an open waterbody.
- The main risk associated with the transfer has been identified as the infrequent discharge of treated water from washout points along the pipeline to nearby waterbodies. An increase in flow in the receptor waterbody could potentially facilitate the spread of INNS already present in the system.
- INNS risk associated with the new WTW at the intake location was assessed as being Low. However, it is thought that the movement of personnel and vehicles from the WTW following contact with raw water will be the most likely pathway of INNS spread associated with the T2ST SRO. Biosecurity measures can be put in place to mitigate against this risk.

5.5.2 Recommendations

The data and information input to INNS risk assessment tool were based on the latest available SRO conceptual design. It is recommended that the INNS risk assessment is reviewed upon finalisation of the conceptual design to account for any changes that may introduce INNS risk.

Biosecurity measures have already been incorporated into the water transfer component of the SRO in the form of chemical and UV treatment of raw water at the source, which will effectively eliminate the risk of INNS transmission via the pipeline to the receptor site(s).

Measures to mitigate the INNS risk associated with assets have not yet been incorporated into the conceptual design. It is recommended that the next iteration of the design involves the review the pathway-specific biosecurity measures identified by the EA's risk assessment tool with the aim of incorporating Medium and High confidence biosecurity measures into operational protocol for the new WTW at the intake location.

6 Natural Capital and Biodiversity Net Gain

6.1 Introduction

6.1.1 Natural Capital and Biodiversity Net Gain

This section presents the findings from the NC assessment and Biodiversity Net Gain (BNG) calculation undertaken for the T2ST SRO.

Natural Capital refers to the elements of the natural world that provide benefits to society and includes aspects such as woodland, grassland, freshwater, marine, urban greenspace and wetland habitats.

The benefits that are provided to humans by the natural environment vary from regulating services such as natural flood management to cultural services such as recreational value.

BNG refers specifically to the combination of habitats present within a site and their ability to support biodiversity. Each habitat is given a distinct score that relates to its area, condition, distinctiveness and connectivity. The change in habitat due to the construction and operation of the regional plan options informs the overall BNG score and whether they are likely to contribute to a net gain in biodiversity.

At Gate 1, a BNG, NC and ecosystems services assessment was carried out. This assessment used the most-up-to-date guidance available at the time to undertake the assessment, The Biodiversity 2.0 Metric. In July 2021, Defra and Natural England launched The Biodiversity 3.0 Metric. The 3.0 metric presents significant improvements for measuring and accounting for nature losses and gains. The 3.0 metric has been used for this Gate 2 assessment, which therefore acts as a replacement to the assessment carried out at Gate 1.

The T2ST SRO is committed to achieving 10% biodiversity net gain, as required by the Environment Act 2021[38]. This section provides some opportunities to achieve this, however the habitat mitigation and enhancement proposals will be set out in the next phases of design.

6.1.2 Structure of this section

This section presents the NCA, BNG, and opportunities relating to the SRO. There are five parts to this section.

1. **Methodology**. Definition of how the NCA and BNG has been assessed for the SRO.
2. **Assumptions and limitations**. A list of assumptions and limitations that are applicable to the results.
3. **The Gate 2 NC and BNG Assessment Findings**. Outputs of the NCA and BNG and description of NC-optimised routes. Assessments have been undertaken in line with the methodology found in the *WRSE Regional Plan Environmental Assessment Methodology Guidance* (Mott MacDonald, 2020).
4. **Results and opportunities**. Summaries of the assessment and the potential opportunities to achieve a 10% net gain in BNG as well as improve the overall provision of ecosystem services provided by natural capital.

[38] Environment Act 2021, c.30. Available at: https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted [Accessed April 2022]

5. **Summary and Next Steps**. Developed design, finalised feasibility, pre-planning investigations and planning investigations.

6.2 Methodology

6.2.1 Defining the natural capital baseline

6.2.1.1 Zone of influence

The Zone of Influence (ZoI) was defined as the area of receiving (i.e. a watercourse receiving a discharge) or providing (i.e. an aquifer where abstraction will occur) environment with the potential to be altered or changed as a result of the SRO.

The T2ST SRO involves two options for the transfer of potable water from a new WTW near land to the west of A34 near Drayton, Oxfordshire to the existing Yew Hill WSR near Winchester, Hampshire. The majority of each pipeline option will be 1000 to 1100mm diameter which will be installed primarily using open cut excavation. To provide sufficient working space to construct the pipeline a temporary working easement will be required, which will include the temporary removal of natural capital stocks within that easement. It has been assumed that for each pipeline, the easement will extend a maximum of 20m on both sides of the pipe, resulting in a total width of 40m. The natural capital stocks that are both temporarily and permanently impacted by the construction of permanent aboveground infrastructure and the temporary easement required to construct the pipeline are include within the ZoI. In later stages of design, the ZoI will need to be further refined with the availability of greater design detail and site survey data.

6.2.1.2 Developing a natural capital baseline

As part of the NCA, a natural capital baseline was developed for the SRO. This baseline was developed using open-source data as described in NECR285 to generate a Natural Capital account of the stocks within the ZoI. The list of stocks considered within the accounts and the methodology for mapping them are shown in Appendix C. The methodology used to map natural capital utilises the same breakdown of stocks as the NECR285 National Natural Capital Atlas[39] where possible. However, the list has been supplemented with additional abiotic stocks and key habitats that are vital such as chalk streams and rivers.

The Natural Capital baseline reports the total quantity of each stock within the study area, and where suitable, an indication of natural capital condition.

6.3 Overview assessment methodology: NCA

A natural capital assessment has been undertaken on the SRO in accordance with the Water Resources Planning Guideline[40] (WRPG) and Enabling a Natural Capital Approach (ENCA) requirements. ENCA is recommended for use by HM Treasury's Green Book: appraisal and evaluation in central government (2020)[41] and represents supplementary guidance to the Green Book.

[39] Natural England (2020). National Natural Capital Atlas: Mapping Indicators (NECR285). Available at: http://publications.naturalengland.org.uk/publication/4578000601612288 [Accessed April 2022]

[40] GOV.UK. 2021. Water resources planning guideline. Available online at: https://www.gov.uk/government/publications/water-resources-planning-guideline/water-resources-planning-guideline [Accessed April 2022].

[41] 2020, The Green Book Central Government Guidance On Appraisal And Evaluation. [online] London: HM Treasury. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938046/The_Green_Book_2020.pdf [Accessed April 2022].

In August 2021, ENCA updated its guidance. The approach for Gate 2 will be updating the natural capital assessments in line with this.

The August 2021 ENCA guidance (GOV.UK, 2021[42]) includes updated values within the Asset Databook and Service Databook. Within the Service Databook, the carbon reduction tab now includes Department for Business, Energy and Industrial Strategy (BEIS) (2021) carbon values - a set of values produced by the government to be used in policy appraisal and evaluation, reflecting the latest evidence. The climate regulation section of the assessment has been updated in line with this.

The impact of the SRO on the Natural Capital stocks and indicators of condition was reported for each element quantitatively. This impact was reported for during construction and post construction to give an estimation of the impact of the SRO's whole lifecycle. The results of the stock assessment were reported in total losses and gains within each option's ZoI.

The results of the change in natural capital stocks informed the assessment against the six natural capital metrics (also known as ecosystem services) listed below using the Natural England logic chains, shown in Figure 6.1. The cost / benefit assessment was informed by the option type, option description and any embedded mitigation. The outputs of the NCA were compared to the pre-construction provision of impacted services to assess the impact of the SRO. Three ecosystem services were monetised, and the results of the assessment reported as a discreet monetary figure (subject to the ecosystem service scoping exercise set out below), water purification was assessed qualitatively, and biodiversity has been assessed via the 3.0 metric. Water regulation has not been included for assessment to avoid the potential double accounting of benefits with capacity-based and financial assessment, and to align with Environment Agency guidance[43] that recommends not including monetisation of water regulation benefits in decision making.

Figure 6.1 Ecosystem Services valuation logic chain

The metrics used to assess the impact on natural capital include:

- Carbon sequestration (Climate regulation)
- Natural hazard management

[42] GOV.UK. 2021. Enabling a Natural Capital Approach guidance. Available online at: https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance/enabling-a-natural-capital-approach-guidance [Accessed April 2022].

[43] Environment Agency (2020) Water resources planning guideline supplementary guidance – Environment and society in decision-making.

- Water purification (Qualitative assessment only)
- Biodiversity and habitats (assessed as part of the BNG assessment)
- Air pollutant removal
- Recreation and amenity
- Food production

Both natural capital assessment strategies, as outlined in the Environment Agency's Water Resource Planning Guidelines (GOV.UK, 2020[2]) and the Defra: Enabling a Natural Capital Approach (GOV.UK, 2021[4]), discuss taking a proportionate approach to the assessment. It is therefore important to accommodate this when integrating a natural capital approach within the SRO gated process. A natural capital approach has the potential to inform concept design and aid decision making, by quantifying the relative cost benefits and disbenefits of the SRO to aid the initial assessment of the identified strategic solutions.

During the initial phase of the NCA, all of the six ecosystem services were reviewed and scoped in or out due to the geographical or socio-economic context of the SRO and its ZoI. Specific guidance on the screening process for individual metrics is provided below.

6.3.1 Carbon sequestration (Climate regulation)

The climate regulation metric focuses on carbon sequestration, which can be defined as the capture and secure storage of carbon that would otherwise be emitted to, or remain, in the atmosphere. The carbon sequestration NCA will be in addition to constructional carbon and operational carbon calculations and provides a holistic assessment of carbon emissions for the SRO.

The assessment was determined by land management within the SRO's footprint which influenced the carbon store for prolonged periods of time and results in a change in net emissions. The estimate of the carbon stocks for the SRO footprint was based on the area of broad land use types according to literature and research. The estimated carbon stocks for broad habitat types are listed below and the sequestration rates are shown in Table 6.1.

Table 6.1 Carbon sequestration rates for broad habitat types (JBA Consulting)[44] [45]

Land use type	C Seq rate (tCO2e/ha/yr)
Woodland - (deciduous)	4.97
Woodland – (coniferous)	12.66
Arable Land	0.107
Pastoral land	0.397
Peatland - Undamaged	4.11
Peatland - Overgrazed	-0.1
Peatland - Rotationally burnt	-3.66
Peatland - Extracted	-4.87
Grassland	0.397
Heathland	0.7
Shrub	0.7
Saltmarsh	5.188
Urban	0

[44] Alonso, I., Weston, K., Gregg, R. and Morecroft, M. 2012. Carbon storage by habitat - Review of the evidence of the impacts of management decisions and condition on carbon stores and sources. Natural England Research Reports, Number NERR043.

[45] The Environment Agency, (2020) Water resources planning guideline supplementary guidance – Environment and society in decision-making.

Land use type	C Seq rate (tCO2e/ha/yr)
Green Urban	0.397

The carbon sequestration rates were converted to monetary values using standard methods and the UK Business, Energy, & Industrial Strategy (BEIS) Interim Non-Traded Carbon Values from 2022, as shown in Table 6.2. The natural capital assessment is based on a 2022 price year, however it is assumed that adjustments for inflation have been accounted within the annual projections provided by BEIS and therefore the 2022 value presented below has not been adjusted. High series values were used to reflect a conservative estimate for the price of carbon.

Table 6.2 BEIS updated short-term traded sector carbon values for policy appraisal, £/tCO2e (£2020)

Year	Low series	Central series	High series
2020	120	241	361
2021	122	245	367
2022	124	248	373
2023	126	252	378
2024	128	256	384
2025	130	260	390
2026	132	264	396
2027	134	268	402
2028	136	272	408
2029	138	276	414
2030	140	280	420
2031	142	285	427
2032	144	289	433
2033	147	293	440
2034	149	298	447
2035	151	302	453
2036	155	307	460
2037	156	312	467
2038	158	316	474
2039	161	321	482
2040	163	326	489
2041	165	331	496
2042	168	336	504
2043	170	341	511
2044	173	346	519
2045	176	351	527
2046	178	356	535
2047	181	362	543
2048	184	367	551
2049	186	373	559
2050	189	378	568

6.3.2 Natural hazard management

Different habitat types have intrinsic flood risk management values by intercepting, storing and slowing water flows. This is known as natural flood management and is listed as a policy within the Government's 25 Year Environment Plan[46]. The capacity of habitats to achieve this can be quantified, and then a monetary value can be assigned based on the damage-costs avoided from flooding or replacement costs due to their capacity to regulate flood waters. The capacity for a given natural capital asset to provide a flood regulation service will depend on two factors:

- Its capacity to slow overland flows
- Whether the asset is located in an area of flood risk

This ecosystem service also applies in urban areas, where vegetation can reduce surface water flooding from heavy rainfall, with benefits to sewerage capacity. Coastal flood risk, which has been predicted to increase with future climate change, is reduced by coastal margin habitats such as saltmarsh.

The SRO was assessed on the ability to positively or negatively impact flood risk through the comparison of pre- and post-construction natural capital stocks and the catchment in which it is located. The assessment is restricted to catchment areas which drain to downstream communities impacted by flooding. These communities were identified using the Environment Agency's Indicative Flood Map, which overlays areas at risk of fluvial flooding and the National Receptor Database. The ecosystem service was scoped in for assessment where it was identified that the SRO would have a temporary or permanent impact upon the relevant natural capital stocks, such as areas of woodland, located within the floodplain.

Reduced flood damage to downstream or coastal settlements as a result of reduced magnitude / frequency of flood / storm events; and / or lower sewer capacity or water storage costs was valued in line with Broadmeadow et al, 2018[47]. This assessment was developed to provide indicative national estimates of water regulation services of woodland to inform natural capital accounts, this is based on modelling to estimate the potential volume of flood water avoided by woodland ecosystems in flood risk catchment. The methodology adopts a replacement-cost (rather than damage cost) approach to valuing the flood regulation service of woodland by applying annualised average capital and operating costs of flood reservoir storage that would be required in the absence of the ecosystem service.

Central estimate of the average annual costs of reservoir floodwater storage is £0.42 / m^3. The range is from £0.10 to £1.19 /m3 per year. The central estimate was used to derive an annual average estimate for the flood regulation service of woodland in Great Britain, which was then uplifted to a 2022 price year. These "replacement costs" can be considered a lower bound of the benefit if it can be assumed that such expenditure would be deemed value for money by the flooding authorities within flood risk catchments in terms of avoided flood damage costs.[48]

6.3.3 Water purification

Based on their ecological functioning, different habitat types, have varying capacities for absorbing pollutants from a given water source. This service is dependent on the location of the natural capital asset and the nature of the surrounding area. If a natural capital asset has a high capacity to remove pollutants but is not close to a water source, the service will not be provided.

[46] 25 Year Environment Plan – Policy Paper. GOV.UK. Available online at: https://www.gov.uk/government/publications/25-year-environment-plan [Accessed April 2022]

[47] Broadmeadow, S., Thomas, H., Nisbet, T. and Valatin, G., 2018. Valuing flood regulation services of existing forest cover to inform natural capital accounts. Forest Research.

[48] GOV.UK. 2021. Enabling a Natural Capital Approach guidance. Available online at: https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance/enabling-a-natural-capital-approach-guidance [Accessed April 2022].

Due to this, valuation of the static water purification services of different natural capital assets as part of the NCA was not considered appropriate. A common value for different habitat types could not be applied due to extensive variation in local factors which determine the provisioning of this service.

To account for the provision of this service within the NCA the impact of the SRO associated with the provision or removal of woodland and semi-natural grassland was considered considered qualitatively and with consideration of the NEVO[49] tool. The tool defines the resulting changes for the following water quality variables:

- Dissolved oxygen concentration;
- Nitrogen concentration (including organic nitrogen, nitrate, nitrogen dioxide, ammonium);
- Phosphorous concentration (including organic and mineral phosphorous); and
- Pesticide concentration (for eighteen different pesticide types.

This approach followed the methodology that if an area of woodland were to be lost, the resultant impacts on water quality can be qualitatively assessed within the SRO's ZoI. Any negative changes to the natural capital in theory, reflects the loss of this service within the SRO's ZoI.

6.3.4 Air pollution removal

Air pollution presents a major risk to human health, resulting in premature deaths and reduced quality of life. By removing air pollution, habitats help to lessen these impacts on health and wellbeing. The provisioning of the service is positively related to several key aspects:

- The surrounding area of the natural capital assets with regards to background pollution, especially particulate pollutant;
- The quantity and type of natural capital asset, woodland is the major service provider; and
- The density of population potentially benefiting from reduced exposure. Because pollutants are transported, beneficiaries may be downwind of the ecosystem[42].

The SRO was screened against the provision of air pollutant removal according to its location. Air pollutant removal was only considered within built up areas or when the ZoI includes AQMAs. The impact of the SRO was assessed according to changes in natural capital stocks.

The value provided by natural capital assets was taken from the UK government's air quality economic assessment methodology[50]. The assessment embeds these values (based on the damage cost approach, i.e. damage to health avoided from reductions in air pollution) and estimates the present value automatically based on the quantitative estimates provided.

Indicative average values for air pollution removal in 2015 for different habitats were calculated from aggregate UK values published in February 2019, as shown in Table 6.3.

The value of each habitat will be combined with the changes expected in natural capital stocks to provide a value for the change in service provision. The final impact will be reported as a single value that will be incorporated within the NCA metric.

Table 6.3 Air pollutant value by habitat type (£2022)

Habitat group	Value (£ per hectare per year)
Urban Woodland	942

[49] Luizzo, L., (2019) Natural Environment Valuation Online Tool - Chapter 6a: Water Quantity & Quality Model

[50] Jones L., Vieno M., Morton Dan et al. (2017) Developing Estimates For The Valuation Of Air Pollution Removal In Ecosystem Accounts. Final Report For Office Of National Statistics - NERC Open Research Archive

Habitat group	Value (£ per hectare per year)
Rural Woodland	299
Urban grassland	182
Enclosed farmland	17
Coastal margins	31

Following the development of the natural capital baseline for the SRO, it was determined that the construction of the proposed route options does not result in the permanent loss of associated stocks within an AQMA or urban area. Therefore, the change in air quality removal ecosystem services has been scoped out of this assessment.

6.3.5 Recreation and amenity

The recreational value of green spaces can be significant. This value reflects both the natural setting and the facilities on offer at the site and often has a strong non-market element. It varies with the type and quality of habitat, location, local population density and the availability of substitute recreational opportunities. Recreational values can be beneficially affected by enhancements in green spaces, or adversely affected by new developments or infrastructure. The wider tourism and outdoor leisure sector is also dependent upon nature to varying degrees[42]. This metric depends on the extent to which the natural capital stocks the SRO provides will enhance the opportunity for recreation.

The key parameter needed to estimate in this category is the number of additional or enhanced recreational visits created because of the option. This was estimated using the Outdoor Recreation Valuation Tool (ORVal). ORVal[51] is referenced in HM Treasury Green Book. Random utility / travel cost model of recreational demand for all sites in England and Wales and generates probabilistic predictions of visitor numbers for any publicly accessible outdoor recreation park, path, or beach. It takes account of scarcity of sites and substitution possibilities, as well as travel distances to sites and their attributes. This is useful for baseline initial assessment, accounting, and multiple sites. This should be seen as an estimation in the absence of site-specific data on visitor numbers.

Following the development of the natural capital baseline for the SRO, it was determined that the construction of the proposed route options does not result in the permanent loss of greenspace. Therefore, the change in recreation and amenity services has been scoped out of this assessment. However, it should be noted that access to existing greenspace and the resulting impacts on recreational values have not been quantified as part of the assessment. The impact of the SRO upon access to greenspace will need to be considered beyond Gate 2.

6.3.6 Food production

Food is produced by a range of ecosystems and in some cases, the food for human consumption is effectively the same as the ecosystem service (e.g. wild fruit, fishing). More often the provisioning service is a raw material (e.g. crops) that is harvested and processed by humans and produced capital into added value processed food (e.g. bread). The boundary between what is provided by natural capital and the contribution of other forms of capital is often a grey area, e.g. crops require agricultural management; livestock need grassland ecosystems[42].

Food production has been calculated using the NEVO agricultural model, this is a structural model of agricultural land use and production for Great Britain estimated using Farm Business Survey (2005 – 2011) and June Agricultural Census data. The agricultural land use component

[51] ORVal, Land, Environment Economics and Policy Institute. University of Exeter. Available online at: https://www.exeter.ac.uk/research/leep/research/orval/ [Accessed April 2022]

in NEVO builds upon the approach developed by Fezzi and Bateman[52]. NEVO was used to assess the impact of the creation or removal of agricultural land for the SRO. The change in value of food provision for the footprint of the SRO was calculated using this online tool and reported within the NCA.

6.4 Overview assessment methodology: BNG

The BNG requirement as outlined in the WRPG stipulates that each SRO should look to maximise BNG. In July 2021, Defra and Natural England launched The Biodiversity 3.0 Metric. The 3.0 metric presents significant improvements for measuring and accounting for nature losses and gains. It encourages users to create and enhance habitats where they are most needed to help establish or improve ecological networks through rural and urban landscapes. By linking to current and future habitat plans and strategies, including the future Local Nature Recovery Strategies (LNRS), the 3.0 metric incentivises habitat creation and enhancement where most needed. It also 'rewards' landowners who undertake work early, creating or enhancing habitats in advance, allowing them to generate more biodiversity units from their land. Condition assessment approaches have also been significantly updated and simplified for the 3.0 metric and some key changes made.

The Defra 3.0 metric is the recommended approach to net gain assessments. The government anticipates the 3.0 metric to become the industry standard for biodiversity assessments for on-land and intertidal development types in England. As proposed in the Environment Act 2021 in November 2021, biodiversity net gain must be measured using a recognised biodiversity metric. The metric essentially underpins the Environment Bill's provisions for mandatory biodiversity net gain in England, subject to any necessary adjustments for application to major infrastructure projects. The Act further specifies the requirement of biodiversity reports to include specified quantitative data relating to biodiversity, and as such any tool which evaluation is predominantly qualitative is not recommended.

As such, the Gate 2 approach has been to use the 3.0 metric. Any new scheme elements brought into the gated process at this stage have been assessed by the 3.0 metric, in line with current guidance. It should be noted that in April 2022, Defra and Natural England released the Biodiversity Metric 3.1, providing an update to the Biodiversity 3.0 Metric. The BNG calculation will be revisited and updated using the latest version of the metric in later stages of design. These calculations are to be further refined throughout the gated process to inform planning requirements.

A biodiversity baseline has been developed from spatial data sets of habitats inventories to calculate BNG change through land use. The Priority Habitat Inventory and sites with Site of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), Special Protection Area (SPA) and Ramsar designations were used to identify areas with high biodiversity importance. Units have been assigned to the pre-construction land use according to the habitats present in the ZoI. Post construction land use, including any mitigation described in the scheme description (see Annex B1 EAR), has been used to calculate the post construction score. As this assessment will be carried out using only open-source data a precautionary approach is applied, presuming that where not specifically known, habitats will be assigned the moderate habitat score.

6.5 NC optimised routes

There are two options within the T2ST SRO for transferring water from the new WTW at the intake location to the existing Yew Hill WSR near Winchester:

[52] Fezzi, C., Bateman, I., Hadley, D. & Harwood, A. 2019. Natural Environment Valuation Online Tool - Chapter 1: Agriculture Model

- Option B - Central route via Newbury (West of Newbury and remaining west of the A34, to Winchester)
- Option C - Central route via Newbury (West of Newbury and then crossing to the east of A34, to Winchester)

These options have been developed based on series of criteria that consider engineering, environmental, social, and planning constraints. The route for each option has been identified within a wider corridor that meets a majority of the criteria. For example, there may be woodland priority habitat located within the Option B corridor, however the Option B route has been designed to avoid intersecting the woodland priority habitat wherever possible.

As part of the natural capital assessment, the route alignment for both Option B and Option C were altered in discrete locations to ensure that the temporary working easement, assumed to be 20m on both sides of the route, similarly avoids temporary impacts on natural capital assets, wherever possible, while remaining within the corridor of each option. For example, if the Option B route avoids intersecting woodland priority habitat, but passes within 20m of the habitat, then the route has been realigned further away from that habitat within the corridor. These routes are referred to as “optimised” routes, e.g. ‘Option B – NC Optimised’ and ‘Option C – NC Optimised’. These NC-optimised routes are assessed using the same NC and BNG methodology set out above and the findings are presented in Section 3 for comparison against the proposed Option B and Option C routes. It should be noted that for both the original routes and the NC-optimised routes, the assumed temporary easement area is considered to be constrained by the option corridor, and therefore, the temporary easement is narrower in discrete locations so that the easement, and any associated works, do not extend outside the option corridor.

6.6 Assumptions and limitations

The following assumptions and limitations are applicable to the results.

For NC:

- The costs for constructing, operating and maintaining the options was not considered within the assessments.
- The provision of public water supply has been excluded from all assessments to avoid potential double accounting of benefits with capacity-based and financial assessment. Benefits of public water supply may be considered beyond Gate 2.
- Natural capital stocks identified within the areas allocated for above ground infrastructure have been assumed to be completely lost as a result of the SRO.
- Natural capital stocks presumed temporarily lost are expected to be reinstated/compensated.
- It has been assumed that for each pipeline, the temporary working easement required to facilitate construction will extend a maximum of 20m on both sides of the pipe, resulting in a total width of 40m.
- The area provided for the temporary working easement is assumed to be constrained by the option corridor. Permanent and temporary works are assumed to not extend outside the option corridor.

For BNG:

- No enhancement of biodiversity post construction was considered. BNG habitat units were assigned to the pre-construction land use according to the habitats present within each option boundary. The post construction land use, including agreed mitigation, was used to calculate the post construction biodiversity score.

- The desk-based assessment was carried out using open-source data. As such, a precautionary approach was applied, presuming that where not specifically known, habitats were assigned the maximum habitat score. Habitats were not assigned a strategic significance as part of the BNG calculation. Habitat identification, condition and strategic significance will need to be refined with habitat surveys and associated data at later gates to refine the accuracy of the BNG calculations for each option.
- It has been assumed that for each pipeline, the temporary working easement required to facilitate construction will extend a maximum of 20m on both sides of the pipe, resulting in a total width of 40m.
- The area provided for the temporary working easement is assumed to be constrained by the option corridor. Permanent and temporary works are assumed to not extend outside the option corridor.
- The duration of disturbance and timeline for habitat creation has not been included in the assessment. Durations of disturbance, including proposals for creating habitats in advance of disturbance, will need to be refined with greater design detail at later gates to refine the accuracy of the BNG calculations for each option.

6.7 NCA and BNG Findings

The NCA and BNG findings for Option B are summarised in Table 6.4, Table 6.5, Table 6.6, Table 6.7, and Table 6.8. Mitigation has only been considered when outlined in the scheme description, or where standard mitigation must be applied.

A summary of what is included within each table is as follows:

- Table 6.4 shows the predicted impacts on natural capital during and post construction. **Note:** Only those stocks with predicted impacts are listed.
- Table 6.5 summarises the predicted impacts to the provision of ecosystem services screened in for detailed assessment.
- Table 6.6 summarises the predicted impacts to the provision of water purification for the SRO, where screened in for qualitative assessment.
- Table 6.7 shows the unmitigated BNG outputs for the SRO which have been informed using the predicted impacts on natural capital in Table 6.4. **Note:** At this stage the BNG only takes account of reinstatement, areas for reprovision or additional habitat creation have not been outlined in the scheme description. Areas for habitat reprovision and habitat creation will be developed in greater detail beyond Gate 2.

The BNG assessment can be revisited at a further stage of design, and mitigation or enhancement opportunities developed further to achieve the 10% BNG required within the SRO.

Additionally, where possible, the SRO could aim to not only reinstate lost habitat, but also provide a greater or more diverse habitat than is lost, to achieve overall Biodiversity Net Gain in line with regulatory requirements for BNG (at the time of the project consenting) as stated as a mandatory requirement within the Environment Act 2021. The latter could be achieved during later stages of design by identifying local sites of ecological interest and proposing measures which enhance these features.

Table 6.4 Predicted impacts on natural capital stocks for Option B

Natural capital stock	Area of stocks within ZoI pre-construction (Ha)	Stocks present within ZoI during construction (Ha)	Stocks present within ZoI post construction (Ha)	Change (Ha)
Option B				
Coastal floodplain grazing marsh	2.15	0.00	2.15	0.00
Lowland Fens	0.08	0.00	0.08	0.00
Arable	307.62	0.00	288.38	-19.23
Pastures	55.85	0.00	55.23	-0.62
Other semi-natural grassland	10.59	0.00	10.03	-0.56
Broadleaved, mixed and yew woodland	0.52	0.00	0.52	0.00
Woodland priority habitat	4.18	0.00	4.18	0.00
Coniferous woodland	0.39	0.00	0.39	0.00
Ancient woodland	0.15	0.00	0.00	-0.15
Greenspace	0.03	0.00	0.03	0.00
Active Floodplain	7.03	6.87	6.87	-0.16
Rivers	0.27	0.27	0.27	0.00
Ponds (non-linear)	0.06	0.06	0.06	0.00
Option B – NC Optimised				
Coastal floodplain grazing marsh	2.45	0.00	2.45	0.00
Lowland Fens	0.06	0.00	0.06	0.00
Arable	313.27	0.00	293.35	-19.92
Pastures	62.90	0.00	61.81	-1.08
Other semi-natural grassland	9.32	0.00	8.76	-0.57
Broadleaved, mixed and yew woodland	0.30	0.00	0.30	0.00
Woodland priority habitat	3.03	0.00	3.03	0.00
Coniferous woodland	0.001	0.00	0.001	0.00
Greenspace	0.04	0.00	0.04	0.00
Active Floodplain	7.18	3.36	3.36	-3.83
Rivers	0.25	0.25	0.25	0.00
Ponds (non-linear)	0.06	0.06	0.06	0.00

Table 6.5 Quantitative detailed assessment of the unmitigated predicted impacts on the provision of ecosystem services for Option B (£2022[53])

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Option B					
Carbon storage	£32,965.14	£0.00	-£32,965.14	£29,097.48	-£3,867.66
Natural hazard management	£513.65	£0.00	-£513.65	£373.98	-£139.67
Air Pollutant Removal [54]	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation and Amenity Value [55]	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£851,300.00	£844,500.00	-£6,800	£844,500.00	-£6,800.00
Total	£884,778.79	£844,500.00	-£40,278.79	£873,971.46	-£10,807.33
Option B – NC Optimised					
Carbon storage	£29,358.53	£0.00	-£29,358.53	£26,779.01	-£2,579.52
Natural hazard management	£325.58	£0.00	-£325.58	£244.18	-£81.39
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation and Amenity Value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£851,800.00	£845,000.00	-£6,800	£845,000.00	-£6,800.00
Total	£881,484.10	£845,000.00	-£36,484.10	£872,023.19	-£9,460.91

Table 6.6 Qualitative assessment of the unmitigated predicted impacts on the provision of water purification for Option B

Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Option B			
The stocks, both temporarily and permanently lost, likely provide a high provision of the ecosystem service due to the natural capital assets high capacity to store and absorb pollutants and the proximity of the asset to a water source. These stocks include, for example, the different types of woodland area, floodplain grazing marsh and lowland fens.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stock will likely be reduced.	The provision of water purification provided by the associated stocks will likely be reduced due to the option. Future provision of ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.
Option B – NC Optimised			
The stocks temporarily lost likely provide a high provision of the ecosystem service due to the natural capital assets high	The provision of services will be	The future provision of the ecosystem service provided by	The provision of water purification provided by the associated stocks will likely

[53] Ecosystem service values have been calculated as the present value for a consistent price year (£2022), where possible. The price of carbon has relied on BEIS annual projections for 2022, as set out in the methodology above.

[54] Scoped out when the option does not cause the temporary and/or permanent loss of associated stocks within an AQMA or urban area.

[55] Scoped out when the option does not cause the permanent loss of greenspace.

Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
capacity to store and absorb pollutants and the proximity of the asset to a water source. These stocks include, for example, the different types of woodland area, floodplain grazing marsh and lowland fens.	lost during construction.	the stock will likely be reduced.	be reduced due to the option.

Table 6.7 Summary of the unmitigated BNG Metric outputs for Option B

Route Option	On-site Baseline (Biodiversity Units)	On-Site Post Intervention (Biodiversity Units)	Total Net Unit change (Biodiversity Units)	Total Percentage Change
Option B	1049.28	792.06	-257.22	-24.51%
Option B – NC Optimised	1059.74	818.48	-241.27	-22.77%*

* Option B route will result in the loss of ancient woodland. Ancient woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore biodiversity net gain cannot be achieved when the SRO causes the loss of ancient woodland. Option B – NC Optimised route avoids the loss of ancient woodland and results in a reduced net loss of biodiversity when compared to the original route B option.

The NCA and BNG findings for Option C are summarised in Table 6.8, Table 6.9, Table 6.10, Table 6.11, and Table 6.12. Mitigation has only been considered when outlined in the scheme description, or where standard mitigation must be applied.

A summary of what is included within each table is as follows:

- Table 6.8 shows the predicted impacts on natural capital during and post construction. **Note:** Only those stocks with predicted impacts are listed.
- Table 6.9 summarises the predicted impacts to the provision of ecosystem services screened in for detailed assessment.
- Table 6.10 summarises the predicted impacts to the provision of water purification for the SRO, where screened in for qualitative assessment.
- Table 6.11 shows the unmitigated BNG outputs for the SRO which have been informed using the predicted impacts on natural capital in Table 6.8. **Note:** At this stage the BNG only takes account of reinstatement, not reprovision or additional habitat creation unless outlined in the scheme description.

Table 6.8 Predicted impacts on natural capital stocks for Option C

Natural capital stock	Area of stocks within ZoI pre-construction (Ha)	Stocks present during construction (Ha)	Stocks present post construction (Ha)	Change (Ha)
Option C				
Coastal floodplain grazing marsh	4.31	0.00	4.31	0.00
Lowland Fens	0.08	0.00	0.08	0.00
Arable	302.53	0.00	279.82	-22.71
Pastures	51.61	0.00	51.31	-0.30
Other semi-natural grassland	5.63	0.00	5.06	-0.58
Broadleaved, mixed and yew woodland	0.70	0.00	0.70	0.00

Natural capital stock	Area of stocks within ZoI pre-construction (Ha)	Stocks present during construction (Ha)	Stocks present post construction (Ha)	Change (Ha)
Woodland Priority Habitat	6.21	0.00	6.21	0.00
Coniferous woodland	0.36	0.00	0.36	0.00
Ancient Woodland	0.17	0.00	0.00	-0.17
Greenspace	0.03	0.00	0.03	0.00
Active Floodplain	7.15	6.99	6.99	-0.16
Rivers	0.32	0.32	0.32	0.00
Ponds (non-linear)	0.07	0.07	0.07	0.00
Option C – NC Optimised				
Coastal floodplain grazing marsh	2.73	0.00	2.73	0.00
Lowland Fens	0.05	0.00	0.05	0.00
Arable	312.32	0.00	287.46	-24.86
Pastures	55.74	0.00	55.26	-0.47
Other semi-natural grassland	5.02	0.00	4.26	-0.76
Broadleaved, mixed and yew woodland	0.55	0.00	0.55	0.00
Woodland priority habitat	5.84	0.00	5.84	0.00
Coniferous woodland	0.27	0.00	0.27	0.00
Ancient Woodland	0.01	0.00	0.00	-0.01
Greenspace	0.03	0.00	0.03	0.00
Active Floodplain	6.90	3.07	3.07	-3.83
Rivers	0.30	0.30	0.30	0.00
Ponds (non-linear)	0.07	0.07	0.07	0.00

Table 6.9 Quantitative detailed assessment of the unmitigated predicted impacts on the provision of ecosystem services for Option C (2022 prices)

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Option C					
Carbon storage	£35,385.73	£0.00	£35,385.73	£30,406.47	-£4,979.25
Natural hazard management	£729.28	£0.00	-£729.28	£534.59	-£194.70
Air Pollutant Removal [56]	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation and Amenity Value [57]	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£758,400.00	£750,400.00	-£8,000.00	£750,400.00	-£8,000.00
Total	£794,515.01	£750,400.00	-£44,115.01	£781,341.06	-£13,173.95

[56] Scoped out when the option does not cause the temporary and/or permanent loss of associated stocks within an AQMA or urban area.

[57] Scoped out when the option does not cause the permanent loss of greenspace.

Ecosystem services	Baseline value (£/year)	Estimated value post construction (£/year)	Temporary impact from construction (£/year)	Total future value (£/year)	Overall change in value (£/year)
Option C – NC Optimised					
Carbon storage	£34,577.55	£0.00	-£34,577.55	£30,110.12	-£4,467.43
Natural hazard management	£652.64	£0.00	-£652.64	£488.78	-£163.86
Air Pollutant Removal	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Recreation and Amenity Value	Scoped out	Scoped out	Scoped out	Scoped out	Scoped out
Food production	£759,200.00	£749,300.00	-£9,900.00	£749,300.00	-£9,900.00
Total	£794,430.20	£749,300.00	-£45,130.20	£779,898.91	-£14,531.29

Table 6.10 Qualitative assessment of the unmitigated predicted impacts on the provision of water purification for Option C

Likely baseline provision	Construction impacts	Likely future provision	Overall change in provision
Option C			
The stocks, both temporarily and permanently lost, likely provide a high provision of the ecosystem service due to the natural capital assets high capacity to store and absorb pollutants and the proximity of the asset to a water source. These stocks include, for example, the different types of woodland area, floodplain grazing marsh and lowland fens.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stock will likely be reduced.	The provision of water purification provided by the associated stocks will likely be reduced due to the option. Future provision of ecosystem services provided by Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.
Option C – NC Optimised			
The stocks, both temporarily and permanently lost, likely provide a high provision of the ecosystem service due to the natural capital assets high capacity to store and absorb pollutants and the proximity of the asset to a water source. These stocks include, for example, the different types of woodland area, floodplain grazing marsh and lowland fens.	The provision of services will be lost during construction.	The future provision of the ecosystem service provided by the stock will likely be reduced.	The provision of water purification provided by the associated stocks will likely be reduced due to the option. Ancient Woodland will be permanently lost as is a high value natural capital stock that cannot be replaced or replicated once lost.

Table 6.11 Summary of the unmitigated BNG Metric outputs for Option C

Route Option	On-site Baseline (Biodiversity Units)	On-Site Post Intervention (Biodiversity Units)	Total Net Unit change (Biodiversity Units)	Total Percentage Change
Option C	1014.30	757.60	-256.70	-25.31%*
Option C – NC Optimised	1017.72	777.75	-239.97	-23.58

*Option C route will result in the loss of ancient woodland. Ancient woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore biodiversity net gain cannot be achieved when the SRO causes the loss of ancient woodland. Option C – NC Optimised route will result in the loss of a smaller area of ancient woodland.

6.8 Results

6.8.1 Option B

NCA

The route B option will likely cause the temporary and permanent loss of natural capital stocks during construction. Stocks that are likely to be permanently lost include arable land, pasture, other semi-natural grassland, and active floodplain. However, best practice mitigation (such as pipejack or micro tunnel crossings) and reinstatement/compensation of habitat means that most Natural Capital stocks post construction will have no to little change.

The route option will likely cause the permanent loss of ancient woodland. Ancient woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock is presumed permanently lost. The routes and associated aboveground infrastructure of the SRO at this stage are concept designs and through further investigative work the route could be diverted to minimise the impact upon this priority habitat and to avoid irreplaceable habitats such as ancient woodland. Therefore, ancient woodland will likely be avoided as the pipeline will be routed around this habitat.

Ecosystem Services

The route option is likely to generate the loss of natural capital stocks during construction. However, habitat that is expected to be reinstated/compensated to pre-construction conditions following best practice technique will likely have no permanent impact to the provision of ecosystem services. Broadleaved, mixed and yew, priority, coniferous and urban woodland have a significant maturity time with a delay of 30 years. Therefore, this delay is considered within potential future provision of this stock through the ecosystem services assessment. This can be accounted to the tree mortality rate presumed after woodland areas are replanted. While a tree mortality rate has been assumed for the assessment, the time to reach maturity will need to be considered in greater detail beyond Gate 2.

Construction impacts include a reduction in carbon sequestration capacity due to habitat clearance, a reduction in food production services, loss of natural hazard management, and a reduction in water purification. For those stocks that are temporarily lost, it is expected that the future value is not affected as stocks are expected to be reinstated. However, ancient woodland is irreplaceable and once lost cannot be replaced. Therefore, the future provision of ecosystem services provided by ancient woodland, namely carbon sequestration, natural hazard management, and water purification will be permanently lost, subject to further optimisation as set out above.

The route option presents an opportunity to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats. The route option crosses several priority habitats, Network Enhancement Zones, Fragmentation Action Zones, and Network Expansion Zones and is therefore suitable for the planting of new high value habitats.

BNG

Applying the methodology, the route option will result in the loss of approximately 257 BNG habitat units due to the temporary removal of habitats during construction. The route option will also result in the permanent loss of ancient woodland, subject to further optimisation as set out above. Ancient woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore biodiversity net gain cannot be achieved when the SRO causes the loss of ancient woodland. For the purposes of calculating biodiversity net gain, ancient woodland has been excluded.

6.8.2 Option B – NC Optimised

NCA

The Option B – NC Optimised route will likely cause the temporary and permanent loss of natural capital stocks during construction. Stocks that are likely to be permanently lost include arable land, pasture, other semi-natural grassland, and active floodplain. However, best practice mitigation (such as pipejack or micro tunnel crossings) and reinstatement/compensation of habitat means that most Natural Capital stocks post construction will have no to little change.

The Option B – NC Optimised route has avoided the loss of ancient woodland when compared to the route B option. The routes and associated aboveground infrastructure of the SRO at this stage are concept designs and through further investigative work, the route could be further optimised to minimise the impact upon natural capital stocks, such as by increasing the use of pipejack or micro tunnel crossings in areas where feasible and practical.

Ecosystem Services

The Option B – NC Optimised route is likely to generate the loss of natural capital stocks during construction. However, habitat that is expected to be reinstated/compensated to pre-construction conditions following best practice technique will likely have no permanent impact to the provision of ecosystem services. Broadleaved, mixed and yew, priority, coniferous and urban woodland have a significant maturity time with a delay of 30 years. Therefore, this delay is considered within potential future provision of this stock through the ecosystem services assessment. This can be accounted to the tree mortality rate presumed after woodland areas are replanted. While a tree mortality rate has been assumed for the assessment, the time to reach maturity will need to be considered in greater detail beyond Gate 2.

Construction impacts include a reduction in carbon sequestration capacity due to habitat clearance, a reduction in food production services, loss of natural hazard management, and a reduction in water purification. For those stocks that are temporarily lost, it is expected that the future value is not affected as stocks are expected to be reinstated.

The Option B – NC Optimised route presents an opportunity to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats. The route option crosses several priority habitats, Network Enhancement Zones, Fragmentation Action Zones, and Network Expansion Zones and is therefore suitable for the planting of new high value habitats.

BNG

Applying the methodology, the Option B – NC Optimised route will result in the loss of approximately 241 BNG habitat units due to the temporary removal of habitats during construction. When compared to the route B option, the Option B – NC Optimised route results in a lower loss of biodiversity units and avoids the loss of ancient woodland.

6.8.3 Option C

NCA

The route option will likely cause the temporary and permanent loss of stocks during construction. Stocks that are likely to be permanently lost include arable land, pasture, other semi-natural grassland, and active floodplain. However, best practice mitigation (such as pipejack or micro tunnel crossings) and reinstatement/compensation of habitat means that most Natural Capital stocks post construction will have no to little change.

The route option will likely cause the permanent loss of ancient woodland. Ancient woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore,

future provision of stock presumed permanently lost. The routes and associated aboveground infrastructure of the SRO at this stage are concept designs and through further investigative work the route could be diverted to minimise the impact upon this priority habitat and to avoid irreplaceable habitats such as ancient woodland. Therefore, ancient woodland will likely be avoided as the pipeline will be routed around this habitat.

Ecosystem Services

The route option is likely to generate the loss of natural capital stocks during construction. However, habitat that is expected to be reinstated/compensated to pre-construction conditions following best practice technique will likely have no permanent impact to the provision of ecosystem services. Broadleaved, mixed and yew, priority, coniferous and urban woodland have a significant maturity time with a delay of 30 years. Therefore, this delay is considered within potential future provision of this stock through the ecosystem services assessment. This can be accounted to the tree mortality rate presumed after woodland areas are replanted. While a tree mortality rate has been assumed for the assessment, the time to reach maturity will need to be considered in greater detail beyond Gate 2.

Construction impacts include a reduction in carbon sequestration capacity due to habitat clearance, a reduction in food production services, loss of natural hazard management, and a reduction in water purification. For those stocks that are temporarily lost, it is expected that the future value is not affected as stocks are expected to be reinstated. However, ancient woodland is irreplaceable and once lost cannot be replaced. Therefore, the future provision of ecosystem services provided by ancient woodland, namely carbon sequestration, natural hazard management, and water purification will be permanently lost, subject to further optimisation as set out above.

The route option presents an opportunity to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats. The route option crosses several priority habitats, Network Enhancement Zones, Fragmentation Action Zones, and Network Expansion Zones and is therefore suitable for the planting of new high value habitats.

BNG

Applying the methodology, the route option will result in the loss of approximately 257 BNG habitat units due to the temporary removal of habitats during construction. The route option will also result in the permanent loss of ancient woodland, subject to further optimisation as set out above. Ancient woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore biodiversity net gain cannot be achieved when the SRO causes the loss of ancient woodland. For the purposes of calculating biodiversity net gain, ancient woodland has been excluded.

6.8.4 Option C – NC Optimised

NCA

The Option C – NC Optimised route will likely cause the temporary and permanent loss of natural capital stocks during construction. Stocks that are likely to be permanently lost include arable land, pasture, other semi-natural grassland, and active floodplain. However, best practice mitigation (such as pipejack or micro tunnel crossings) and reinstatement/compensation of habitat means that most Natural Capital stocks post construction will have no to little change.

The Option C – NC Optimised route will likely cause the permanent loss of ancient woodland. Ancient woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore, future provision of stock presumed permanently lost. The routes and

associated aboveground infrastructure of the SRO at this stage are concept designs and through further investigative work the route could be diverted to minimise the impact upon this priority habitat and to avoid irreplaceable habitats such as ancient woodland. Therefore, ancient woodland will likely be avoided as the pipeline will be routed around this habitat.

Ecosystem Services

The Option C – NC Optimised route is likely to generate the loss of natural capital stocks during construction. However, habitat that is expected to be reinstated/compensated to pre-construction conditions following best practice technique will likely have no permanent impact to the provision of ecosystem services. Broadleaved, mixed and yew, priority, coniferous and urban woodland have a significant maturity time with a delay of 30 years. Therefore, this delay is considered within potential future provision of this stock through the ecosystem services assessment. This can be accounted to the tree mortality rate presumed after woodland areas are replanted. While a tree mortality rate has been assumed for the assessment, the time to reach maturity will need to be considered in greater detail beyond Gate 2.

Construction impacts include a reduction in carbon sequestration capacity due to habitat clearance, a reduction in food production services, loss of natural hazard management, and a reduction in water purification. For those stocks that are temporarily lost, it is expected that the future value is not affected as stocks are expected to be reinstated. However, ancient woodland is irreplaceable and once lost cannot be replaced. Therefore, the future provision of ecosystem services provided by ancient woodland, namely carbon sequestration, natural hazard management, and water purification will be permanently lost, subject to further optimisation as set out above.

The Option C – NC Optimised route presents an opportunity to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats. The route option crosses several priority habitats, Network Enhancement Zones, Fragmentation Action Zones, and Network Expansion Zones and is therefore suitable for the planting of new high value habitats.

BNG

Applying the methodology, the Option C – NC Optimised route will result in the loss of approximately 240 BNG habitat units due to the temporary removal of habitats during construction. The Option C – NC Optimised route will result in a smaller area of permanent loss of ancient woodland when compared to the route C option, subject to further optimisation as set out above. Ancient woodland is a high value natural capital stock that cannot be replaced or replicated once lost, therefore biodiversity net gain cannot be achieved when the SRO causes the loss of ancient woodland. For the purposes of calculating biodiversity net gain, ancient woodland has been excluded.

6.9 Opportunities

6.9.1 Mitigation and enhancement opportunities

Following the BNG and NCA, opportunities should be considered to ensure the natural environment is left in better condition than pre-construction conditions. When considering these opportunities, it is important to note that the construction and operation of the SRO may not be required for a considerable period of time, with the SRO potentially not required for 20 years or more. Opportunities for mitigation and enhancement will need to consider the timing of delivery, noting that there may be changes to land use by existing landowners over this period. Therefore, to allow for greater flexibility, the identification of opportunities should be considered for both the existing routes and for the wider route corridors. This should be achieved by one or both of the following:

- Mitigation: Opportunities to offset the net loss of biodiversity asset(s) and/or Natural Capital stock(s) (ecosystem service).
- Enhancements: Opportunities that, once introduced and established, would result in a net gain to a biodiversity asset and/or Natural Capital stock(s) (ecosystem service).

As a core principle, where possible, the SRO should aim to not only reinstate lost habitat, but also provide a greater or more diverse habitat than is lost, to achieve overall BNG. The latter could be achieved by identifying local sites of ecological interest and proposing measures. Any habitats that are created or enhanced to achieve BNG are required to be secured for 30 years, through management, maintenance, and monitoring.

A summary of the potential NCA, BNG mitigation and enhancement measures for each sub-component type are outlined in Table 6.12. Further explanation into the potential enhancement measures is provided within the sections below.

Table 6.12 Summary of potential net gain mitigation and enhancement opportunities

Route Options	Mitigation opportunity	Enhancement opportunity
All route options	Scheme layouts, including the aboveground infrastructure and pipeline alignment, to be amended to avoid the permanent loss of natural capital assets, wherever possible.	Creation of higher value habitat within grassland, arable and pasture natural capital assets onsite to achieve an increase in Biodiversity Units (BU) and work towards a 10% uplift in BNG.
	Schemes to identify area for the creation and/or reinstatement of high value natural capital assets, including: Coastal and floodplain grazing marsh Lowland fens Lowland raised bog Reedbeds Blanket bog Hay meadows Dwarf shrub heath Broadleaved, mixed and yew woodland Coniferous woodland Bluespace Greenspace	Habitat creation work within the adjacent priority habitats that the SRO falls within, or within the vicinity of habitat network zones[58]: Habitat restoration-creation Restorable habitat Fragmentation action zone Network enhancement zones 1 and 2 Expansion zone These areas identify specific locations for a range of actions to help improve the ecological resilience for each of the habitats/habitat networks. The SRO should look to identify habitat network zones and priority habitats within the near vicinity and look to improve/create/restore habitats which would help to work towards increasing BU and work towards a 10% uplift in BNG.
	Construction practices to be considered to reduce the amount of clearance required for, especially in areas that include high value natural capital assets (see above for list).	Increase the quality/quantity of freshwater assets, including lakes, ponds located in designated SSSIs, pending detailed assessment of local conditions and available space.
	Pipejack or micro tunnel crossings to be used where possible to avoid loss of high value natural capital assets (see above for list).	Identify suitable areas offsite of the SRO, for creation, enhancement and/or restoration in order to develop off-site net gains, working towards achieving a 10% uplift in BNG.
		Identify areas of local peatland restoration
SRO elements located along the canals		Possibly create man-made floating wetland islands, enabling plants and microbes to form and attract wildlife both above and below the water's surface and create biochemical and

[58] Edwards J, Knight M, Taylor S & Crosher I. E (May 2020) 'Habitat Networks Maps, User Guidance v.2', Natural England

Route Options	Mitigation opportunity	Enhancement opportunity
		physical processes to improve things such as water quality.
Water treatment works and other SRO elements that contain above ground infrastructure		Seeding of grassland within footprints of the above ground infrastructure, where possible.

It should be noted that the potential NCA, BNG measures can be used to target mitigation and enhancement to support the NRN areas identified in Section 107, as well as other local sites of ecological interest. For example, Biodiversity Opportunity Areas (BOAs) similarly identify areas where improved habitat management and restoration activities can be targeted to support priority habitats and increase connectivity. Both the Option B and Option C corridors extend through Berkshire County Council and Hampshire County Council. Both Berkshire County Council[59] and Hampshire County Council[60] have identified BOAs that are located within, or in proximity to, the option corridors. The BOAs include a description of the local environment and target measures such as woodland management, restoration of lowland calcareous grassland, river restoration, and parkland management.

For example, the route corridor passes through Kennet Valley West[61] , which has been identified as a BOA by the Berkshire Local Nature Partnership (LNP). The BOA profile for Kennet Valley West provides a summary of a number of environmental characteristics, such as the geology and topography, as well summaries on habitat characteristics, for example identifying that there are areas of fen at Hungerford Marsh and Eddington Marsh. In addition to the environmental and habitat characteristics, the following opportunities are also identified:

- **Targets and opportunities**: River management, restoration and protection. Restoration of wet grassland, lowland meadow and fen habitat. Management of wet woodland. Parkland management.

The BOAs provide a useful resource to supplement the areas identified at the national scale by the NRN, providing further local context as to which mitigation and enhancement opportunities will yield the most environmental benefit. It is anticipated that the forthcoming Local Nature Recovery Strategies, as set out by the Environment Act 2021, will bring together information on existing priority habitats, as well as the opportunities identified by these regional and national networks, to set out the biodiversity priorities for a given strategy area.

It is recommended that these opportunities be further explored at later stages of design. Wider partnership working with landowners, conservation groups and other organisations should be explored to help deliver opportunities for biodiversity enhancement.

[59] Available online at: https://berkshirelnp.org/index.php/what-we-do/strategy/biodiversity-opportunity-areas#:~:text=There%20are%2029%20Biodiversity%20Opportunity%20Areas%20%28BOAs%29%20in,of%2048%2C112%20hectares%21%20Conservation%20need%20outweighs%20available%20funding.?msclkid=b0e61844b67011ec96b93e54b7fc3638 [Accessed April 2022]

[60] Available online at: https://www.hants.gov.uk/landplanningandenvironment/environment/biodiversity/informationcentre/information [Accessed April 2022]

[61] Available online at: https://berkshirelnp.org/kennet-valley-west [Accessed April 2022]

6.9.2 BNG Unit Purchase

BNG can be achieved via a new statutory biodiversity credits scheme. Credits can be bought by developers as a last resort when onsite and local offsite provision of habitat cannot deliver the BNG required. It is important to emphasise that the purchase of BNG units should only be considered as a last resort when alternative methods for habitat provision are not possible for achieving a 10% net gain in biodiversity. The price of biodiversity credits will be set higher than prices for equivalent biodiversity gain on the market and are expected to be purchased through a national register for net gain delivery sites. Natural England is in the process of running pilot schemes to provide a practical insight into the implications of the scheme, which is expected to go live spring 2023. The number of credits required to be purchased to obtain a 10% increase in BNG for each route option has been calculated and presented in Table 6.13 BNG habitat units required to be purchased to achieve 10% net gain (i.e. how many BNG units are required to offset the loss plus achieve a 10% net gain).

Habitat creation possibilities, other than unit purchase, to achieve a 10% BNG gain include:

On-site: Improve the existing habitats on-site through post construction remediation and replacement of low BNG value habitats with higher BNG value habitats

Off-site: Purchase suitable areas of off-site land within the local area and/or at a regional scale to offset BNG decrease by improving the existing habitats within the off-site land and/or by replacing existing habitats with higher BNG value habitats.

On-site and off-site: Improve existing habitats and/or replacement of low BNG value habitats with higher BNG value habitats as part of the catchment management options.

Table 6.13 BNG habitat units required to be purchased to achieve 10% net gain

Route option	BNG habitat unit purchase
Option B	362.15
Option B – NC Optimised	347.24
Option C	358.13
Option C – NC Optimised	341.74

6.9.3 Network Enhancement Zones

The Government's 25 Year Environment Plan includes provision for a Nature Recovery Network (NRN) and states that it will deliver on the recommendations of the Lawton Report[62] and that recovering wildlife will require more habitat; in better condition; in bigger patches that are more closely connected. As well as helping wildlife thrive, the NRN could be designed to bring a wide range of additional benefits: greater public enjoyment; pollination; carbon capture; water quality improvements and flood management.

Natural England have produced a series of habitat network maps[63] to help address the challenges outlined in the Lawton report and believe they should provide a useful baseline for the development of a NRN as required within the 25 Year Environment Plan and Local Nature Recovery Strategies as proposed within the Environment Bill. The maps have been created to provide a national overview of the distribution of habitat networks with suggestions for future action to enhance biodiversity, to help stimulate local engagement with partners and to agree

[62] Lawton, J.H., Brotherton, P.N.M., Brown, V.K., Elphick, C., Fitter, A.H., Forshaw, J., Haddow, R.W., Hilborne, S., Leafe, R.N., Mace, G.M., Southgate, M.P., Sutherland, W.A., Tew, T.E., Varley, J., & Wynne, G.R. (2010) Making Space for Nature: a review of England's wildlife sites and ecological network. Report to Defra

[63] Edwards J, Knight M, Taylor S & Crosher I. E (May 2020) 'Habitat Networks Maps, User Guidance v.2', Natural England

local priorities and identify where action might help build more ecologically resilient ecosystems across landscapes.

- **Habitat Creation/Restoration**: Areas where work is underway to either create or restore the primary habitat.
- **Restorable Habitat**: Areas of land, predominantly composed of existing semi-natural habitat where the primary habitat is present in a degraded or fragmented form and which are likely to be suitable for restoration.
- **Network Enhancement Zone 1**: Land connecting existing patches of primary and associated habitats which is likely to be suitable for creation of the primary habitat. Factors affecting suitability include proximity to primary habitat, land use (urban/rural), soil type, slope and proximity to coast. Action in this zone to expand and join up existing habitat patches and improve the connections between them can be targeted here.
- **Network Enhancement Zone 2**: Land connecting existing patches of primary and associated habitats which is less likely to be suitable for creation of the primary habitat. Action in this zone that improves the biodiversity value through land management changes and/or green infrastructure provision can be targeted here.
- **Fragmentation Action Zone**: Land within Enhancement Zone 1 that connects existing patches of primary and associated habitats which are currently highly fragmented and where fragmentation could be reduced by habitat creation. Action in this zone to address the most fragmented areas of habitat can be targeted here.
- **Network Expansion Zone**: Land beyond the Network Enhancement Zones with potential for expanding, linking/joining networks across the landscape i.e., conditions such as soils are potentially suitable for habitat creation for the specific habitat in addition to Enhancement Zone 1. Action in this zone to improve connections between existing habitat networks can be targeted here.

The NCA and BNG assessments consider the impacts of the route options on priority habitat, however there are opportunities for the SRO to support the NRN. For example, where pipeline is to be constructed within one of the identified habitat zones, reinstatement of land following construction could be linked to the priorities of that area such as habitat creation, restoration, or improvement. To provide an indication of the potential opportunity associated with each route option, the total area of Network Enhancement Zone 1, Network Enhancement Zone 2, Fragmentation Action Zone, and Network Expansion Zone located within each corridor and in proximity to each corridor (i.e. within 500m of the option corridor) has been summarised in Table 6.14 and Table 6.15 below. Both the proposed route and the route optimised to avoid impacts on natural capital are located within the corridor for each option. Therefore, the NRN areas have been summarised for the Option B corridor and Option C corridor (and surrounding 500m area), rather than summarised for each of the four route options.

Table 6.14 Area of Nature Recovery Network in proximity to Option B

Option Corridor	NRN Classification	Total NRN area located within, and in proximity to (500m), the option corridor (Ha)
Option B Corridor	Network Enhancement Zone 1	2893.82
	Network Enhancement Zone 2	3359.94
	Fragmentation Action Zone	339.56
	Network Expansion Zone	5356.93

Table 6.15 Area of Nature Recovery Network in proximity to Option C

Option Corridor	NRN Classification	Total NRN area located within, and in proximity to (500m), the option corridor (Ha)
Option C Corridor	Network Enhancement Zone 1	2505.14
	Network Enhancement Zone 2	2685.97
	Fragmentation Action Zone	284.39
	Network Expansion Zone	4926.16

6.10 Summary and next steps

The NCA, BNG and ecosystem services outputs identified the following:

NC: The SRO will cause the temporary and permanent loss of natural capital stocks. The SRO is likely to cause the permanent loss of ancient woodland that once lost cannot be replaced, and therefore, further SRO development could look towards re-iterating the design to avoid impacting these areas.

BNG: The SRO is likely to result in a loss of BNG habitat units due to the temporary and permanent loss of natural capital stocks during construction. Mitigation and enhancement opportunities for the SRO have been suggested in this section, which can work in tandem to reduce the loss of BNG and introduce net gain. These will be developed further during later stages of design.

Ecosystem services: The SRO presents opportunities to improve the existing habitats along the route through post construction remediation and replacement of low value habitats with higher value habitats. The potential permanent loss of ancient woodland could result in the permanent loss of several ecosystem services that the stock provides in synergy, including carbon sequestration, natural hazard management and water purification.

The Option B – NC Optimised route resulted in greater value retained for those ecosystem services scoped in for quantitative assessment. The Option B – NC Optimised route has also avoided the loss of ancient woodland and resulted in a reduction of biodiversity net loss when compared to the original routes. For later stages of design, the feasibility of the routes optimised for natural capital should be further investigated against engineering, environmental, social, and planning constraints, as well as against potential opportunity areas and proposals for environmental net gain.

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.

For later stages of design, the SRO should look to confirm and refine underlying data sources with on-site surveys to provide a more-detailed understanding of habitat condition. The SRO should also consider opportunities to create and improve habitat on-site and off-site through local schemes, NRNs and wildlife corridors in order to achieve a 10% net gain in BNG units and increase the provision of ecosystem services, therefore aiding in developing more resilient options for the future provision of water for T2ST.

7 Wider benefits

7.1 Introduction

This chapter summarises the wider benefits that are predicted to arise from implementing the T2ST SRO. Wider benefits are those areas of environmental and social value that are associated with constructing and operating the scheme. Areas of disbenefit are also considered.

The consideration of wider benefits draws on the findings of other assessment work to inform the Gate 2 submission, as well as introducing additional information where material in the context of the T2ST SRO.

The overall Best Value and solution benefits are presented in the Gate 2 Report.

7.2 Methodology

This section sets out the methodology for identifying and assessing wider benefits.

7.2.1 Six Capitals Framework

There is no specific methodology guiding wider benefits assessments for SROs. Approaches set out in WRMP Guidance[64] (on identifying benefits (both monetary and non-monetary) for customers, environment and society) and Ofwat's Public Value Principles[65] have influenced the methodology.The starting point for the assessment of wider benefits is the Six Capitals framework[66] (see Table 7.1), which is used by organisations, including UK water companies, as a framework for considering social, governance and environmental issues.

Table 7.1: Six Capitals Framework

Capital	Description
Financial	The pool of funds available for use in the production of goods or provision of services, obtained through financing or generated through operations or investments.
Human	People's competencies, capabilities and experiences, and their motivation to innovate.
Manufactured	Manufactured physical objects available to an organisation for use in the production of goods and services.
Intellectual	Organisational, knowledge-based intangible aspects such as intellectual property, systems and procedures.
Social	The institutions and relationships within and between communities, groups of stakeholders and other networks and the ability to share information to improve individual and collective wellbeing
Natural	The physical stocks of renewable and non-renewable resources that provides goods and services of value to society.

[64] Available online at: https://www.gov.uk/government/publications/water-resources-planning-guideline/water-resources-planning-guideline [accessed April 2022]

[65] Available online at: https://www.ofwat.gov.uk/about-us/our-strategy/ofwats-public-value-principles/ [accessed April 2022]

[66] Available online at: https://www.integratedreporting.org/resource/international-ir-framework/ [accessed April 2022]

7.2.2 Scoping of potential benefits

The Zone of Influence (ZoI) was defined as the area of receiving (i.e. experiencing a benefit or disbenefit) or providing (i.e. providing workforce) environment with the potential to be altered or changed as a result of the T2ST SRO. A review of the potential wider benefits that are relevant to the T2ST SRO was undertaken. Table sets out the findings of the review.

Table 7.2: Wider Benefits Scoping

Capital	Description	Applicability to T2ST SRO options	Scoped in to Wider Benefits
Financial	Economic benefits – Job creation	The T2ST SRO is expected to generate temporary and permanent employment opportunities. This will bring benefits through the supply chain.	Yes
Financial	Economic benefits – through capital expenditure		
Financial	Economic benefits – through supply chain		
Financial	Economic benefits – increase in tourism related to new recreation assets	The T2ST SRO would not build or enhance assets that could be used for tourism or recreation.	No
Financial	Financial asset value – some properties or premises may experience a change in value due to proximity to the SRO	The T2ST SRO is not likely to increase or decrease the value of property. The implications for businesses / landowners directly affected by the requirement for land are considered separately in the Cost analysis for Gate 2.	No
Social	Health and wellbeing – from access to recreation and / or open space	The T2ST SRO provides the opportunity to enhance recreation features such as Public Rights of Way.	Yes
Social	Education – opportunities to provide educational resource	The T2ST SRO would not provide additional educational resources.	No
Social	Social value – quality of life benefits associated with other economic benefits	The T2ST SRO could provide an opportunity to continue the deployment of apprenticeships.	Yes
Social	Partnerships – working collaboratively with other organisations	The T2ST SRO provides the opportunity to link with local organisations to deliver benefits, for example, implementing Biodiversity Net Gain initiatives.	Yes
Natural	Natural capital – any additional benefits in addition to the scope of the NCA	The ability of the T2ST SRO to contribute to other aspects of natural capital has been reviewed and no additional issues to the NCA have been identified.	No
Natural	Flood risk – any additional benefits derived from decreasing flood risk	The T2ST is not likely to affect wider flood risk management measures.	No

The scoping exercise identified that items applicable to financial, social and natural capital were relevant to the assessment, and that items relating to human, manufactured and intellectual capital were not specifically relevant. The items relating to natural capital are already covered and assessed and are therefore not duplicated here.

In summary, the key issues for the T2ST SRO are:

- Economic impacts deriving from employment and the benefits through the supply chain;
- Health and well-being benefits occurring from opportunities to enhance local footpaths / PRoW;
- Ongoing contribution to enabling apprenticeships; and
- Partnership strategy to work with local organisations.

The detailed methodology for assessing the wider benefits varies for each of these issues and the following section presents these details alongside the results.

7.3 Results

This section set out the findings from the assessment of wider benefits for employment impacts, health and well-being benefits and apprenticeships.

7.3.1 Employment Impacts

Employment impacts are expected to result in positive outcomes. The beneficiaries are those who are directly employed, as well as indirect and induced impacts on the local economy (goods and services). The number of potential employees is identified for both the construction and operation phases.

Employment impacts were calculated by applying standard data from the ONS on Gross Value Added (GVA) per worker at the UK level in the production sector, as this includes employment in the utilities and water industries the number of jobs estimated by the client. This gross figure was adjusted for additionality by applying deadweight and displacement. Leakage was considered to be zero as the study area for this analysis is too large for leakage to be likely. This data was adjusted to 2022 prices using Gross Domestic Product (GDP) deflators from HM Treasury. The GVA impact was then modelled over a 30-year appraisal period and the present value of this benefit was calculated using the standard HMT discount rate of 3.5% per annum. Indirect and induced employment impacts were calculated using a standard multiplier of 1.1 from the HCA (now Homes England) Additionality Guide[67]. GVA per worker data was then applied to the multiplier jobs and discounted.

For the construction of the either Option B or Option C, it is anticipated that up to approximately 1,200 full time equivalent staff would be employed at the peak of the five-year construction period. The construction jobs could generate positive economic impacts (direct, indirect and induced) of approximately £277 million. However, the assumption here is that construction jobs are likely to be fully displaced from elsewhere. The assumption is based on how construction jobs are supported, in that many construction firms, big and small, will move around between jobs and if they were not working on this, would likely be working on another project elsewhere. The water companies and any contractors would likely be working on other projects or maintenance if it were not for this project being delivered. This would mean that the jobs supported by the delivery of this project would otherwise be supported by another project. As this assessment looks at national level impacts, a conservative assumption that the jobs would not otherwise exist means this financial benefit is not likely to be able to be attributed to the T2ST SRO.

For the operational phase, it is anticipated that 50-60 full time equivalent staff would be employed. The operational jobs could generate positive economic impacts (direct, indirect and induced) of approximately £22 million. These jobs could be attributable to either one of the Option B or Option C of the T2ST SRO and therefore represent a benefit associated with the scheme.

[67] Homes and Communities Agency 'Additionality Guide'. Fourth Edition 2014. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/378177/additionality_guide_2014_full.pdf [accessed April 2022]

7.3.2 Health and Well-being

Health and well-being benefits, such as physical and mental health benefits, could accrue through enhancing opportunities for recreation by enhancing local footpaths / PRoW to enable access and exposure to greenspace. A Public Health England[68] review concluded that people who have greater exposure to greenspace have a range of more favourable physiological outcomes. Greener environments are also associated with better mental health and wellbeing outcomes including reduced levels of depression, anxiety, and fatigue, and enhanced quality of life for both children and adults.

Opportunities to enhance access to greenspace are most likely to occur in areas where construction activity is affecting existing PRoW. This is likely to benefit local people, although linkages to any national trails could have a wider benefit. No specific proposals have been incorporated into the scheme design at this stage, therefore benefits are qualitative. The benefits would accrue following construction activity. Examples of opportunities include:

- Opportunities to enhance nearby riparian vegetation and strengthen connections within the blue-green network.
- Opportunities to enhance nearby sections of the long distance footpaths in terms of planting, resurfacing, information boards, way markers and social enhancements.
- Opportunities to enhance landscape character and the character of views from PRoW through additional planting.

7.3.3 Apprenticeships

Both Thames Water and Southern Water have existing apprenticeship schemes to assist in introducing people to the workplace and develop skills through a variety of advanced, higher and degree level apprenticeships across a range of roles. As well as benefits to the individual employee, a skilled workforce contribute to increased Human capital of the organisation. The educational / training facility also benefits through running successful apprenticeship programmes (developing knowledge, skills of trainers) and the local employment and economic market also benefit. Although the apprenticeships are timebound for an individual, organisations such as water companies can provide long term career options as a wide range of roles at all levels are available. Water companies also partner with other organisations, such as contractors, and it is therefore likely that apprentices contribute to construction activities.

As the water companies run the apprenticeship schemes at a corporate level, rather than recruit for specific projects, it is not possible to assign particular numbers of apprentices to the T2ST SRO.

7.4 Summary of Main Findings

The main findings from a review of the wider benefits associated with the T2ST SRO options are as follows.

- Beneficial economic impacts associated with new operational phase jobs are expected to generate approximately £22 million (over the 30 year appraisal period).
- Proposals to enhance green infrastructure links and local footpaths could lead to health and well-being benefits. Further work to develop these opportunities and incorporate into the scheme design could be undertaken beyond Gate 2.

[68] Public Health England (March 2020): Improving access to greenspace- a new review for 2020 [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904439/Improving_access_to_greenspace_2020_review.pdf [accessed April 2022]

8 Carbon

8.1 Introduction

This section reviews and summarises the considerations for the T2ST options as to how whole life carbon has been reduced within the design and reviews the estimations of carbon costs and absolute operational and embodied carbon of the solution.

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

8.2 T2ST drive towards net zero

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

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

English water companies have made several Public Interest Commitments[69] (PIC) to demonstrate the broad value they deliver to society. One of these PICs included a commitment to be a net zero operational carbon sector by 2030. In 2020 the sector, through Water UK, released its net zero routemap[70], which laid out a range of decarbonisation options and pathways the sector could look to adopt to move towards net zero emissions and meet the 2030 commitment. Thames[71] and Southern Water[72] have both signed up to this commitment to achieve Net Zero carbon emissions from their operations by 2030. Thames Water have additionally made a commitment to go beyond net zero by 2040.

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

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

[69] Link to https://www.water.org.uk/publication/public-interest-commitment/ [accessed April 2022]

[70] Link to Water-UK-Net-Zero-2030-Routemap.pdf https://www.water.org.uk/routemap2030/wp-content/uploads/2020/11/Water-UK-Net-Zero-2030-Routemap.pdf [accessed April 2022]

[71] Link to https://www.thameswater.co.uk/about-us/responsibility/climate-change [accessed April 2022]

[72] Link to https://www.southernwater.co.uk/our-performance/carbon-emissions [accessed April 2022]

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 water sector net zero target follows a decarbonisation hierarchy that is based on good international practice – emissions have to be reduced as much as possible first before any sequestration options are considered. The water sector routemap provides further details on the decarbonisation hierarchy.

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

Figure 8.1: Emissions reduction hierarchy

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

8.3 Estimations of carbon costs

Table 8.1 summarises the carbon impacts of the T2ST options.

Full details of the carbon values are reported in the RAPID Gate 2 Annex A3: Cost and Carbon Report.

All carbon estimates have been prepared in accordance with industry standard methodologies, data and modelling. The monetised whole life carbon cost estimates have used the most recent carbon value figures published in the BEIS Green Book supplementary guidance (October 2021) together with the discount rates recommended in the Green Book for the 80 year appraisal period.

Table 8.1 highlights that the majority of the capital (embedded) carbon and operational carbon emissions sit within the construction and pumping associated with the transfer pipelines.

Table 8.1: Summary of the estimated capital and operational carbon impacts of the T2ST transfer options

Option	Capacity (Ml/d)	Capital Carbon (tCO2e)	Operational Carbon (tCO2e)	Whole Life Carbon (tCO2e)	Monetised Whole Life Carbon (£M)
B	50	62,400	1,083	154,100	28
	80	101,400	1,766	245,700	46
	120	130,800	2,635	340,500	62
C	50	67,000	1,049	156,200	29
	80	102,700	1,706	242,400	45
	120	129,500	2,580	334,700	61

The results show that the estimated carbon capital and operational carbon impacts for the T2ST transfer options B and C are relatively similar. The estimated capital carbon (tCO2e) required for the 80Ml/d and 120Ml/d options are similar for both transfer options B and C, although the 50Ml/d option is somewhat higher for Option C. Operational carbon is similar for both route options, but higher for Option B than Option C. Whole life carbon and the monetised carbon values are also similar for both route options, with the 50Ml/d option being higher for Option C, and the 80 Ml/d and 120Ml/d options being higher for Option B. The cost base for the monetised whole life carbon estimates is 2020.

8.4 Methodology

The decarbonisation considerations suggested take into consideration the minimum scope of the net zero PIC but also align to the carbon consideration requirements under EA Water Resource Planning guidelines. The latest consultation response[73] states that updated guidance will:

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

This section includes broad considerations the T2ST options could take to mitigate:

- Capital carbon emissions; and
- Operational carbon emissions.

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

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

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

[73] Link to https://www.gov.uk/government/consultations/water-resources-planning-guideline-proposed-update/outcome/water-resource-planning-guideline-consultation-response-summary [accessed April 2022]

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

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

8.5 Assumptions and limitations

It is too early in the design to be definitive about materials use in the T2ST SRO. At this stage, use of ductile iron has been assumed for pricing as this is a standard industry product. However, alternative materials are available such as steel pipe and HDPE.

A detailed assessment will be required to select the pipe material, which will consider carbon assessment of pipe material, associated construction method and an economic assessment of the material.

8.6 Decarbonisation considerations

Decarbonisation considerations that T2ST transfer options could take to decarbonise and drive towards net zero include:

- Material specification and procurement
- Efficient construction approaches and construction waste minimisation
- Low carbon construction plant
- Optimising energy efficiency and maintenance activities
- Low carbon power generation and decarbonised electricity procurement choices
- Residual emissions

8.6.1 Material specification and procurement

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

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

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

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

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

Specify lower carbon materials and products

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

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

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

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

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

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

8.6.2 Efficient construction approaches and construction waste minimisation

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

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

8.6.3 Low carbon construction plant

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

- Biomethane;
- Hydrogen; and
- Electric.

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

8.6.4 Optimising energy efficiency and maintenance activities

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

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

8.6.5 Low carbon power generation and decarbonised electricity procurement choices

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

- **Opportunities for renewable generation:** To mitigate the impact of the significant power consumption the scheme could look to generate all or a proportion of the power demand through renewables onsite. Alternatively, the scheme could look for commercial arrangements to procure green power through a direct wire Power Purchase Agreement (PPA). This would reduce the carbon impact of the associated power consumption with the site from the grid average value to zero.
- **Procurement of green tariff electricity:** A more immediate decision could be made to procure all power associated with the site through REGO backed green energy tariffs. This would reduce the generation impact of grid power from the grid average to zero but would still incur the associated transmission and distribution losses associated with grid supply. There are currently plenty of green tariffs available on the market and the price premium for these is relatively small currently, however, this may change over time as the competition for REGO backed green electricity increases.

Additionally, consideration of grid carbon intensity at the point the scheme is due to come on-line should also be considered. The recent trend of UK grid carbon intensity shows significant reduction in the carbon intensity of power generation. BEIS grid carbon intensity forecasts[74]

[74] Table 1 (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/793632/data-tables-1-19.xlsx) [accessed April 2022]

show an expectation for the UK grid to continue to significantly decarbonise over the coming years (up to 70% by 2030). This will reduce the carbon impact of the power demand associated with the treatment plant and also potential carbon/cost benefit assessments associated with renewable generation schemes. However, self-generation schemes can support this national decarbonisation and also potentially boost the resilience of schemes too.

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

8.6.6 Residual emissions

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

Natural sequestration improvements

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

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

Export of renewable energy

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

8.7 T2ST specific considerations

As part of the Gate 2 design of the T2ST options, whole life carbon has been considered as a best value planning measure. Carbon reduction has been intrinsically applied to the design by minimising construction works by limiting the size of the SRO in order to meet forecast demand, phasing of construction of the new WTW at the intake location, and routing of the pipeline to keep as short and shallow as possible to minimise materials and avoiding environmental designations.

Sweetening flows during non-drought periods will be minimised to reduce energy use.

There may be scope to include a hydropower turbine in the pipeline to generate electricity.

Options for solar and wind power will be considered as the design develops at the new WTW at the intake location, and at the other above ground asset locations.

A carbon monitoring programme should be developed at the appropriate stage of the SRO. This would include a programme for monitoring and reporting on project emissions during and post project completion.

8.8 Summary and next steps

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

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

The key recommendations therefore are:

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

9 Conclusion and Recommendations

9.1 Conclusion

During Gate 2, the studies undertaken in Gate 1 have been reviewed and updated, following the selection of two preferred options. Option B and C are similar in their location, which results in their impacts on receptors also being similar, with the key differences between them being the following:

- Option B affects Cliffeville authorised landfill and an additional scheduled monument, which is not affected by Option C;
- Option C affects Bere Mill Meadows SSSI, which is not affected by Option B, and is in close proximity (within 15m) to a greater number of Ancient Woodlands than Option B; and
- Option C requires an additional crossing of the River Test SSSI.

In applying the environmental assessments to the route corridors and sites comprising the options, a number of constraints and issues for further investigation and work were identified. However, the assessments did not identify any significant environmental risks where mitigation could not be provided and the viability of the T2ST scheme would be affected.

Constraints and issues identified include the potential for impacts on sensitive habitats, including several SSSI (some of which are also GWDTE), SAC and LWS and some priority habitats and species. The proposed pipeline intersects Source Protection Zones, including five SPZ1s. There is an opportunity to move the indicative location of the new WTW at the intake location to just outside Flood Zone 2 and 3. Temporary construction activity and intermittent operational activity is likely to affect tranquillity within the North Wessex Downs AONB which is noted for its quiet rural character from views. It is expected that, during construction, the temporary diversion or closure of several footpaths and cycleways, would temporarily reduce recreational connectivity.

In terms of historic environment, the impacts of the options are minor and temporary, mainly affecting conservation areas and non-designated assets, although one Scheduled Monument has the potential to be temporarily impacted. The setting of several Grade II listed buildings could also be affected. The options avoid the requirement for land affecting residential property, business premises and community facilities. There may be some temporary impacts on the amenity of those close to construction activity and from temporary disturbance to Public Rights of Way. The options also involve crossings of transport and utility infrastructure, as well as historic landfills and one active landfill (Option B only).

The results from other assessments have also fed into the environmental appraisal.

An informal HRA and Stage 2 Appropriate Assessment has been undertaken (Annex B2) which identified that with appropriate mitigation, no adverse effects to site integrity are likely to result from the implementation of either Option B or Option C, and any residual effects are considered negligible.

The Water Framework Directive Assessment (Annex B3), undertaken at plan level, finds that if mitigation measures set out in Annex B3 are incorporated into the design and construction that no adverse, permanent impacts on the water environment will occur as a result of the implementation of either of the options of the T2ST scheme.

The Strategic Environmental Assessment (Annex B4) concluded that both the options have similar effects and score the same for each of the SEA objectives. During construction, moderate negative residual effects were identified for biodiversity, flora and fauna as a result of

the options intersecting international (Natura 2000 sites) and nationally designated sites, and potential impacts on priority habitats and Ancient Woodland. The SEA also identified minor negative residual effects for landscape during construction and operation due to impacts on the North Wessex Downs AONB, minor negative residual effects for soil during construction due to proximity to landfill sites, and minor negative residual effects for material assets (built assets and infrastructure) during construction due to crossing of highways and railways during construction. Major positive residual effects during operation were identified for the SEA objective on delivering reliable and resilient water supplies given the options improve the transfer of water across regions.

An Invasive Non-Native Species risk assessment identified that the risks of the options were the same. The proposed transfers will introduce a new hydrological connection between previously isolated catchments. The SRO involves the transfer of treated water from a WTW to an enclosed WSR. At no point during the normal operation of the transfer will raw or treated water be discharged to an open waterbody. Therefore, there is no risk of INNS introduction to the receptor catchment. Biosecurity measures have already been incorporated into aspects of the design and this will need to continue as the design develops.

The NCA identified that the options will likely cause the temporary and permanent loss of natural capital stocks during construction. Stocks that are likely to be permanently lost include arable land, pasture, other semi-natural grassland, and active floodplain. However, best practice mitigation (such as pipejack or micro tunnel crossings) and reinstatement/compensation of habitat means that most Natural Capital stocks post construction will have no to little change. The NCA has identified that pipeline routes through the route corridors exist that avoid the majority of impacts on ancient woodland.

The assessment of BNG calculates that in the range 240-260 BNG habitat units would be lost due to the temporary removal of habitats during construction.

The routes present an opportunity to improve the existing habitats through post construction remediation and replacement of low value habitats with higher value habitats. The route option crosses several priority habitats, Network Enhancement Zones, Fragmentation Action Zones, and Network Expansion Zones and is therefore suitable for the planting of new high value habitats.

The wider benefits that are predicted to arise from implementing the T2ST SRO options have been reviewed and areas of disbenefit are also considered. The wider benefits are those areas of environmental and social value that are associated with constructing and operating the scheme. Beneficial economic impacts associated with new operational phase jobs are expected to generate approximately £22 million (over the 30 year appraisal period). Proposals to enhance green infrastructure links and local footpaths could lead to health and well-being benefits.

Reducing whole life carbon is an important aspiration and opportunities have been investigated. The estimations of carbon costs show that the estimated carbon capital and operational carbon impacts for the T2ST transfer options B and C are relatively similar. The estimated capital carbon (tCO2e) required for the 80Ml/d and 120Ml/d options are similar for both transfer options B and C, although the 50Ml/d option is somewhat higher for Option C. Operational carbon is similar for both route options, but higher for Option B than Option C. Whole life carbon and the monetised carbon values are also similar for both route options, with the 50Ml/d option being higher for Option C, and the 80 Ml/d and 120Ml/d options being higher for Option B. The cost base for the monetised whole life carbon estimates is 2020. Some considerations have been identified that the T2ST transfer options could take to decarbonise and drive towards net zero. An important part of turning some of the considerations into deliverable opportunities is to have a robust carbon management process embedded into the scheme development.

Overall, there are a number of issues that have been identified that can feed into the ongoing design and a number of mitigation measures and management plans that need to be developed to avoid and reduce predicted impacts. Potential high risk issues identified at this stage include the crossing of an active landfill site in Option B (Cliffeville landfill), potential impacts on SSSI GWDTE (both options, but an additional one for Option C) and loss of ancient woodland (both options, but higher risk in Option C). However, no significant environmental issues have been identified at this stage.

9.2 Recommended activities beyond Gate 2

The activities beyond Gate 2 will be influenced by the programme for implementing the SRO. As the environmental and social landscape is subject to change, there are some activities that would not be worthwhile carrying out until closer to the commencement of the formal consenting process. However, activities that could be prioritised include:

- Specific work on routing and siting, particularly focusing on the location of above ground assets (e.g. to avoid Flood Zones) and pipeline routing to avoid priority habitats and ancient woodland.
- Informing the design, to integrate biosecurity measures and deal with climate change risks.
- Further work to identify impacts to Source Protection Zones, for example undertaking a hydrological risk assessment to identify risks and likely mitigation.
- Further work to minimise impacts on the North Wessex Downs AONB, particularly identifying areas with high or low landscape value.
- Where the environment is unlikely to change significantly, for example historic environment and cultural heritage, further work to investigate risks and impacts to the setting of affected features could be undertaken.
- Undertake optioneering on delivering biodiversity net gain, including identifying specific locations for opportunities and investigating the merits of the timing of interventions.
- Scope and undertake walk-over surveys of hot-spots in order to investigate impacts to habitats, and the qualifying features of designated sites and inform scheme design and detailed mitigation.
- Investigate mitigation and enhancement options for irreplaceable habitats such as Ancient Woodland.
- Investigate the feasibility of the routes optimised for natural capital against engineering, environmental, social, and planning constraints, as well as against potential opportunity areas and proposals for environmental net gain.
- Consider opportunities to create and improve habitat on-site and off-site through local schemes, NRNs and wildlife corridors in order to achieve a 10% net gain in BNG units and increase the provision of ecosystem services, therefore aiding in developing more resilient options for the future provision of water for T2ST.

A. INNS records

Table 9.1: INNS functional groups

Animals	Plants
Mobile, juveniles < 1mm, eggs	Seed, aquatic, annual
Sessile, juveniles < 1mm, eggs	Vegetative, aquatic, annual
Mobile, juveniles > 1mm, eggs	Seed + vegetative, aquatic, annual
Sessile, juveniles > 1mm, eggs	Seed, riparian, annual
Mobile, juveniles < 1mm, no eggs	Vegetative, riparian, annual
Sessile, juveniles < 1mm, no eggs	Seed + vegetative, riparian, annual
Mobile, juveniles > 1mm, no eggs	Seed, aquatic, perennial
Sessile, juveniles > 1mm, no eggs	Vegetative, aquatic, perennial
	Seed + vegetative, aquatic, perennial
	Seed, riparian, perennial
	Vegetative, riparian, perennial
	Seed + vegetative, riparian, perennial
	Seed, aquatic + riparian, annual
	Vegetative, aquatic + riparian, annual
	Seed + vegetative, aquatic + riparian, annual
	Seed, aquatic + riparian, perennial
	Vegetative, aquatic + riparian, perennial
	Seed + vegetative, aquatic + riparian, perennial

Table 9.2: Invasive non-native fish species identified in EA (✓) and NBN Atlas (✓) records within 1km of the transfer routes

Common name	Scientific name	Functional group	Non-native status	Option B	Option C
Common carp	*Cyprinus carpio*	Mobile, juvenile >1mm, eggs	UKTAG – High[75]	✓ ✓	✓
Rainbow trout	*Oncorhynchus mykiss*	Mobile, juvenile >1mm, eggs	UKTAG – Low	✓ ✓	✓ ✓

Table 9.3: Invasive non-native macroinvertebrate species identified in EA (✓) and NBN Atlas (✓) records within 1km of the transfer routes

Common name	Scientific name	Functional group	Non-native status	Option B	Option C
Bladder snail	*Physella acuta*	Mobile, juvenile <1mm, no eggs	UKTAG - Unknown	✓	✓
Caspian mud shrimp	*Chelicorophium curvispinum*	Mobile, juvenile >1mm, no eggs	UKTAG – Unknown	✓	✓
Jenkins spire snail	*Potamopyrgus antipodarum*	Mobile, juvenile <1mm, no eggs	UKTAG – Moderate	✓ ✓	✓ ✓

[75] WFD-UKTAG listed INNS, categorised as High / Medium / Low / Unknown Impact

Common name	Scientific name	Functional group	Non-native status	Option B	Option C
Northern river / Florida crangonyctid	*Crangonyx pseudogracilis/floridanus*	Mobile, juvenile >1mm, no eggs	UKTAG – Unknown	✓	✓
Signal crayfish	*Pacifastacus leniusculus*	Mobile, juvenile >1mm, no eggs	UKTAG – High WACA 1981 Sch. 9[76] EU species of special concern[77] IAS Order 2019 Sch. 2[78]	✓ ✓	✓ ✓
Wautier's limpet	*Ferrissia wautieri*	Sessile, juvenile <1mm, eggs	UKTAG - Unknown		✓

Table 9.4: Invasive non-native aquatic plant species identified in EA (✓) and NBN Atlas (✓) records within 1km of the transfer routes

Common name	Scientific name	Functional group	Non-native status	Option B	Option C
Canadian pondweed	*Elodea canadensis*	Vegetative, aquatic, perennial	UKTAG – High WACA 1981 Sch. 9	✓	✓ ✓
Giant rhubarb	*Gunnera spp.*		UKTAG – High	✓	✓
Himalayan balsam	*Impatiens glandulifera*	Seed, riparian, annual	UKTAG - High EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch. 2	✓ ✓	✓ ✓
Least duckweed	*Lemna minuta*	Vegetative, aquatic, perennial	UKTAG – unknown	✓	✓
Monkeyflower	*Mimulus guttatus*		UKTAG - unknown	✓	✓
Nuttall's pondweed	*Elodea nuttallii*	Vegetative, aquatic, perennial	UKTAG – High EU species of special concern WACA 1981 Sch. 9 IAS Order 2019 Sch. 2	✓	✓
Orange balsam	*Impatiens capensis*	Seed, riparian, annual	UKTAG – Low	✓ ✓	✓ ✓
Water fern	*Azolla filiculoides*	Seed + vegetative, aquatic, perennial	UKTAG – High impact WACA 1981 Sch. 9	✓	✓ ✓

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

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

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

B. Natural Capital Assessment and Biodiversity Net Gain Tables

Broad Natural Group	Subgroup	Mapping Methodology
Freshwater	Active flood plain	Areas at high or medium risks within the Environment Agency (EA)'s Risk of Flooding from Rivers and Sea dataset.
	Blanket Bog	Area of blanket bog mapped using Natural England's Priority Habitat Inventory.
	Chalk Rivers*	Mapped using the EA chalk rivers dataset and mapping intersections with OS watercourse polygons
	Coastal and floodplain grazing marsh	Area of coastal floodplain and grazing marsh mapped using Natural England's Priority Habitat Inventory
	Lakes and standing waters	Area of lakes and reservoirs mapped using the Centre for Ecology and Hydrology (CEH)'s UK Lakes Portal dataset.
	Lowland Fens	Area of lowland fens mapped using Natural England's Priority Habitat Inventory.
	Lowland raised bog	Area of lowland raised bog mapped using Natural England's Priority Habitat Inventory
	Modified waters e.g. reservoirs	Area of reservoirs mapped by selecting Ordnance Survey (OS) surface water polygons (VectorMap District) that coincide with CEH's Inventory of UK reservoirs (points).
	Other semi-natural habitats	Area of other semi-natural habitat mapped using Natural England's Priority Habitat Inventory (including upland and lowland grasslands, heathland and saltmarsh).
	Ponds and ditches	Mapped by selecting surface waterbodies (from OS VectorMap District) that do not intersect rivers, are smaller than 2ha in size.
	Reedbeds	Area of reedbed habitat mapped using NE's Priority Habitat Inventory
	Rivers	Length of rivers mapped using EA's Water Framework Directive (WFD) river waterbodies dataset (cycle 1, to include coastal streams
Mountain, Moor and Heath	Blanket bog	Area of blanket bog mapped using Natural England's Priority Habitat Inventory.
	Dwarf shrub heath	Mapped using Natural England's Priority Habitat Inventory ('fragmented heath', 'lowland heathland' and 'upland heathland')
	Inland rock, scree and pavement (AML*)	Area of inland rock and limestone pavement above the moorland line, mapped using CEH's LCM2015 ('inland rock'), Natural England's Priority Habitats Inventory ('limestone pavement') and the Rural Payment Agency (RPA)'s Moorland Line dataset.
	Lakes and Reservoirs	Area of lakes and reservoirs above the moorland line, mapped using CEH's UK Lakes dataset, CEH's Inventory of UK reservoirs dataset and RPA's Moorland Line dataset.
	Mountain heath and willow scrub	Area of mountain heath and willow scrub mapped using Natural England's Priority Habitat Inventory.
	Rivers (AML)	Length of rivers mapped using EA's WFD river waterbodies dataset and RPA's Moorland Line dataset.
	Semi-natural grassland (AML*)	Area of semi-natural grassland above the moorland line, mapped using Natural England's Priority Habitat Inventory and RPA's moorland line dataset.

Broad Natural Group	Subgroup	Mapping Methodology
	Upland flushes fens and swamps	Area of upland flushes, fens and swamps, mapped using Natural England's Priority Habitat Inventory.
	Wood pasture (AML*)	Area of wood pasture above the moorland line, mapped using Natural England's provisional Wood-Pasture and Parkland BAP Priority Habitat Inventory and RPA's Moorland line dataset.
	Woodland (AML*)	Area of woodland above the moorland line, mapped using FC's National Forest Inventory and RPA's moorland line dataset.
Urban	Blue space	Mapped by intersecting OS VectorMap District Surface Water with the Office for National Statistic (ONS)'s Built-Up areas dataset.
	Green space - not semi-natural	Area of urban green space (not semi-natural), mapped using the OS Open Greenspace Layer.
	Open mosaic habitats	Area of open mosaic habitats on previously developed land, mapped using Natural England's draft Open Mosaic Habitat dataset
	Woodland, scrub and hedge	While urban scrub and hedge are difficult to map at a national scale, the area of urban woodland is mapped here by intersecting FC's National Forest Inventory with ONS Built-Up Areas.
	Semi-natural habitats	Mapped by intersecting Natural England's Priority Habitat Inventory habitats (excluding woodland, good quality semi-improved grassland and traditional orchards) with ONS Built-Up Areas
Farmland	Arable and rotational leys	Area of arable and rotational leys, and horticulture individually, this map shows the area of arable and horticulture combined. Mapped using UK Land Cover 2018 Sub Classes.
	Horticulture	Area of arable and rotational leys, and horticulture individually, this map shows the area of arable and horticulture combined. Mapped using CEH's Land Cover Map 2015 (LCM2015).
	Improved grassland	Area of improved grassland mapped using CEH's LCM2015.
	Orchards and top fruit	Area of orchards and top fruit mapped using Natural England's Priority Habitat Inventory ('traditional orchards')
Woodland	Ancient Woodland	Mapped using Natural England's Ancient Woodland dataset.
	Broadleaved, mixed and yew woodland	Mapped using FC's National Forest Inventory.
	Coniferous woodland	Area of coniferous woodland mapped using FC's National Forest Inventory
	Woodland priority habitats	Mapped using Natural England's Priority Habitat Inventory ('deciduous woodland').
Grasslands	Hay meadows	Area of hay meadow mapped using Natural England's Priority Habitat Inventory ('upland meadow' and 'lowland meadow').
	Other semi-natural grasslands	Area of other semi-natural grassland, mapped using Natural England's Priority Habitat Inventory ('upland calcareous', 'lowland calcareous', 'lowland dry acid', 'good quality semi-improved', 'grass moorland' and 'purple moor grass and rush pasture').
Coastal	Beach	Area of beach mapped using OS VectorMap District ('foreshore'). Note that this dataset includes areas of intertidal sediment as well as beaches.
	Coastal lagoons	Area of coastal lagoons mapped using Natural England's Priority Habitat Inventory ('saline lagoons').

Broad Natural Group	Subgroup	Mapping Methodology
	Mudflats	Area of intertidal mudflats mapped using the EMODnet (Natural England) Intertidal Mudflats dataset.
	Salt marsh	Area of saltmarsh mapped using EA's Saltmarsh Extent dataset.
	Sand dunes	Area of sand dunes mapped using Natural England's Priority Habitat Inventory ('coastal dunes')
	Sea Cliff	Area of sea cliff habitat mapped using Natural England's Priority Habitat Inventory ('maritime cliff and slopes').
	Shingle	Area of shingle mapped using Natural England's Priority Habitat Inventory ('coastal vegetated shingle').
Marine	Intertidal rock	Area of intertidal rock mapped using Natural England's Open Marine Evidence Base (EUNIS code A1).
	Maerl beds	Area of maerl beds mapped using Natural England's Open Marine Evidence Base (EUNIS code A5.51).
	Reefs	Area of potential reefs mapped using JNCC's Potential Annex 1 Reefs
	Sea grass beds	Area of seagrass beds mapped using Natural England's Open Marine Evidence Base (EUNIS code A2.61)
	Shallow subtidal sediment	Area of shallow subtidal sediment mapped using JNCC's UKSea Map 2018 (biozone = shallow ircalittoral or infralittoral and substrate = sediment, sand or mud).
	Shelf subtidal sediment	Area of shelf subtidal sediment mapped using JNCC's UKSea Map 2018 (biozone = deep circalittoral and substrate = sediment, sand or mud).
	Subtidal rock	Area of subtidal rock mapped using JNCC's UKSea Map 2018 (substrate = rock).
Soils	Nutrient Status of Soil	Mean estimates of total nitrogen concentration in topsoil (0-15cm depth) - % dry weight of soil, mapped using data produced from Natural England and CEH's 'Mapping Natural Capital' project (2016).
	Soil Carbon/Organic Matter	Mean estimates of carbon density in topsoil (0-15cm depth) – tonnes per hectare, mapped using data produced from Natural England and CEH's 'Mapping Natural Capital' project (2016)
	Soil Biota	Mean estimates of total abundance of invertebrates in topsoil (0-8 cm depth), mapped using data produced from Natural England and CEH's 'Mapping Natural Capital' project (2016)
Indicators of condition	Natural Aquifer Function	Area of groundwater catchment with 'good' quantitative status for WFD 2016, mapped using EA's WFD data and groundwater catchment boundaries (C2).
	Naturalness of Flow Regime	The WFD hydrological regime classification describe the naturalness of river flows. This map shows the length of river with 'high' WFD hydrological status in 2016, mapped using EA's WFD data and river water bodies (C2)
	Lack of Physical Modifications of Water Bodies	Lack of physical modification of rivers, mapped using EA's Reasons for Not Achieving Good Status data (SWMI = 'physical modification'), 2013-2016.
	Presence and Frequency of Pollinator Food Plants	Mean estimates of number of nectar plant species for bees per 2x2m plot, mapped using data produced from Natural England and CEH's 'Mapping Natural Capital' project (2016)
	Chemical status of water bodies	River chemical status for WFD 2016, mapped using EA's WFD data and river water bodies (C2)