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Thames to Southern Transfer (T2ST) SRO

Concept Design Report

Thames Water

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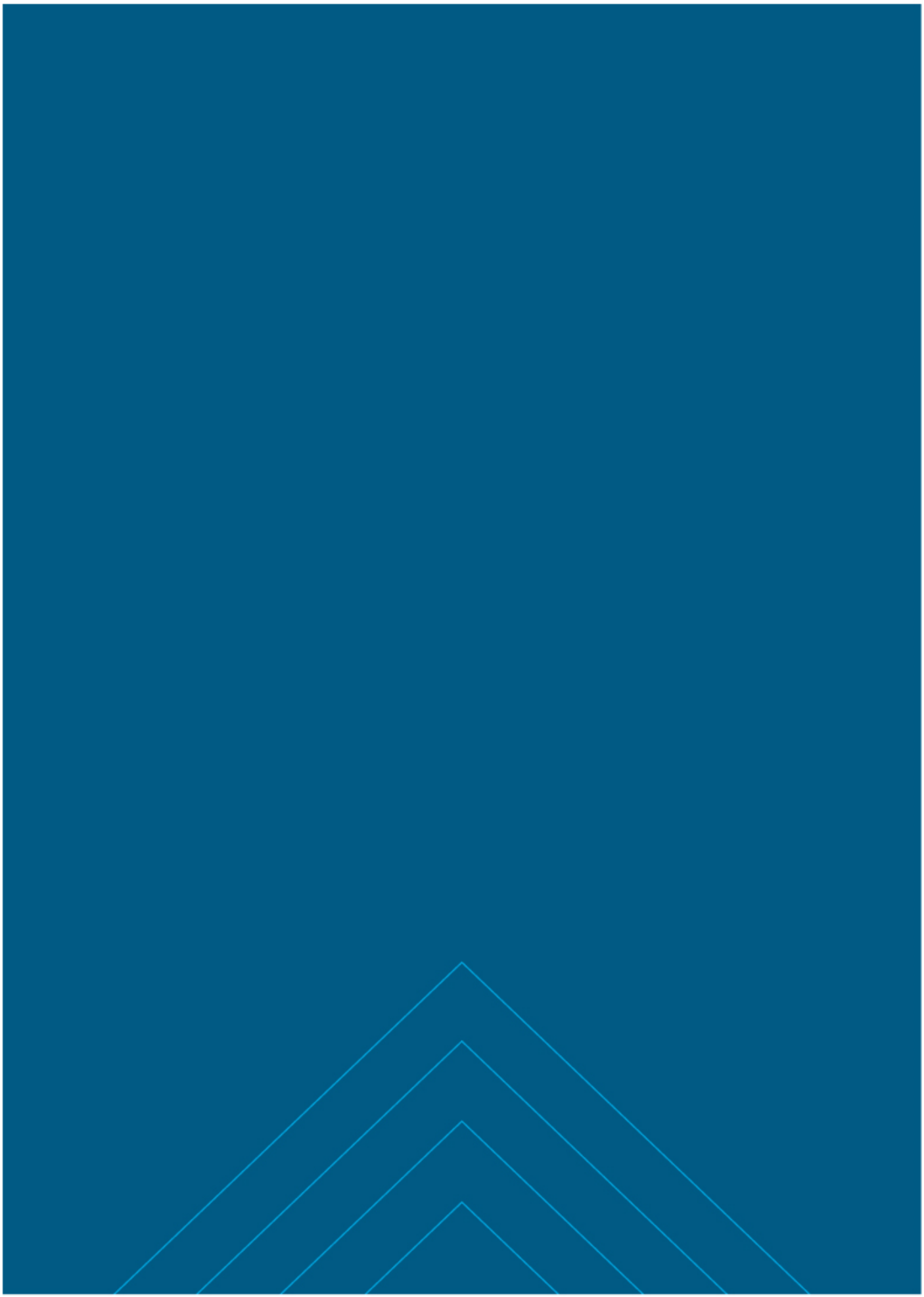


Executive Summary

Scheme overview

The Thames to Southern Transfer (T2ST) option has been identified as a Strategic Regional Water Resource Option (SRO) in the PR19 Final Determination, with funding allocated between Thames Water (TW) and Southern Water (SRN).

The SROs need to progress through a formal gate process of review and approval, with Gate 1 in July 2021.

This draft Gate 1 report details the findings of the work completed to date and will be updated to take into account stakeholder comments for the final Gate 1 submission.

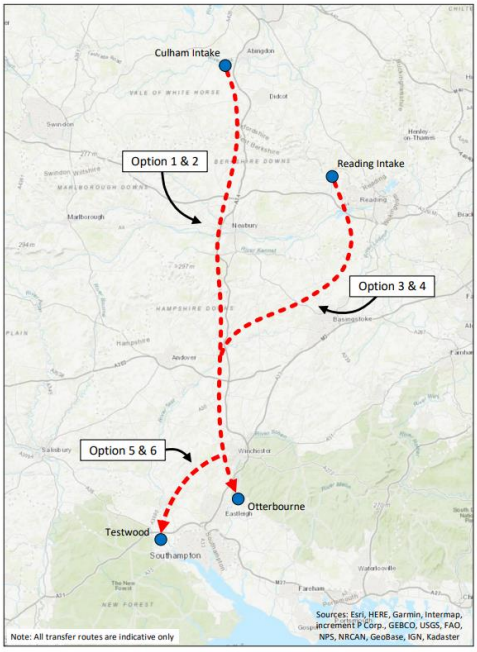
The aim of the T2ST study is to investigate options for transferring available water from the Severn Thames Transfer (STT) and/or SESRO from the Thames Water SWOX water resource zone to Southern Water's Hampshire area, and to identify a recommended option for the Gate 1 submission in July 2021. T2ST is dependent on the prior development and commissioning of a water resource option to provide additional water in the River Thames (STT or SESRO). T2ST is therefore unlikely to be available until the mid to late 2030s but provides a long-term resilience option for the region and potential key link in the regional grid.

T2ST Options

As a result of the Option Appraisal Stage for T2ST completed in December 2020, 6No. constrained options were identified to take forward into the concept design stage as follows.

- Option 1: Culham to Otterbourne - potable water transfer
- Option 2: Culham to Otterbourne - raw water transfer
- Option 3: Reading to Otterbourne - raw water transfer
- Option 4: Reading to Otterbourne - potable water transfer
- Option 5: Culham to Testwood - raw water transfer
- Option 6: Reading to Testwood - raw water transfer

Key Plan, T2ST constrained options (Options 1-6).



Through discussion and agreement with the T2ST PMB and WRSE, 50Ml/d, 80Ml/d and 120Ml/d scheme capacities have been considered for each of the 6No. constrained options. This is considered to be an appropriate range of scheme capacities for Gate 1 to inform the WRSE regional plan modelling. Dependent on the outcome of the WRSE modelling, it is however possible that a wider range of scheme capacities for T2ST

may need to be developed in Gate 2. To support this need Thames and Southern Water have agreed for a 200Ml/d T2ST option to be included in the WRSE modelling and further support to WRSE will be provided as required.

For Gate 1 it has also been agreed with SRN that 10Ml/d spur connections from the T2ST pipeline should be included to supply the Kingsclere and Andover Water resource zones in Hampshire for all T2ST options. These connections have been sized on the basis that projected resource deficit within the combined Kingsclere and Andover zones in the 2080s is likely to be circa 20Ml/d. In Gate 2 the size of the spur connections to Andover and Kingsclere will need to be reviewed against the output of WRSE modelling and the latest SRN strategic water resource planning position for the Hampshire region.

TW have also identified a potential spur connection from the T2ST pipeline to provide support to the Kennet Valley Water Resource Zone. This spur connection has not been considered at this stage of the T2ST SRO for Gate 1 but may be a requirement in Gate 2 depending on the outcome of WRSE modelling and TW strategic planning for WRMP24.

South East Water (SEW) and WRSE have developed an option for a spur connection from the T2ST transfer main to supply Northgate SR to the south of Basingstoke, at 10Ml/d and 20Ml/d capacity. Whilst this option has been identified and modelled by WRSE the offtake has not currently been included as part of the T2ST SRO. Hence no consideration of this spur has been included as part of the T2ST concept design for Gate 1. Depending on the outcome of the WRSE modelling further work on this option may be required for inclusion in the T2ST scope for Gate 2.

Scheme Delivery

The delivery of T2ST is dependent on whether a robust project need case can be established. To enable the scheme to progress beyond Gate 2 and obtain planning consent, the capacity and timing of the transfer must be fully supported by both the WRSE regional plan and TW and SRN strategic planning for WRMP24.

Hence it would not be appropriate to apply for DCO consent for T2ST until the outcome of both the WRSE regional plan and WRMP24 is published. The WRSE regional plan will be published in late 2023. WRMP24 may also be finalised and published by late 2023, but dependent on whether the company plans are subject to enquiry in which case publication may not occur until March 2025.

At this early stage of the SRO development it has been assumed that an application for DCO consent could not be submitted until the later date of March 2025 following publication of both the WRSE regional plan and WRMP24. It is further assumed that both WRSE and WRMP24 will fully support the T2ST transfer allowing the formal planning consent process to begin. Without support from WRSE and WRMP24 planning work for the T2ST transfer would be placed on hold and the need for the transfer considered again as part of the next planning round for WRMP29.

On the assumption that a clear need for the scheme is provided by WRSE and WRMP24 two programme scenarios has been considered for scheme delivery; Scenario 1 assuming no water resources constraints apply to determine the earliest possible date for commissioning of T2ST and Scenario 2, on the assumption that T2ST construction would be delayed until water from SESRO is available to commission the T2ST scheme. Due to the existing uncertainties around the outcomes of both WRSE and WRMP24 it is not possible to have any certainty over the final scheme delivery plan for T2ST. Under Scenario 1 the preliminary programme indicates an earliest completion date of 2034 for T2ST, and between 2036-2037 for Scenario 2 for the constrained SESRO programme**.** In practice T2ST will either be supplied by STT or SESRO. Provisional programming for STT suggests that this scheme could be available by 2033, in which case T2ST could potentially be commissioned in 2034.

T2ST Preferred Option

The concept design of the 6No. identified options for T2ST has been developed and set out within Section 2 of this report. It is however too early within the scheme development to rule any of the options out at this stage prior to Gate 1. Further development of the options will be required following Gate 1, taking into account output from the WRSE regional plan and ongoing WRMP24 strategic planning, to establish a preferred T2ST option for submission at Gate 2 in October 2022. Key areas for further option development in Gate 2 are set out as follows:

1. T2ST Utilisation

   The utilisation of the T2ST is dependent on the outcome of the WRSE regional modelling. At this stage it is expected that the transfer would only be required in periods of extreme drought but increased utilisation

	of the transfer may be required to meet longer term supply demand balance of the Hampshire region depending on the implementation and timing of other schemes and future environmental ambition targets.
2. Potable or raw water transfer	At this stage of the SRO development, potable water transfers for T2ST (Options 1 and 4) have a number of identified advantages over raw water transfers, including greater resilience for the Kennet Valley area (with water treatment located within the Thames supply area); less risk of transferring INNS to Hampshire as water would be treated at source; lower capex due to fewer treatment sites; and potentially reduced maintenance costs associated with transfer of treated water compared to the transfer of higher turbidity raw water/cost of cleaning pipes and tanks. SEW have also indicated that they would prefer to receive a potable water transfer from T2ST rather than a raw water transfer, as part of SEW's non SRO option for a branch connection from T2ST to Basingstoke. However, the Testwood raw water options could still potentially be preferred if existing storage capacity could be utilised at Testwood Lakes, resulting in a reduction in the required T2ST transfer capacity.
3. Culham or Reading abstraction	The water source for T2ST will comprise either an abstraction from SESRO/or connection from STT at Culham, or from a new river intake on the River Thames at Reading (with supported river flows from SESRO/STT). The Reading option would result in a reduced length of transfer pipeline compared to Culham but has a higher planning risk than Culham, in that the abstraction and associated water treatment works or pumping station would be a new site located upstream of Reading [redacted] compared to Culham where T2ST would be integral to the proposed SESRO development site. There is also a risk that by abstracting water from the River Thames at Reading for T2ST could restrict the volume of SESRO/STT water available for transfer along the River Thames to London. This is because there is an expected maximum permissible discharge rate into the River Thames at Culham. Further river modelling in Gate 2 is required to model the proposed T2ST abstraction at Reading. There are also potential risks of losses to groundwater along the River Thames between Culham and Reading that will need to be assessed as part of the river modelling work in Gate 2. At this stage it is considered that sweetening flows to maintain the operational readiness of the transfer for the Reading options will be supported by releases from SESRO or STT, to avoid any derogation of existing abstractions along the River Thames.
4. Destination of transfer water	The identified options for Gate 1 have considered the transfer of water from Culham or Reading to Otterbourne or Testwood with smaller spur connections to Kingsclere and Andover. A further non SRO option has also been modelled by WRSE for an offtake to SEW at Basingstoke. TW may also potentially require a branch connection from T2ST to provide increased resilience to the Kennet Valley water resource zone. The preferred destination sites for T2ST will be informed by the output from the WRSE regional modelling and ongoing WRMP24 strategic planning by TW and SRN during Gate 2. As noted in Section 8.1 there

	are a number of alternative solutions that may affect the required need and timing of T2ST. It is possible that a proportion of the existing treatment capacity at Otterbourne and Testwood could be utilised for the T2ST, thus reducing the capital works and costs required under T2ST. However, at this time there is uncertainty concerning the future utilisation of Otterbourne and Testwood, which will depend upon the outcome of the WRSE regional modelling and SRN's ongoing strategic planning for the Hampshire area including the potential implementation of desalination, water recycling and Havant Thicket Reservoir transfers to the Hampshire area.
5. Receiving network improvements	Further work will be required to understand the requirements for distribution of T2ST water within the receiving treated water network and associated costs and associated water quality assessments to ensure there are no residual risks such as taste/odour or corrosivity issues.
6. Site Selection and route Corridor	Following identification of preferred abstraction and destination sites for T2ST and hence definition of the preferred T2ST option, further work will be required to demonstrate a robust approach is taken in the site selection of all associated infrastructure sites including water treatment works, pumping stations, and break pressure/storage tanks. This is so that a robust case can be made to the LPAs and other stakeholders that all alternative solutions have been adequately assessed in determining the location of all sites. This will also apply to the routeing of the pipeline corridor. Further detailed work in Gate 2 will be needed to establish the preferred alignment and width of the pipe corridor, demonstrating that all reasonable alternatives have been properly considered and assessed.

1. Introduction

1.1. Previous work

The Thames to Southern Transfer (T2ST) option has been identified as a Strategic Regional Water Resource Option (SRO) in the PR19 Final Determination, with funding allocated between Thames Water (TW) and Southern Water (SRN).

The SROs need to progress through a formal gate process of review and approval, with Gate 1 in July 2021. This draft Gate 1 report details the findings of the work completed to date and will be updated to take into account stakeholder comments for the final Gate 1 submission.

The aim of the T2ST study is to investigate options for transferring available water from the Severn Thames Transfer (STT) and/or SESRO from the Thames Water SWOX water resource zone to Southern Water's Hampshire area, and to identify a recommended option for the Gate 1 submission in July 2021. T2ST is dependent on the prior development and commissioning of a water resource option to provide additional water in the River Thames (STT or SESRO). T2ST is therefore unlikely to be available until the mid to late 2030s but provides a long-term resilience option for the region and potential key link in the regional grid.

1.2. T2ST Options WRMP19

During WRMP19, options for T2ST were identified for inclusion within SRN's WRMP but were not selected as preferred options as they could not be developed in time to meet the current deficit in resources within Hampshire as required by 2027. The WRMP19 T2ST options included potable water transfers from SESRO to Otterbourne WTW, assuming water treatment located at SESRO (30Ml/d and 80Ml/d).

For PR19, SRN also referred to a 100Ml/d option from SESRO to Hampshire (ref: TA.11.03 Regional Water Grid Technical Annex).

Since completion of WRMP19 further work on the T2ST option definition has evolved and within the SRO project brief for T2ST the following two options were identified.

Option 1: Potable water transfer from SESRO to Micheldever SR (50Ml/d and 80Ml/d) and:

Option 2: Raw water transfer from SESRO to Otterbourne WTW (50Ml/d and 80Ml/d)

Through subsequent discussions with Water Resources South East (WRSE) and the Project Management Board in September 2020, it was agreed that a transfer capacity of 120Ml/d should also be assessed for both options, given the uncertainties of the long-term supply demand balance in the South East region. It was also agreed that Option 3 should be included for a raw water transfer from the River Thames at Reading to Otterbourne WTW, with 50, 80 and 120Ml/d capacities for consistency with Options 1 and 2.

1.3. Option Appraisal Report

The Options Appraisal stage for T2ST was completed in December 2020. A copy of the final Options Appraisal report is provided as a separate annex.

An options workshop attended by representatives from TW, SRN and the project team was held on 6th October 2020 to review the initial identified options and to identify any other potential options that should be included within the unconstrained options list. A further options workshop was held on 16th October 2020 attended by SRN, SEW, WRSE and the project team. Copies of the workshop notes are included within as appendices to the Options Appraisal Report.

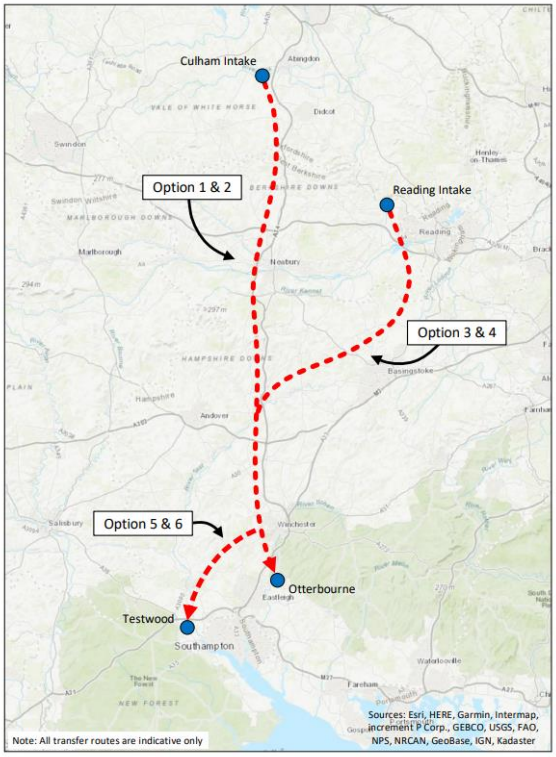
Following completion of the workshops, all unconstrained options were screened using a two stage screening process to define a list of constrained options to take forward into the concept design stage, as detailed within the Options Appraisal report. The initial stage of the option screening removes all options from the list that are not technically, or environmentally feasible, on a pass/fail basis. The secondary screening stage uses a RAG system (red/amber/green) to present the findings of the assessment and to demonstrate how the options perform against the assessment criteria. The assessment criteria ensures consistency with the Strategic Environmental Assessment (SEA), Habitats Regulations Assessment (HRA) and Water Framework Directive

(WFD), that underpin the environmental assessment of options consistent with the approach taken for WRMP24.

As a result of the screening process 6No. constrained options were identified to take forward into the concept design stage as follows. A key plan showing the location of the raw and potable transfer options is provided by Figure 1.1.

- raw and potable water transfers from Culham to Otterbourne WTW (Options 1 and 2),
- raw and potable water transfers from the River Thames at Reading to Otterbourne WTW and (Options 3 and 4):
- raw water transfers from Culham to Testwood WTW and Reading to Testwood WTW (Options 5 and 6).

Figure 1.1: Key Plan, T2ST constrained options (Options 1-6).



Further details concerning the capacity of each option and connectivity to the SRN water resource zones are detailed below in Table 1.1.

Table 1.1: T2ST constrained options (Options 1-6).

Option Ref:	Option Name	Option Description
Option 1	Potable water transfer from Culham to Otterbourne WTW. (50, 80 and 120Ml/d)	Transfer of potable water from the River Thames at Culham near Abingdon to Otterbourne. Water provided from either the Severn to Thames Transfer or SESRO. Water treatment located at Culham and transfer of potable water to SRN Otterbourne WTW. This option also includes potable water offtakes to the SRN Andover and Kingsclere water resource zones. A connection point to the SEW Basingstoke water resource zone is also provided (Northgate).
Option 2	Raw water transfer from Culham to Otterbourne WTW (50, 80 and 120Ml/d)	Transfer of raw water from the River Thames at Culham near Abingdon to Otterbourne. Water provided from either the Severn to Thames Transfer or SESRO. Raw water transfer for treatment at Otterbourne WTW. This option also includes raw water offtakes to the SRN Andover and Kingsclere water resource zones, and water treatment within Andover/Kingsclere. A connection point to the SEW Basingstoke water resource zone is also provided (Northgate).
Option 3	Raw water transfer from the River Thames at Reading to Otterbourne WTW (50, 80 and 120Ml/d)	Transfer of raw water from the River Thames upstream of Reading [redacted] to Otterbourne. Water provided from either the Severn to Thames Transfer or SESRO. Raw water transfer for treatment at Otterbourne WTW. This option also includes raw water offtakes to the SRN Andover and Kingsclere water resource zones, and water treatment within Andover/Kingsclere. A connection point to the SEW Basingstoke water resource zone is also provided (Northgate).
Option 4	Potable water transfer from the River Thames at Reading to Otterbourne WTW (50, 80 and 120Ml/d)	Transfer of potable water from the River Thames upstream of Reading [redacted] to Otterbourne. Water provided from either the Severn to Thames Transfer or SESRO. Water treatment located at upstream of Reading [redacted] and transfer of potable water to SRN Otterbourne WTW. This option also includes potable water offtakes to the SRN Andover and Kingsclere water resource zones. A connection point to the SEW Basingstoke water resource zone is also provided (Northgate).
Option 5	Raw water transfer from Culham to Testwood WTW.	As Option 2, with an additional transfer to Testwood WTW. Making use of potential buffer storage at Testwood/Broadlands Lake and existing treatment capacity.
Option 6	Raw water transfer from the River Thames at Reading to Testwood WTW	As Option 3, with an additional transfer to Testwood WTW making use of potential buffer storage at Testwood/Broadlands Lake and existing treatment capacity.

2. Concept Design

As summarised in Section 1.0, 6No. constrained potable and raw water options were taken through the options appraisal stage into concept design. This section provides information on the development of each option and key issues considered at this stage of the SRO.

Conclusions concerning the viability of each option and recommendations for further work between Gate 1 (July 2021) and Gate 2 (October 2022) are set out in Section 8.

2.1. T2ST Scheme capacity

Through discussion and agreement with WRSE, 50Ml/d, 80Ml/d and 120Ml/d scheme capacities have been considered for each of the 6No. constrained options. This is considered to be an appropriate range of scheme capacities for Gate 1 to inform the WRSE regional plan modelling. Dependent on the outcome of the WRSE modelling it is however possible that a wider range of scheme capacities for T2ST may need to be developed in Gate 2 to meet longer term environmental objectives.

2.1.1. Kingsclere and Andover Water Resource Zones

For Gate 1 it has also been agreed with SRN that 10Ml/d spur connections from the T2ST pipeline should be included to supply the Kingsclere and Andover water resource zones in Hampshire for all T2ST options. These connections have been sized on the basis of a projected resource deficit within the combined Kingsclere and Andover zones in the 2080s of circa 20Ml/d. In Gate 2 the size of the spur connections to Andover and Kingsclere will need to be reviewed against the output of WRSE modelling and the latest SRN strategic water resource planning position for the Hampshire region.

2.1.2. Thames Water supply to Kennet Valley

TW have also identified a potential spur connection from the T2ST pipeline to provide support to the Kennet Valley water resource Zone. This spur connection has not been considered at this stage of the T2ST SRO for Gate 1 but may be a requirement in Gate 2 depending on the outcome of WRSE modelling and TW strategic planning for WRMP24.

2.1.3. South East Water supply to Basingstoke

South East Water (SEW) and WRSE have developed an option for a spur connection from the T2ST transfer main to supply Northgate SR to the south of Basingstoke, at 10Ml/d and 20Ml/d capacity. Whilst this option has been identified and modelled by WRSE the offtake has not currently been included as part of the T2ST SRO. Hence no consideration of this spur has been included as part of the T2ST concept design for Gate 1. It is understood that WRSE have also considered a connection option from T2ST to Whitedown to the north of Basingstoke, as an alternative to Northgate. Depending on the outcome of the WRSE modelling further work on the SEW option to Basingstoke may be required for inclusion in the T2ST scope for Gate 2.

2.2. T2ST Site Selection for Gate 1

For Gate 1 it should be noted that the proposed location of the water treatment sites, break pressure tanks and pumping stations is preliminary only, based on a high level assessment of topography, site access, and proximity to existing development and infrastructure. For options taken forward into Gate 2 a detailed site selection study will be required to justify the site selection process for all T2ST options.

2.3. Scheme Dependencies

The T2ST SRO is dependent on the construction of either SESRO or STT to provide available water for transfer to the SRN water resource zones in Hampshire and hence the scheme is unlikely to be commissioned before the mid to late 2030s.

There are two potential locations for water abstraction for T2ST,

- the SESRO reservoir site at Culham, where water would be supplied directly from the reservoir or from a cross connection with STT pipeline, and
- a new river intake on the River Thames upstream of Reading [redacted] to the west of Reading.

At the SESRO site, water for the T2ST SRO would be provided from a connection to the SESRO gravity outlet pipeline, located in the north east corner of the reservoir site. Through liaison with the SESRO SRO team an area of land for location of a new pumping station and water treatment works for the T2ST options has been identified to the north east of reservoir between the reservoir embankment and the A34. The same location for the T2ST pumping station and water treatment works is also proposed in the event of water being supplied from the STT pipeline which is planned to be laid across the SESRO site in close vicinity to the proposed T2ST site.

The alternative abstraction location identified for T2ST is a new river intake location on the River Thames upstream of Reading [redacted] This location has been identified on the basis that an intake at this location would minimise the T2ST pipeline length to Hampshire. This abstraction location was also identified by SEW as a WRMP19 option for a direct river abstraction supply from the River Thames to Basingstoke. Moving the abstraction point either further to the west of Reading or to the east of Reading would increase the T2ST conveyance length and hence [redacted] is the preferred location at this stage of the SRO development.

[redacted] Two potential sites have been considered for the new treatment works, one located adjacent to the River Thames and an alternative site set back to the south of the railway line. It is likely that the site to the south of the railway would be preferable due to lower flood risk and less requirement for compensatory storage. Further consideration of the site locations for the T2ST abstraction at Reading and at Culham will be required for Gate 2 as discussed under Section 8.

It should also be noted that the need for T2ST is dependent on the outcome of the WRSE regional plan. There a number of strategic resource schemes in the Hampshire region that could affect the need and timing of T2ST as described later in this report under Section 8. The need and timing of the Thames to Affinity transfer T2AT could also potentially affect the volume of water available for T2ST. As part of Gate 2, once a preferred T2ST option has been identified, further work will be required on the connectivity of T2ST into the Southern Water distribution network at the receiving sites at Otterbourne or Testwood and Andover and Kingsclere.

2.4. Water Treatment

2.4.1. Potable Options: Culham/Reading

For the two identified potable water options (Option 1 – Culham to Otterbourne, and Option 4 Reading to Otterbourne, a new water treatment works would be required at the point of abstraction at Culham or Reading, to fully treat the source water prior to transfer to Otterbourne.

The treatment processes required for water treatment at Culham or Reading for T2ST has been determined in accordance with the All Company Working Group (ACWG) Water Quality Risk Framework methodology. Full details of the adopted approach are set out within the T2ST Water Quality Assessment Report.

Drinking water safety plans were provided by Thames Water and Southern Water for treatment works around the abstraction regions and receiving zones respectively, allowing risk profiles at both ends of the transfer to be created. Limiting hazards were also provided from the SESRO and STT SROs which allowed five water source scenarios to be established as defined as follows, with 2No. water source scenarios for SESRO (A and B) and 3No. water source scenarios for STT (C,D and E):

A. Abstraction from SESRO – sourced from the River Thames at Culham at high flow;
B. Abstraction from the River Thames upstream of Reading [redacted] – sourced from SESRO water released upstream;
C. Abstraction from the River Thames upstream of Reading [redacted] or Culham – sourced from STT, with pipeline conveyance;
D. Abstraction from the River Thames upstream of Reading [redacted] or Culham– sourced from STT, with canal conveyance;
E. Abstraction from the River Thames upstream of Reading [redacted] or Culham– sourced from STT (conveyance by either pipeline or canal) with planned support from Minworth STW effluent.

Water abstracted from SESRO (source A) has a greater algae and soluble metal risk compared to the river abstraction upstream of Reading [redacted] (source B), which has a greater insoluble metal and pesticide risk. Water source scenario C, D and E all rely on the Severn to Thames Transfer. The STT water source is expected to have increased hydrocarbon and organics risks compared to the SESRO risks. The

difference in source waters give rise to differing limiting hazards, in turn, requiring differing treatment processes to successfully mitigate and control the risks. Initial assessment indicates water source scenario E is the highest risk source due to the increased microbiological and bromate formation risks expected from planned support from Minworth STW effluent. Further detailed information on the water source scenarios for T2ST, completed water quality risk assessments, and required treatment processes for each T2ST water source scenario are set out in the Water Quality Assessment Report.

The required treatment process for water source scenario A (abstraction from SESRO) would include:

- coagulation and flocculation;
- dissolved air flotation (DAF);
- rapid gravity filters (RGF) and
- granular activated carbon (GAC) filters.
- [redacted]
- Ultraviolet disinfection units and chlorine contact tanks would be required at the end of the treatment to provide full disinfection to the treated water before entering the supply network.
- Sludge thickening using lamellas and disposal to sewer

For the Reading abstraction for water source scenario B (supported by SESRO releases to the River Thames at Culham) the proposed treatment process for the direct river abstraction is the same as the treatment for direct abstraction from SESRO (Scenario A) apart from the need for screening of the river water and the use of high rate lamella clarifiers instead of dissolved air flotation to remove floc particles. Process block diagrams for each water source scenario are included within the Water Quality Assessment Report, together with details of selected treatment process against each limiting water quality hazard.

For the STT water source scenarios, Scenario C (pipeline conveyance) has the same treatment process as Scenario A as shown above, and Scenario D (canal conveyance) has the same processes as Scenario B including high rate lamella clarifiers instead of dissolved air flotation.

Water source E with planned support from Minworth STW effluent requires additional treatment [redacted] The treatment process for water source E is similar to Scenario B [redacted] dosing and Ultrafiltration (UF) membrane filtration may also be required for water source E subject to further investigation in Gate 2 as detailed within the Water Quality Assessment Report.

2.4.2. Raw Water Options: Otterbourne/Testwood

For the 4No. raw water options (Option 2: Culham to Otterbourne, Option 3 Reading to Otterbourne, Option 5: Culham to Testwood and Option 6 Reading to Testwood), the scheme solution would involve the abstraction of raw water at Culham or Reading, conveyance of the raw water to Hampshire, and water treatment located at the receiving water treatment sites at Otterbourne or Testwood. In addition new water treatment sites would be required at Kingsclere and Andover for the spur connections.

Each of the proposed T2ST treatment sites is discussed below. New treatment works will be required at Testwood, Otterbourne, Kingsclere and Andover as discussed below. The required treatment processes for the raw water options will be dependent on the water source scenario (A-E) from either SESRO or STT, as for the potable options 1 and 4 detailed in Section 2.4.1.

For the raw water options coarse and fine screens have also been assumed at the abstraction point from SESRO at Culham and at the river intake from the River Thames at Reading to limit the transfer of organic material along the T2ST. As set out below under Section 2.4.3 further pre-treatment measures will also be needed for the raw water options to effectively remove microscopic larvae and plant seeds, such as membrane filtration, UV or chlorination. However at this stage there is insufficient information on the Invasive non-native species risk to define the pre-treatment requirements for the raw water options. For the Gate 1 costings coarse and fine screens have been included in the base capex, with an allowance for pre-treatment measures within the risk budget. The required level of pre-treatment works for the raw water options will be established in Gate 2 once INNS baseline survey data is available.

2.4.2.1. Otterbourne WTW (Raw Water Options 2 and 3)

The existing SRN Otterbourne treatment works [redacted] comprising of separate treatment trains for groundwater abstraction and run-of-river abstraction. An AMP7 capital maintenance scheme is currently ongoing at the Otterbourne site which will increase the maximum treatment capacity at the works to 80Ml/d.

At this stage of the T2ST design it has been assumed through consultation with SRN that new treatment capacities of 50,80 and 120Ml/d would be provided as part of the T2ST scheme. It is possible that a proportion of the existing treatment capacity at Otterbourne could be utilised for the T2ST, thus reducing the capital works and costs required under T2ST. However, at this time there is uncertainty concerning the future utilisation of the Otterbourne works, which will depend upon the outcome of the WRSE regional modelling and SRN's ongoing strategic planning for the Hampshire area including the potential implementation of desalination, water recycling and Havant Thicket Reservoir transfers to the Hampshire area. Should the existing Otterbourne works be used to treat T2ST water then changes to the existing treatment process would be required due to changes in water quality risk associated with the new water source. Further work on the potential utilisation of Otterbourne WTW is proposed for Gate 2 of the T2ST SRO as discussed under Section 8 of this report.

It has also been established at this stage of the concept design that any increase in treatment capacity at Otterbourne as part of the T2ST SRO is likely to require a new treatment site located [redacted] to the north of the existing works located between Winchester and Otterbourne. This is because the existing Otterbourne site is very constrained with limited space for future expansion. Other alternative locations for a new works at Otterbourne may also be available and a full site selection study would be required in Gate 2 to determine the preferred site if the Otterbourne option is developed further .

The existing Otterbourne site is bounded by a railway to the east, the urban area of Otterbourne to the west, woodland to the north and high ground to the south. There is a small area of open land to the north of the site owned by SRN but this area would be too small to utilise for a new treatment process and has already been identified as a potential water balance tank for a separate SRN option. To the south of the site there is a disused cricket pitch also owned by SRN and a solar array facility.

The cricket pitch area has been identified as a space required as part of a proposed further upgrade of the site during AMP7, and it has been assumed at that stage that the solar array facility would not be available for any future expansion of the treatment process. Development of a new satellite site to Otterbourne to the north of the town in open agricultural land to the west of the Itchen is technically feasible as part of the T2ST scheme but would be locally controversial and likely to be subject to strong planning objections.

2.4.2.2. Testwood WTW (Raw Water Options 5 and 6)

The existing SRN Testwood water treatment works [redacted] comprising separate treatment trains for groundwater abstraction and run-of-river abstraction. An AMP7 capital maintenance scheme is currently ongoing at the Testwood site which will increase the maximum treatment capacity at the works to 80Ml/d.

As for the Otterbourne raw water options it has been assumed through consultation with SRN that new treatment capacities of 50, 80 and 120Ml/d would be provided at Testwood as part of the T2ST scheme. It is possible that a proportion of the existing treatment capacity at Testwood could be utilised for the T2ST, thus reducing the capital works and costs required under T2ST. However, at this time there is uncertainty concerning the future utilisation of the Testwood works, which will depend upon the outcome of the WRSE regional modelling and SRN's ongoing strategic planning for the Hampshire area including the potential implementation of desalination, water recycling and Havant Thicket Reservoir transfers to the Hampshire area. Should the existing Testwood works be used to treat T2ST water then changes to the existing treatment process would be required due to changes in water quality risk associated with the new water source.

In addition to the potential for utilisation of the existing treatment works capacity at Testwood, T2ST raw water options could potentially benefit from raw water storage provided within Testwood Lakes. Storing T2ST raw water within the Testwood Lakes could provide buffer storage allowing for possible reduction in conveyance capacity of the transfer and associated capex savings. The use of Testwood Lakes as a storage facility has been considered by SRN as part of the Company's strategic water resources planning for the Hampshire region, but currently there are no plans to progress this option. Any scheme to utilise Testwood Lakes storage would require dredging of the lakes and lining works to prevent leakage of stored water into the aquifer. In addition to the use of Testwood Lakes, SRN has also previously considered the use of Broadlands Lake to the north of Testwood Lakes as a potential resource option. The potential benefits of storing water within Testwood Lakes or Broadlands will be considered in further detail for Gate 2, alongside utilisation of the existing treatment

capacity, as set out in Section 8 of this report. Testwood Lakes and Broadlands Lake are both existing SRN owned assets.

Any extension of treatment works capacity at Testwood to treat T2ST water is assumed at this stage to be located on grassland immediately to the north of the existing site, to the west of the River Test. Land to the south of the Testwood site is designated as SSSI, thus precluding any development works. Any extension to the site works at Testwood would be locally controversial and likely to be subject to strong planning objections.

2.4.2.3. Kingsclere WTW (Raw Water Options 2,3, 5 and 6)

The existing Kingsclere WTW [redacted] comprising a number of groundwater (chalk) boreholes. The existing groundwater treatment process at Kingsclere is therefore not adequate for treatment of raw water supplied as part of the T2ST scheme. For the raw water options a new 10Ml/d water treatment works would therefore be required at Kingsclere. For Gate 1 it has been assumed that the new works would be located adjacent to the [redacted] together with a 10Ml extension to the existing service reservoir capacity. Due to the proximity of the service reservoir to the south of the town, any development is likely to be locally controversial and subject to planning risk.

2.4.2.4. Andover WTW (Raw Water Options 2,3, 5 and 6)

The existing Andover WTW [redacted] comprises a number of groundwater (chalk) boreholes. The existing groundwater treatment process at Andover is therefore not adequate for treatment of raw water supplied as part of the T2ST scheme. For the raw water options a new 10Ml/d water treatment works would therefore be required at Andover. For Gate 1 it has been assumed that the new works would be located to the south of the town to the east of the River Anton [redacted] It has been assumed that treated water from the new WTW would be pumped through a new main to a new extended storage tank at Micheldever. Due to the proximity of the WTW and service reservoir to the south of the town any development is likely to be locally controversial and subject to planning risk.

2.4.2.5. Wastewater discharges

At this stage of the concept design it has been assumed that any wastewater discharge from the new treatment works would be discharged to sewer rather than to a stream or river. Further work will be undertaken in Gate 2 to determine the wastewater discharge requirements for each option through consultation with the Environment Agency.

2.4.3. Invasive Non-Native Species (INNS)

The T2ST SRO will involve the transfer of large volumes of water from SESRO or direct from the River Thames to the Hampshire supply area. Hence there is an associated risk of transferring Invasive Non Native Species (INNS) along the pipeline with potentially significant impacts on watercourses within Hampshire.

For the potable water schemes, abstracted water will be fully treated at either Culham or Reading and hence due to the treatment process including UV and chlorination disinfection, any present organic matter would be completely removed from the source water. Hence it is considered that there is no risk of INNS transfer along the T2ST pipeline for the two potable water options (Option 1: Culham to Otterbourne and Option 4: Reading to Otterbourne).

However, this is not the case for the raw water transfer options where the transfer of untreated water between the Thames and Hampshire areas does have an inherent risk of INNS transfer. Whilst the raw water will be contained within a pipeline during conveyance to Hampshire and then treated at the receiving water treatment works, which would then remove INNS through the treatment process, there is a residual risk of leakage from the pipeline, and operational release of raw water from pipeline washouts, which would be a potential source of INNS contamination. Hence pre-treatment of the raw water at Culham or Reading would be required for the raw water options to remove the INNS risk at source prior to transfer to Hampshire.

At this stage of the T2ST concept design, ahead of the planned INNS surveys for SESRO and STT, it is not yet possible to identify particular INNS that could cause a threat to ecology within Hampshire. The INNS surveys will determine the presence of existing INNS risks which will provide a baseline for design development. Consideration will also be required of future potential INNS species that could affect pre-treatment design. An initial INNS risk assessment has been included in the Environmental Assessment Report and this will be further developed in Gate 2, informed by survey data.

However it is considered that the risk of INNS transfer is high for all T2ST raw water options. Coarse and fine screens will be required at the abstraction locations for both Culham and Reading to limit the transfer of organic

material along the T2ST, but further pre-treatment measures will also be needed to effectively remove microscopic larvae and plant seeds, such as membrane filtration, UV or chlorination. It is noted that due to the high organic content of the raw water, chlorination is unlikely to be suitable as this approach is likely to generate Tri Halo Methane (THM) that could then be difficult to treat as the receiving treatment works. Further assessment will be required in Gate 2 once the results of the INNS surveys for SESRO and STT are available to determine the most appropriate pre-treatment process required for the T2ST raw water options.

2.5. Conveyance

For each of the 6No. T2ST potable and raw water options, preliminary pipeline routes and sites for pumping stations and storage tanks have been identified for the conveyance elements of the concept design, as detailed within the following sections of this report.

2.5.1. Pipeline route selection

For all considered options preliminary pipeline routes have been developed between the T2ST abstraction sites at Culham and Reading and the receiving SRN water treatment/supply sites within Hampshire. The preliminary pipeline routes for Gate 1 have been identified based on engineering judgement to minimise the pipeline length and hence capex of the options, whilst avoiding environmentally designated sites wherever possible including areas of woodland, SSSIs, SACs, SPAs and scheduled monuments and taking into account other factors such as topography, soil type and site access. The planning risk associated with each route has also been determined as set out within the Planning and Strategy Consent Report.

At this stage of the concept design the identified pipe routes are preliminary and further work will be required after Gate 1 to establish a preferred T2ST option and associated pipeline corridor for submission at Gate 2.

Table 2.1: T2ST pipelines (lengths)

Pipeline Section:	Option No.	Pipeline Length (km)
Culham to Otterbourne (potable and raw)	1, 2	76.5
Reading to Otterbourne (potable and raw)	3, 4	62.7
Culham to Testwood (raw)	5	90.5
Reading to Testwood (raw)	6	76.7
Kingsclere spur main (from Culham) (potable and raw)	1, 2, 5	7.1
Kingsclere spur main (from Reading) potable and raw	3, 4, 6	6.3
Andover spur main (Culham) potable	1	8.9
Andover spur main (Culham) raw	2	11.0
Andover spur main (Reading) potable	4	14.2
Andover spur main (Reading) raw	3	16.3

2.5.1.1. Culham to Otterbourne pipeline

The Culham to Otterbourne pipeline route is shown in Figures A1 - A4 in Appendix A. This section of pipeline applies to Options 1 and 2 (potable and raw transfers) and has a length of 76.5km. The preliminary pipeline route runs south from the SESRO reservoir site at Culham, adjacent to the route of the A34 through open countryside, passing to the west of Newbury and Winchester and ending at the new Otterbourne North site.

2.5.1.2. Reading to Otterbourne pipeline

The Reading to Otterbourne pipeline route is shown in Figures A5 - A8 in Appendix A. This section of pipeline applies to Options 3 and 4 (potable and raw transfers) and has a length of 62.7km. The preliminary pipeline route runs south from the proposed new River Thames intake upstream of Reading [redacted] passing to the west of Basingstoke and Winchester and ending at the new Otterbourne North site. [redacted]

2.5.1.3. Culham to Testwood pipeline

The Culham to Testwood pipeline route is shown in Figure A9-A10 in Appendix A. This section of pipeline applies to Option 5 (raw water transfer) and has a length of 90.5km. The preliminary pipeline route is common to the Culham to Otterbourne pipeline route from [redacted] The final 19.4km of the pipeline route from [redacted] to Testwood is common to Option 6, passing to the west of Winchester and to the east of Romsey, ending at the Testwood site.

2.5.1.4. Reading to Testwood pipeline

The Reading to Testwood pipeline route is shown in Figures A11 – A12 in Appendix A. This section of pipeline applies to Option 6 (raw water transfer) and has a length of 76.7km. The preliminary pipeline route is common to the Reading to Otterbourne pipeline route for the first 57.3km from Reading to [redacted] The final 19.4km of the pipeline route from [redacted] to Testwood is common to Option 5, passing to the west of Winchester and to the east of Romsey, ending at the Testwood site.

2.5.1.5. Kingsclere pipeline (Culham options)

The pipe route for the Kingsclere spur main for the Culham options is shown on Figures A1, A2 and A5 in Appendix A. This section of pipeline applies to Options 1, 2 and 5 (potable and raw options) and has a length of 7.1km. The preliminary pipeline route branches from the main Culham to Otterbourne transmission pipeline to the north of Winchester, ending to the south of Kingsclere [redacted] The pipeline route is common to both potable and raw options.

2.5.1.6. Kingsclere pipeline (Reading options)

The pipe route for the Kingsclere spur main for the Reading options is shown on Figures A3, A4 and A6 in Appendix A. This section of pipeline applies to Options 3, 4 and 6 (potable and raw options) and has a length of 6.3km. The preliminary pipeline route branches from the main Reading to Otterbourne transmission pipeline to the west of Basingstoke, ending to the south of Kingsclere [redacted] The pipeline route is common to both potable and raw options.

2.5.1.7. Andover pipeline (Culham options)

The pipe route for the Andover spur main for the Culham options is shown on Figures A1, A2 and A5 in Appendix A. This section of pipeline applies to Options 1, 2 and 5 (potable and raw options).

For the potable option (Option 1) the preliminary pipeline route branches from the main Culham to Otterbourne transmission pipeline to the north of Winchester, ending to the south west of Andover at Micheldever WSR. The pipe route has a length of 8.9km.

For the raw water options (Options 2 and 5) the preliminary pipeline route branches from the main Culham to Otterbourne transmission pipeline to the west of Basingstoke and follows the same route as the potable option (Option 1) to Micheldever WSR, but then continues a further 2.1km to the new preliminary WTW location to the south of Andover. The pipe route has a length of 11.0km.

2.5.1.8. Andover pipeline (Reading options)

The pipe route for the Andover spur main for the Reading options is shown on Figures 3, 4 and 6 in Appendix A. This section of pipeline applies to Options 3, 4 and 6 (potable and raw options).

For the potable option (Option 4) the preliminary pipeline route branches from the main Reading to Otterbourne transmission pipeline to the west of Basingstoke, ending to the south west of Andover at Micheldever WSR. The pipe route has a length of 14.2km.

For the raw water options (Options 3 and 6) the preliminary pipeline route branches from the main Reading to Otterbourne transmission pipeline to the north of Winchester and follows the same route as the potable option (Option 4) to Micheldever WSR, but then continues a further 2.1km to the new preliminary WTW location to the south of Andover. The pipe route has a length of 16.3km.

2.5.2. Pipeline crossings

There are several major road, rail and river crossings located along the preliminary pipeline routes, which will require trenchless technology. Given the large diameter of the pipelines, [redacted] diameter for the main transmission pipeline from Culham/Reading to Otterbourne/Testwood directional drilling would not be possible at these pipe sizes and hence either pipe jacked tunnels or micro-tunnelling using a small-bore tunnelling machine would be required at each crossing. For the smaller spur branches the pipeline diameter would be [redacted] for the proposed 10Ml/d capacity. At this pipe size directional drilling may be feasible subject

to further investigation but would be at the upper end of the technology limits. Hence at the concept design stage pipe jacking or micro-tunnelling has been assumed for the spur main crossings as well as the main transmission pipeline, to construct a segmental concrete tunnel beneath each crossing feature through which the T2ST transmission pipeline would be laid. Launch and reception shafts approximately [redacted] in diameter, comprising concrete segmental rings, would be required on either side of the tunnel drive. The depths of the reception and launch pits will be dependent on the local topography of the crossing alignment and will vary depending on the river depth and height of road/rail crossings compared to adjacent land. For Gate 1 it has been assumed that the average shaft depth would be [redacted] Pipe crossing alignments and shaft depths will be further defined in Gate 2 for the preferred option.

The number of tunnelled crossings and associated tunnelled lengths have been identified for each option as set out in the Table 2.2. For the river crossings the shaft locations would be located outside of any environmentally protected areas along the river alignment to avoid any significant impacts on designated sites and sensitive riverine habitats. This will be a key element of the T2ST design and will require close consultation with the Environment Agency and Natural England to obtain agreement on the shaft locations, construction methods and tunnel alignments once the preferred option has been identified before Gate 2. Protecting the environment will be of paramount importance for all affected areas of the T2ST scheme.

Table 2.2: T2ST Road, Rail and River Crossings (estimated crossing length in metres)

Crossing Type	Option 1 : Culham to Otterbourne - potable	Option 2: Culham to Otterbourne - raw	Option 3: Reading to Otterbourne - raw	Option 4: Reading to Otterbourne - potable	Option 5: Culham to Testwood - raw	Option 6: Reading to Testwood - raw
Road Crossings						
M4	180	180	100	100	180	100
A34	685	685	520	520	685	520
A303	150	150	350	350	150	350
A34			220	220		220
M27					100	100
Tunnelled length (m)	*1,015*	*1,015*	*1,190*	*1,190*	*1,115*	*1,290*
Rail Crossings (No.)						
[redacted]	100	100			100	
	120	120			120	
	200	200	200	200	200	200
			100	100		
					100	100
					150	150
Tunnelled length (m)	*420*	*420*	*300*	*300*	*670*	*450*
River Crossings (No.)						
Lambourne	230	230			230	
Kennet	1000	1000	880	880	1000	880
Dever	320	320	540	540	320	540
Test	270	270			890	620
Bourne	650	650	650	650	650	650
Tunnelled length (m)	*2,470*	*1,820*	*2,070*	*2,070*	*3,090*	*2,690*
Total Crossing length (m)	*3,905*	*3,255*	*3,560*	*3,560*	*4,875*	*4,430*

2.5.3. Hydraulic analysis

Hydraulic analysis has been undertaken for each option to establish the required pipe diameter and preliminary hydraulic grade line, using the Cole-Brook White equation for pressure pipelines and a roughness value of 0.15mm. At this stage of the concept design, it is too early to select the final pipeline material, which could be ductile iron, welded steel or HPPE for the range of pipeline diameters required. A roughness value of 0.15mm is considered appropriate at this stage of the design for initial pipe sizing.

To define the hydraulic design profile, it has also been assumed at this stage that working pressure along the pipelines would not exceed 16Bar (PN16 pipework). Other hydraulic design assumptions for the Gate 1 analysis include:

- Peak flowrates in Ml/d and are delivered over a 20-hour period.
- The water temperature is 10 degrees C and therefore has a kinematic viscosity of 1.323x10-6m2/s.
- The discontinuity coefficient is 3.00 per kilometre of pipeline for losses due to bends and valves.
- A pump and motor efficiency of 65% was used.

It has also been assumed for Gate 1 that the location of the pumping station sites along the pipelines between Culham/Reading and Otterbourne/Testwood is common across the range of scheme capacities (50,80 and 120Mld) The preliminary hydraulic profiles for each option are set out in the following sections. Further hydraulic analysis will be required during Gate 2 once final pipeline alignments, location of pumping sites and scheme capacities have been defined.

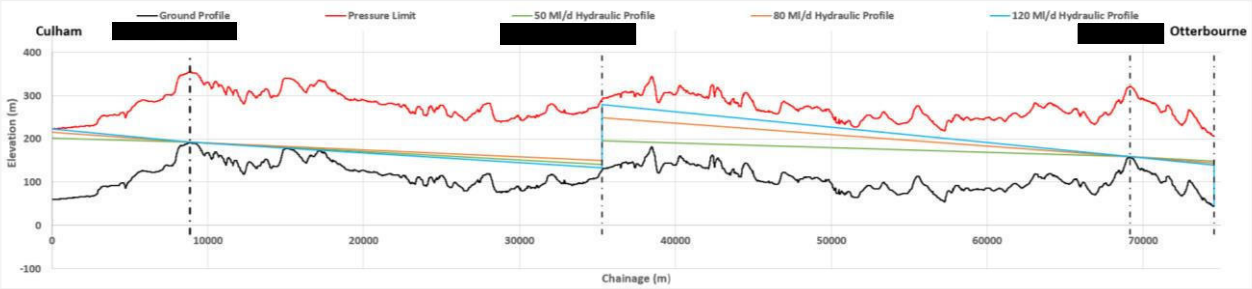
The hydraulic analysis also included modelling the 10Ml/d spur connections to Kingsclere and Andover. In both cases the ground alignment along the spur routes is relatively flat and a positive hydraulic grade line is provided throughout below 16Bar working pressure, avoiding any need for booster stations along the spur mains.

2.5.3.1. Culham to Otterbourne (Options 1 and 2)

The hydraulic profile for the 76.5km Culham to Otterbourne pipeline is shown in the section below, for flow capacities of 50Ml/d (green), 80Ml/d (red) and 180Ml/d (blue). Ground level is represented by the black line and the 16Bar pressure envelope is shown by the red line, with hydraulic profiles within 16Bar working pressure envelope.

To transfer the T2ST flows (50,80 and 120Ml/d) a pumping will be required at Culham to lift the water to a new break-pressure tank [redacted] at chainage 8,900m. From [redacted] water would gravitate through the next section of pipeline to a new pumping station at [redacted] chainage 35,300m, where water is pumped to a new break pressure tank [redacted]. Water from [redacted] would then gravitate through the final section of the transfer to Otterbourne.

Figure 2.2: Culham to Otterbourne Hydraulic profile



Preliminary pipeline diameters, flow velocity and pumping station power ratings for the Culham to Otterbourne pipeline section are shown in the following table. Further detailed analysis will be required during Gate 2 to optimise pipe diameters and pumping head once the preferred option and scheme capacity has been determined.

It is noted that for the Culham to Otterbourne profile the hydraulic grade line is close to ground level at two locations for the gravity section between [redacted] This may require deeper pipe trench depths at these locations or local alignment changes to maintain positive pressure. This will be considered in in Gate 2 once the pipeline alignments have been further developed.

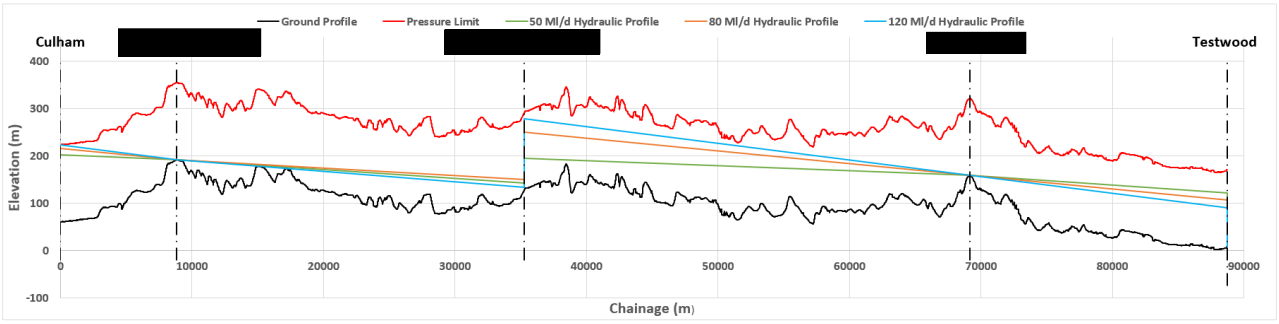
Table 2.3: Pipe diameters, pumping station power requirements and storage tank volumes (Culham options)

Culham to Otterbourne/Testwood Conveyance	Flow Rate Ml/d		
	50	80	120
Culham Pumping Station (kW)	1,493	2,626	4,131
Culham to [redacted] – pipe diameter (mm)	[redacted]		
Culham to [redacted] – flow velocity (m/s)	0.91	1.46	1.77
[redacted] break pressure/storage tank (Ml)	50	80	120
[redacted] – pipe diameter (mm)	[redacted]		
[redacted] – flow velocity (m/s)	0.91	1.18	1.46
[redacted] Pumping Station (kW)	690	2,017	3,761
[redacted] break pressure/storage tank (Ml)	50	80	120
[redacted] pipe diameter (mm)	[redacted]		
[redacted] – flow velocity (m/s)	0.91	1.46	1.77
[redacted] break pressure/storage tank	50	80	120
[redacted] to Otterbourne – pipe diameter (mm)	[redacted]		
[redacted] to Otterbourne – flow velocity (m/s)	1.15	1.46	1.77
[redacted] to Testwood – pipe diameter (mm)	[redacted]		
[redacted] to Testwood – flow velocity (m/s)	1.15	1.46	1.77

2.5.3.2. Culham to Testwood (Option 5)

The hydraulic profile for the 90.5km Culham to Testwood option is shown in the section below. This is the same as the profile for Culham to Otterbourne section (2.5.3.1) except for the longer section of gravity pipeline from [redacted] to Testwood.

Figure 2.3: Culham to Testwood Hydraulic profile

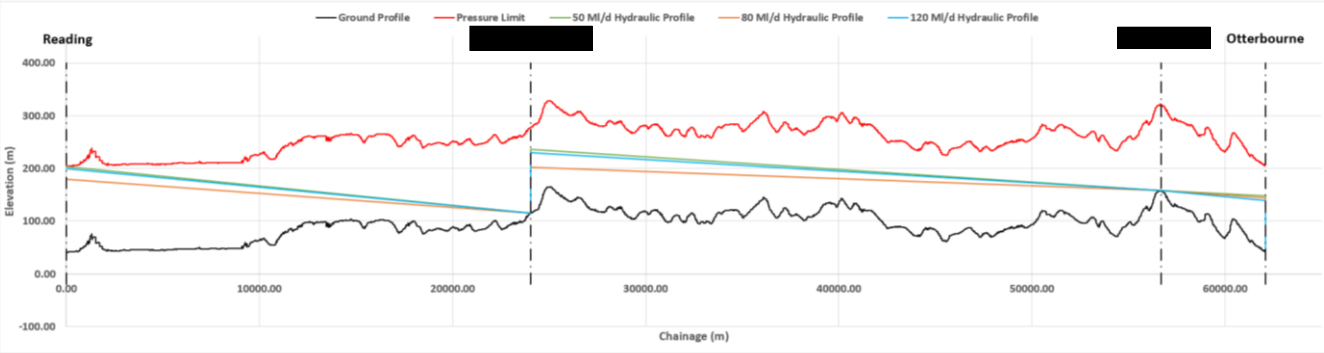


2.5.3.3. Reading to Otterbourne (Option 3 and 4)

The hydraulic profile for the 62.7km Reading to Otterbourne pipeline is shown in the section below, for flow capacities of 50Ml/d (green), 80Ml/d (red) and 180Ml/d (blue). Ground level is represented by the black line and the 16Bar pressure envelope is shown by the red line, with hydraulic profiles within 16Bar working pressure envelope.

To transfer the T2ST flows (50,80 and 120Ml/d) a pumping will be required at Reading to lift the water to a new break-pressure tank and pumping station at [redacted], at chainage 24,000m. From [redacted] water would be pumped to a new break pressure tank at [redacted] at chainage 56,700. Water from [redacted] would then gravitate through the final section of the transfer to Otterbourne (as for the Culham to Otterbourne options).

Figure 2.4: Reading to Otterbourne Hydraulic profile



Preliminary pipeline diameters, flow velocity and pumping station power ratings for the Reading to Otterbourne pipeline section are shown in the following table. Further detailed analysis will be required during Gate 2 to optimise pipe diameters, pump station locations and pumping head once the preferred option and scheme capacity has been determined. Pumping station locations will be finalised based on the final pipe alignment, taking into to consideration local topography and surge analysis to mitigate the risk of air ingress.

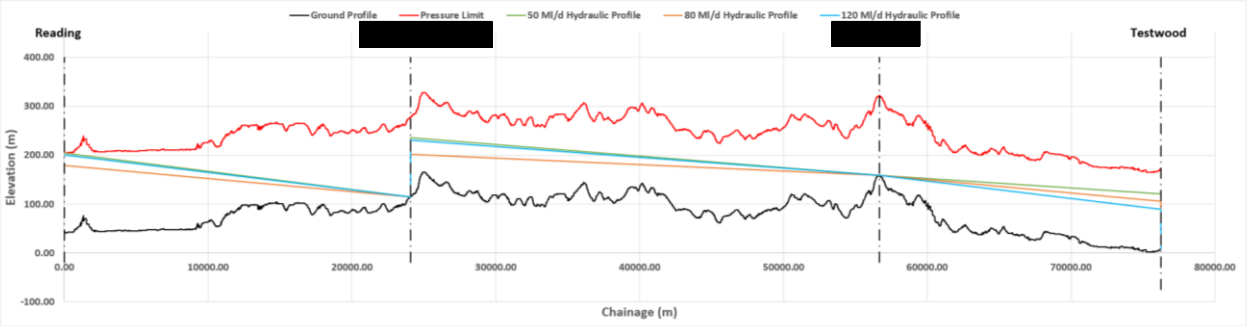
Table 2.4: Pipe diameters, pumping station power requirements and storage tank volumes (Reading options)

Reading to Otterbourne/Testwood Conveyance	Flow Rate Ml/d		
	50	80	120
Reading Pumping Station (kW)	1,657	2,239	3,880
Reading to [redacted] – pipe diameter (mm)	[redacted]		
Reading to [redacted] – flow velocity (m/s)	1.15	1.46	1.77
[redacted] break pressure/storage tank (Ml)	50	80	120
[redacted] Pumping Station (kW)	1,268	2,239	2,908
[redacted] – pipe diameter (mm)	[redacted]		
[redacted] – flow velocity (m/s)	1.15	1.46	1.77
[redacted] break pressure/storage tank	50	80	120
[redacted] to Otterbourne – pipe diameter (mm)	[redacted]		
[redacted] to Otterbourne – flow velocity (m/s)	1.15	1.46	1.77
[redacted] to Testwood – pipe diameter (mm)	[redacted]		
[redacted] to Testwood – flow velocity (m/s)	1.15	1.46	1.77

2.5.3.4. Reading to Testwood (Option 6)

The hydraulic profile for the 76.7km Reading to Testwood option is shown in the section below. This is the same as the profile for Reading to Otterbourne section (2.5.3.3) except for the longer section of gravity pipeline from [redacted] to Testwood.

Figure 2.5: Reading to Testwood Hydraulic profile



2.5.4. Water Storage

At this early stage of the SRO development the break pressure/storage tanks for all potable and raw water options have been sized at 24hr storage capacity, including storage tanks at the treatment sites, break pressure tank locations and pumping station locations. This approach provides 4 days storage for the Reading options and 5 days storage for the Culham options, due to the longer transfer length for the Culham options. The final level of storage provision for the preferred T2ST option once selected during Gate 2 will depend on the proposed utilisation of the transfer scheme to ensure that a resilient supply of water to customers can be maintained. Given the length of the transfer route building in adequate storage along the pipeline will provide a resilient solution that can be relied upon to maintain supplies in the event of unplanned outage events for example pollution incidents at the abstraction site, power or process failures at the treatment works or pumping stations or major pipe bursts along the transmission pipeline.

The storage provision provided at this stage is conservative and further assessment during Gate 2 will be required to optimise the storage volumes once the preferred option and connectivity with the wider network has been established. The level of storage provided by T2ST will also be affected by the need for spur connections to SEW and Kennet Valley which will be addressed in Gate 2 once informed by the WRSE regional plan.

As a minimum storage requirement 24 hour storage will be required at the end of the transfer pipelines. There is hence an opportunity to reduce the volume of storage in Gate 2 as the scheme scope develops as included under Section 8.2.

At this stage it is expected that the transfer would only be required in periods of extreme drought but increased utilisation of the transfer may be required to meet longer term supply demand balance of the Hampshire region depending on the implementation and timing of other schemes and future environmental ambition targets.

2.5.5. Summary of Infrastructure requirements

Table 2.5 provides summary of the water treatment and transmission elements for each of the 6No. constrained options.

Table 2.5: Summary of Infrastructure requirements

Option 1 – Culham to Otterbourne, Potable (50,80 and 120Ml/d)	Option 2 – Culham to Otterbourne, Raw (50,80 and 120Ml/d)	Option 3 – Reading to Otterbourne, Raw (50,80 and 120Ml/d)	Option 4 – Reading to Otterbourne, Potable (50,80 and 120Ml/d)	Option 5 – Culham to Testwood, Raw (50,80 and 120Ml/d)	Option 6 – Reading to Testwood, Raw (50,80 and 120Ml/d)
WTW at Culham and Pumping Station	Coarse and fine Inlet screen inlet works at Culham	New river intake, coarse and fine screens and low lift pumping station	New river intake, screens and low lift pumping station	Coarse and fine Inlet screen inlet works at Culham	New river intake, coarse and fine screens and low lift pumping station
Pipeline to [redacted] BPT	Pumping Station at Culham	Pumping Station at Reading	WTW at Reading and Pumping Station	Pumping Station at Culham	Pumping Station at Reading
Break pressure/storage tank [redacted]	Pipeline to [redacted] BPT	Pipeline from Reading to [redacted]	Pipeline from Reading to [redacted]	Pipeline to [redacted] BPT	Pipeline from Reading to [redacted]
Pipeline from [redacted]	Break pressure/storage tank at [redacted]	Break pressure/storage tank [redacted]	Break pressure/storage tank [redacted]	Break pressure/storage tank [redacted]	Break pressure/storage tank [redacted]
Break pressure/storage tank [redacted]	Pipeline from [redacted]	Pumping Station at [redacted]	Pumping Station at [redacted]	Pipeline from [redacted]	Pumping Station [redacted]
Pumping Station at [redacted]	Break pressure/storage tank [redacted]	Pipeline from [redacted] to [redacted]	Pipeline from [redacted] to [redacted]	Break pressure/storage tank [redacted]	Pipeline from [redacted] to [redacted]
Pipeline from [redacted]	Pumping Station [redacted]	Break pressure/storage tank [redacted]	Break pressure/storage tank [redacted]	Pumping Station [redacted]	Break pressure/storage tank [redacted]
Break pressure/storage tank [redacted]	Pipeline from [redacted]	Pipeline from [redacted] to Otterbourne	Pipeline from [redacted] to Otterbourne	Pipeline from [redacted]	Pipeline from [redacted] to Testwood
Pipeline from [redacted]	Break pressure/storage tank [redacted]	WTW at Otterbourne	Treated water storage tank at Otterbourne	Break pressure/storage tank [redacted]	WTW at Testwood
Treated water storage tank at Otterbourne	Pipeline from [redacted] to Otterbourne	Treated water storage tank at Otterbourne	Spur main from T2ST to Kingsclere	Pipeline from [redacted] to Testwood	Treated water storage tank at Testwood
Spur main from T2ST to Kingsclere	WTW at Otterbourne	Spur main from T2ST to Kingsclere	Storage tank at Kingsclere	WTW at Testwood	Spur main from T2ST to Kingsclere
Storage tank at Kingsclere	Treated water storage tank at Otterbourne	WTW at Kingsclere	Spur main from T2ST to Andover	Treated water storage tank at Testwood	WTW at Kingsclere
Spur main from T2ST Andover at Micheldever	Spur main from T2ST to Kingsclere	Treated water storage tank at Kingsclere	Storage tank at Andover	Spur main from T2ST to Kingsclere	Treated water storage tank at Kingsclere
Storage tank at Andover	WTW at Kingsclere	Spur main from T2ST to Andover		WTW at Kingsclere	Spur main from T2ST to Andover
	Treated water storage tank at Kingsclere	WTW at Andover		Treated water storage tank at Kingsclere	WTW at Andover
	Spur main from T2ST to Andover	Treated water storage tank at Andover		Spur main from T2ST to Andover	Treated water storage tank at Andover
	WTW at Andover			WTW at Andover	
	Treated water storage tank at Andover			Treated water storage tank at Andover	

3. Scheme Delivery

Initial considerations of the T2ST planning application route to consent, risks, mitigation and next steps have been provided as part of the Gate 1 submission, Planning and Consent Strategy Report. This advice is summarised below.

3.1. Summary of Planning Consent Routes

Subject to the type and scale of development proposed under T2ST, the available planning consent routes are either:

- An application for Development Consent under the Planning Act 2008, as a Nationally Significant Infrastructure Project (NSIP); or
- An application for Planning Permission under the Town and Country Planning Act 1990 (as amended).

A raw water transfer development between river basins or water undertaker's areas in England will be an NSIP, and require an application for Development Consent, provided the scheme is above the DCO threshold of 80Ml/d Annual Average Deployable Output (DYAA DO) in a 1 in 200 year drought.

A potable water transfer development, or a raw water transfer below 80 Ml/d, will not automatically qualify as an NSIP. Instead, should a water undertaker wish to seek Development Consent for the scheme, it would be necessary to apply to the Secretary of State for a Direction under S35 of the Planning Act 2008, to direct that the scheme is an NSIP, and thus that an application for Development Consent is required. Alternatively, it can seek planning permission for the scheme from the relevant local planning authorities.

Development of a type and scale meeting the thresholds as an NSIP must be the subject of an application for Development Consent. They cannot be consented any other way, as S160 of the Planning Act 2008 makes it an offence to carry out such a development without first securing Development Consent.

The principal differences between the Development Consent and Planning Permission routes are that a DCO enables a number of separate consents to be secured in a single application, including compulsory acquisition powers (CPO), whereas Planning Permission has a more limited focus, leaving a number of separate consents to be required including any CPO.

3.2. Preferred Planning Route

For the T2ST raw water transfer options at 80Ml/d and 120Ml/d, provided the DO equates to 80 Ml/d DYAA in a 1 in 200 year drought, these options would automatically be an NSIP, and require an application for Development Consent.

For the raw water transfer options at 50Ml/d, and the potable water transfer options, it is considered that the preferred planning consent route would be that an application be made to the Secretary of State for a direction under Section 35 of the Planning Act 2008 to make T2ST an NSIP. This direction would then require that an application for Development Consent is made for T2ST, and not a planning application.

However, should a T2ST option ultimately be selected that falls below the NSIP thresholds, or for which a direction could not be secured from the Secretary of State, then an application for planning permission would instead need to be made. This would potentially affect the 50Ml/d raw water transfer options and the potable water transfers. A planning application would need to be made to each of the 5 or 6 LPAs in whose area the option was located, and each would need to approve their application.

3.3. Planning Risks and Mitigation

On the basis of the Planning and Consent Strategy Report and given the early stage of development of the T2ST scheme, it is considered that there are no identified significant planning risks that are not capable of being mitigated through ongoing technical and environmental assessment work.

The currently identified planning risks are all comparable to the stage of evolution of the T2ST proposals, and with continued technical and environmental feasibility work, including site and route options appraisal ahead of Gate 2, a number of the risks will be mitigated.

Mitigation of certain environmental risks will need to be prioritised as part of work ahead of Gate 2, particularly through engagement with EA, Natural England and other key stakeholders.

Subject to the outcome of that work, there is confidence at this stage that a T2ST scheme can be identified, assessed and promoted to successfully secure planning consent.

Identified planning risks and mitigation at this stage include:

- Securing the identification of T2ST in WRMP24s to establish the 'need' for the scheme;
- The need for a robust consideration of alternatives, including route and site selection, particularly given the policy tests relating to major development in an Area of Outstanding Natural Beauty (AONB);
- Ensuring that the spatial extent of the scheme requiring consent is appropriately defined, including the physical and consenting relationship between T2ST and other SROs;
- The lack of a final Water National Planning Specification (NPS), and the need for this to be finalised before application submission;
- Ensuring that all policy tests relevant to the eventual planning decision are appropriately and robustly considered in further planning and environmental assessments;
- Adopting an appropriate approach to the identification and assessment of land, and the engagement of stakeholders at pre-application stage; and
- Consideration of the risks associated with future development proposals affecting sites and routes.

Note that the overall T2ST programme proposes not to submit application for planning consent until after WRMP24 finalisation, removing one of the key planning risks relating to the 'need' for the development.

3.4. Next Planning Steps to Gate 2

The focus of planning work looking ahead to Gate 2 is to provide a detailed planning route to consent report, outlining a detailed planning programme and the necessary building blocks for a successful application for planning consent, including the documents necessary as part of an application for consent. Planning risks and mitigation will be reviewed and updated as part of this report.

A focus on route and site selection will lead to a route and site selection methodology and outcomes shared with stakeholders to test and verify the assessment of potential route corridors and sites, enabling robust selection of a preferred route and sites.

Alongside this, stakeholder engagement, particularly with relevant LPAs and other consultees will be undertaken. The outcomes of this planning work will be subject to legal review and assurance ahead of Gate 2 submission.

3.5. Planning Steps beyond Gate 2

The delivery of T2ST is dependent on whether a robust project need case can be established. To enable the scheme to progress beyond Gate 2 and obtain planning consent, the capacity and timing of the transfer must be fully supported by both the WRSE regional plan and TW and SRN strategic planning for WRMP24.

Hence it would not be appropriate to apply for DCO consent for T2ST until the outcome of both the WRSE regional plan and WRMP24 is published. The WRSE regional plan will be published in late 2023. WRMP24 may also be finalised and published by late 2023, but dependent on whether the company plans are subject to enquiry in which case publication may not occur until March 2025.

At this early stage of the SRO development it has been assumed that an application for DCO consent could not be submitted until the later date of March 2025 following publication of both the WRSE regional plan and WRMP24. It is further assumed that both WRSE and WRMP24 will fully support the T2ST transfer allowing the formal planning consent process to begin. Without support from WRSE and WRMP24 planning work for the T2ST transfer would be placed on hold and the need for the transfer considered again as part of the next planning round for WRMP29.

On the assumption that a clear need case for the scheme is provided by WRSE and WRMP24 two programme scenarios has been considered for scheme delivery; Scenario 1 assuming no water resources constraints apply to determine the earliest possible date for commissioning of T2ST and Scenario 2, on the assumption that T2ST construction would be delayed until water from SESRO is available commission the T2ST scheme. Due to the existing uncertainties around the outcomes of both WRSE and WRMP24 it is not possible to have any certainty over the final scheme delivery plan for T2ST. The programme will continue to be developed during Gate 2 building on information from the WRSE modelling and strategic water resources planning as this becomes available.

3.5.1. Programme Scenario 1: Earliest delivery date for T2ST

Under this scenario it is assumed that there is no constraint on the availability of water to commission the T2ST scheme to determine the earliest possible date for scheme delivery. Key dates are as follows:

- Commence DCO pre-application stage (December 2022)
- DCO application after WRMP24 (March 2025)
- DCO consent (December 2026)
- CAP award (June 2027)
- Detailed Design (June 2027 to June 2029)
- Mobilisation 2029
- Start on site (January 2030)
- Construction 5 years (January 2030 to December 2034)
- Commissioning 12 months (January 2034 to December 2034)

As described above it is assumed that an application for DCO consent would not be submitted until March 2025 after final publication of WRMP24. However work on the DCO pre-application stage is assumed to begin earlier, following Gate 2 in late 2022 such that the required scheme development design and environmental surveys progress, in parallel to WRMP24. This fast track approach has an inherent risk that the DCO pre-application stage could be abortive should the final WRMP24 not ultimately support the T2ST scheme.

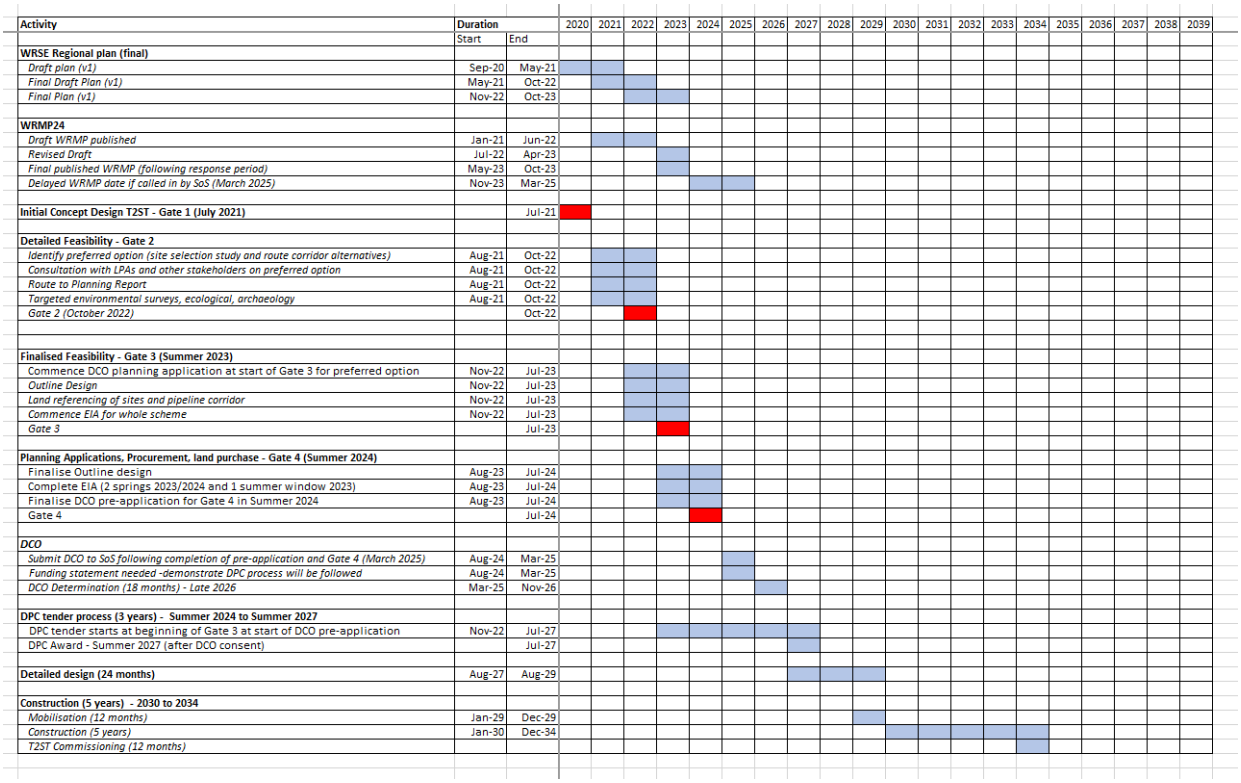
This programme would allow an 18 month period for pre-application activities from late 2022 (Gate 2) to Gate 4 in the summer of 2024. Submission of the DCO application to the Secretary of State would follow in the spring/summer of 2025 following publication of the final WRMP24. Allowing 18 months for determination of the DCO application, DCO consent for T2ST would then be expected to be provided by late 2026. Under this scenario it is also envisaged that DPC tender process would also begin soon after Gate 2 in late 2022 so that sufficient time is provided for CAP contract award before the summer of 2027 after DCO consent has been obtained. Contract award would not proceed until DCO consent is secured.

Following the CAP award, a period of detailed design of not less than 2 years from summer 2027 to summer 2029 would be required to develop the DCO outline design parameters for the pipeline route, and water treatment works, pumping stations and other infrastructure assets to detailed design stage.

A period of 12 months mobilisation has been assumed with a start date on site in early 2030. Given the scale of the T2ST works including long cross country pipelines and infrastructure sites a period of 5 years is expected for construction and commissioning of the scheme thereby achieving an earliest completion date of late 2034, on the assumption that a water source is available to commission the transfer scheme.

In practice T2ST will either be supplied by STT or SESRO. Provisional programming for STT suggest that this scheme may be available by 2033, in which case T2ST could potentially be commissioned by late 2034 as the fast track programme outlined above. This is however a very preliminary view of what may be achievable and further work will be required during Gate 2 on the programme development.

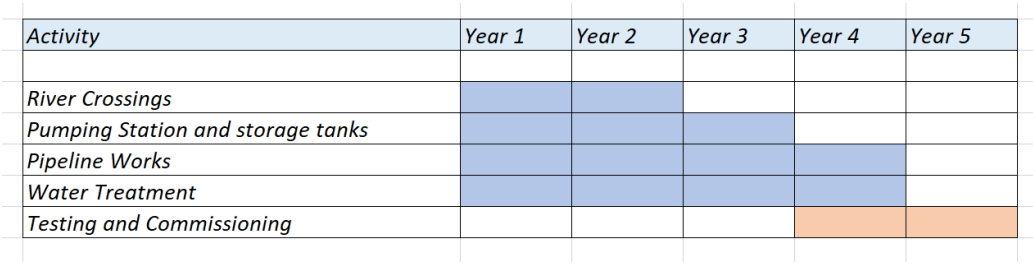
Figure 3.1: T2ST Scheme Delivery Scenario 1: Unconstrained programme



Activity	Duration		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
	Start	End																				
WRSE Regional plan (final)																						
Draft plan (v1)	Sep-20	May-21																				
Final Draft Plan (v1)	May-21	Oct-22																				
Final Plan (v1)	Nov-22	Oct-23																				
WRMP24																						
Draft WRMP published	Jan-21	Jun-22																				
Revised Draft	Jul-22	Apr-23																				
Final published WRMP (following response period)	May-23	Oct-23																				
Delayed WRMP date if called in by SoS (March 2025)	Nov-23	Mar-25																				
Initial Concept Design T2ST - Gate 1 (July 2021)		Jul-21																				
Detailed Feasibility - Gate 2																						
Identify preferred option (site selection study and route corridor alternatives)	Aug-21	Oct-22																				
Consultation with LPAs and other stakeholders on preferred option	Aug-21	Oct-22																				
Route to Planning Report	Aug-21	Oct-22																				
Targeted environmental surveys, ecological, archaeology	Aug-21	Oct-22																				
Gate 2 (October 2022)		Oct-22																				
Finalised Feasibility - Gate 3 (Summer 2023)																						
Commence DCO planning application at start of Gate 3 for preferred option	Nov-22	Jul-23																				
Outline Design	Nov-22	Jul-23																				
Land referencing of sites and pipeline corridor	Nov-22	Jul-23																				
Commence EIA for whole scheme	Nov-22	Jul-23																				
Gate 3		Jul-23																				
Planning Applications, Procurement, land purchase - Gate 4 (Summer 2024)																						
Finalise Outline design	Aug-23	Jul-24																				
Complete EIA (2 springs 2023/2024 and 1 summer window 2023)	Aug-23	Jul-24																				
Finalise DCO pre-application for Gate 4 in Summer 2024	Aug-23	Jul-24																				
Gate 4		Jul-24																				
DCO																						
Submit DCO to SoS following completion of pre-application and Gate 4 (March 2025)	Aug-24	Mar-25																				
Funding statement needed -demonstrate DPC process will be followed	Aug-24	Mar-25																				
DCO Determination (18 months) - Late 2026	Mar-25	Nov-26																				
DPC tender process (3 years) - Summer 2024 to Summer 2027																						
DPC tender starts at beginning of Gate 3 at start of DCO pre-application	Nov-22	Jul-27																				
DPC Award - Summer 2027 (after DCO consent)		Jul-27																				
Detailed design (24 months)	Aug-27	Aug-29																				
Construction (5 years) - 2030 to 2034																						
Mobilisation (12 months)	Jan-29	Dec-29																				
Construction (5 years)	Jan-30	Dec-34																				
T2ST Commissioning (12 months)																						

A preliminary construction programme for T2ST is provided below in Figure 3.2. A period of 5 years for construction including commissioning is considered to be achievable but would require multiple construction teams working in parallel for the scheme components including the pipelines, water treatment, pumping station, river crossings and storage sites.

Figure 3.2 T2ST Scheme Delivery: Construction period



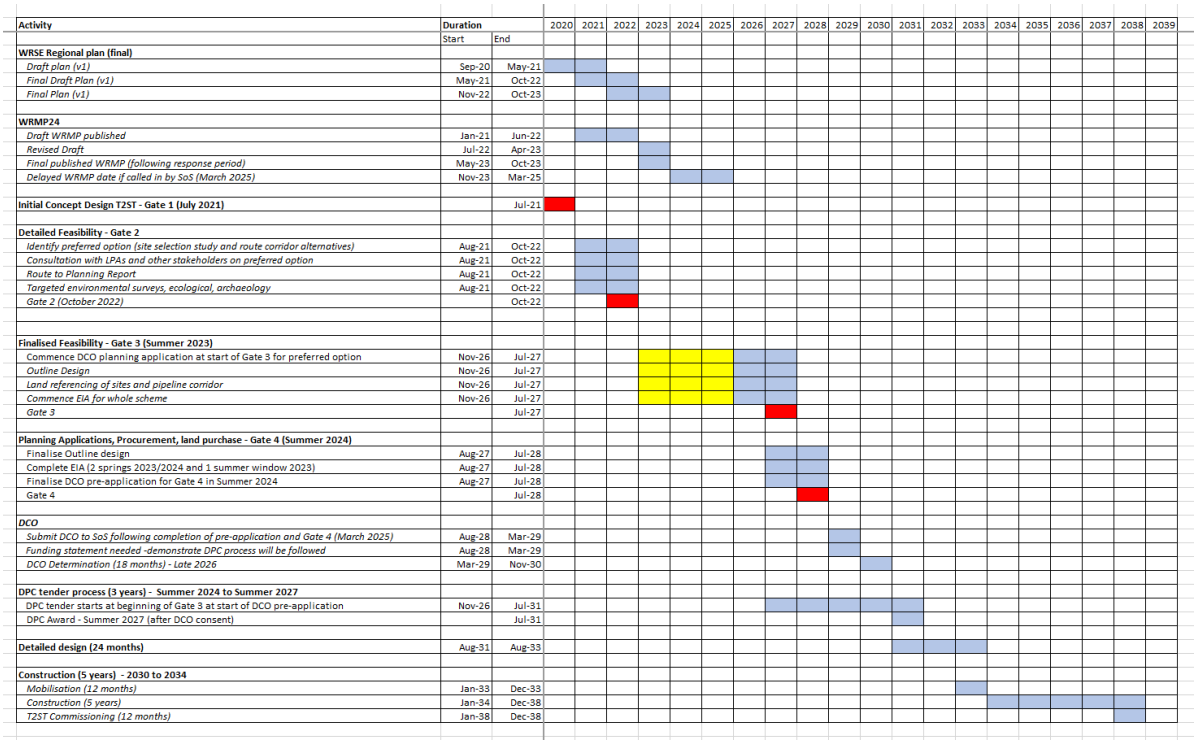
Activity	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
River Crossings					
Pumping Station and storage tanks					
Pipeline Works					
Water Treatment					
Testing and Commissioning					

3.5.2. Programme Scenario 2: T2ST commissioning delayed until SESRO available

For Scenario 2 it is assumed that water for T2ST would not be available until construction of SESRO, where the earliest completion date is currently defined between April 2036 and October 2037.

In this Scenario, all programme activities after Gate 2 could be delayed by three years compared to the fast track Scenario 1, to tie in with the expected completion date of SESRO between 2036-2037. Further development of the programme for Scheme delivery will be undertaken in Gate 2.

Figure 3.2: T2ST Scheme Delivery Scenario 2: SESRO constrained programme



Activity	Duration		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
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DCO																						
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Mobilisation (12 months)	Jan-33	Dec-33																				
Construction (5 years)	Jan-34	Dec-38																				
T2ST Commissioning (12 months)	Jan-38	Dec-38																				

4. Scheme Operation

The utilisation of the T2ST is dependent on the outcome of the WRSE regional modelling. At this stage is expected that the transfer would only be required in periods of extreme drought but increased utilisation of the transfer may be required to meet longer term supply demand balance of the Hampshire region depending on the implementation and timing of other schemes and future environmental ambition targets.

4.1. Potable Water Transfers

For the potable water transfers from Culham to Otterbourne (Option 1) and Reading to Otterbourne (Option 4) the water treatment works would be located at the water abstraction site at Culham or Reading. Following chlorination at the water treatment works booster chlorination would be required along the length of the transfer main to maintain the required chlorine residual. At this stage of the scheme development has been assumed that booster chlorination would be undertaken at each of the break pressure tanks along the transfer route to maintain chlorination levels. In addition to baseline flows to maintain operation of the water treatment works, conditioning flows would be required to prevent build-up of sediment within the treated water mains, typically by operating the transfer scheme at full flow capacity for 1-2hours per week

Whilst the full scheme capacity of the transfer would not be required outside of extreme drought periods, a baseline flow will be required to maintain operation of the water treatment works. The minimum baseline flow for a water treatment works is typically 30% of the maximum works capacity to maintain the plant in operational readiness should peak capacity be required in response to a drought event occurring. Hence a baseline flow rate of 30% of the T2ST capacity will need to be abstracted from SESRO or the new river abstraction at Reading at all times to maintain the operation of the new water treatment process plant.

One operational scenario would be to assume that the treated water for the baseline case would be pumped through the T2ST pipeline for transfer to the SRN Hampshire supply area. Hence in this scenario Southern Water would need to downturn the rate of water treatment from its existing treatment sites in Hampshire to receive the T2ST baseline flow. However due to the long transfer distance for T2ST this scenario is likely to be more expensive than operation of SRNs own water sources during baseline conditions. Maintaining the water quality within the transfer pipeline and storage tanks would also be challenging at the reduced transfer flow rates, due to the length of pipeline and storage volumes.

An alternative scenario would be for Thames Water to take the baseline flow from the T2ST treatment works and downturn its existing abstraction from other sources, to avoid pumping the baseline flow to the Southern Water supply area. The transfer pipeline would be drained down under this scenario and brought into operation when required. Further work is required in Gate 2 to explore opportunities to utilise T2ST water within the Thames and Southern regions once the preferred option and capacity have been established based on the WRSE Regional plan.

4.2. Raw Water Transfers

For the raw water T2ST options baseline flows of 30% scheme capacity would also be required to maintain the operation of the receiving water treatment works located in Hampshire. In these cases transfer of the 30% baseline flows from Thames to Southern would be required as it would be unlikely that sufficient water would be available to operate the new treatment works from Southern Water's existing sources within existing licence limits. Further work will be required in Gate 2 to consider this T2ST scenario based on the outcome of the Regional plan.

The raw water options are likely to have higher associated maintenance costs due to the build-up of sediment within the break-pressure/storage tanks due to the high turbidity of the raw water compared to the potable water options. In addition, the high organic content of the raw water is likely to require mitigation measures such as aeration plant within the break pressure/storage tanks to avoid low levels of dissolved oxygen within the transfer water when reaching the treatment works. Pre-treatment measures to mitigate the risk of INNS being transferred from the Thames to Southern region would also be required at Culham and Reading for the raw water options as described under Section 2.4.3.

5. Environmental Issues, Mitigation and Benefits

5.1. Environmental Assessment Report (EAR)

The Environment Assessment Report (EAR) accompanies the Gate 1 for the Thames to Southern Transfer (T2ST) Strategic Resource Option.

Three regulatory assessments have been completed for the T2ST options:

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

The regulatory assessments are summarised in the EAR and the full assessments are presented as separate annexes.

The Habitats Regulations Assessment reports the findings of the full HRA Stage 2 / Appropriate Assessment (AA). WRSE undertook the initial HRA screening in January 2021 and identified a number of potential 'likely significant effects', and a number of 'uncertain effects' for each of the options. The AA concluded that all six options were identified as having 'no likely significant effects' (alone), after mitigation is implemented. This was dependent on the route for Options 5 and 6 being altered locally to avoid intersecting the Solent and Southampton Water Ramsar and Special Protection Area (SPA) sites, so as to avoid any likely significant effects on these sites. In addition, the HRA specified that trenchless techniques would be required for all options that cross the River Lambourn Special Area of Conservation (SAC) (Options 1,2 and 5), and for Options 5 and 6 that cross the River Test at Testwood, so as to avoid likely significant effects on these sites. The Water Framework Directive Assessment reports the findings of the WFD.

The Strategic Environmental Assessment reports the findings of the SEA applied to the options. WRSE undertook the SEA in January 2021 and based on the outputs for residual effects (post mitigation), no major negative effects are identified. The six pipeline options are predicted to result in similar ***minor positive, neutral or minor negative*** effects across all the SEA objectives in construction and operation.

The results highlighted that Options 1, 2 and 5 are predicted to result in greater residual effects on Biodiversity during construction (due to impacts on Sites of Special Scientific Interest (SSSIs)). Options 3, 4 and 6 are predicted to result in greater residual effects on Population and Human Health during construction (due to impacts on a small number of community facilities).

Some additional assessment was undertaken to consider the impacts of components of the schemes that were not included in the WRSE assessment. The output of this shows that the components would result in some additional negative effects on some of the SEA objectives. The Otterbourne, Reading and Testwood sites each resulted in additional effects for five SEA objectives. The Otterbourne site is required for Options 1, 2, 3 and 4. The Reading site is required for Options 3, 4 and 6, and the Testwood site is required for Options 5 and 6. As such, the SEA concludes that, of the six options, Options 1 and 2 will result in the least negative effects.

5.1.1. Non-native invasive species

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

5.1.2. Biodiversity Net Gain

Biodiversity Net Gain (BNG) and Natural Capital (NC) assessments were completed by WRSE in January 2021. For each option, an assessment of the potential impact of construction and operation of the option on each NC stock was undertaken, using the BNG metric. The NC metrics were then quantified as ecosystem services in order to provide monetised values for natural capital benefit or loss. The outputs of the BNG assessments concluded that all options are likely to result in the same loss of BNG 'Habitat Units'. The outputs

of the NC assessment concluded a similar loss to the BNG assessments. The ecosystem services assessment estimated that all options would result in a loss in value per year, which was smallest for Options 3 and 4.

- *The opportunities identified in the NC assessment have the potential to contribute to Government ambitions for environment 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 social uses of land.

The wider benefits of T2ST have been reviewed, considering the context of the benefits provided to society of water resource planning, including the benefits to, and views of, customers. A number of best practice mitigation measures which could be implemented during construction to avoid or mitigate potential disruption and disturbance to communities are identified.

- *For all options, there is the potential for enhancements to be applied during operation in relation to reinstating land to achieve potential positive effects and public value.*

5.1.3. Carbon emissions

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

5.1.4. Conclusions

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

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

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

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

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

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

- Opportunities for compensatory habitat creation or habitat reinstatement should be explored in Gate 2, as well as opportunities to improve the existing habitats and provide offsetting planting of trees. Opportunities for reinstating land to achieve potential positive community effects should also be explored for example by improving access to recreational and open space, upgrades to outdoor sports facilities and improving access to community resources.

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

6. Economics and Carbon Costs

6.1. Option pricing using TW EES database

Capital and operational cost estimates for the T2ST have been derived using the TW Engineering Estimating System (EES), comprising a database of TW capital project cost/carbon information against a common asset coding structure. The EES system was introduced to TW in 2000 and holds construction costs for all TW capital expenditure within infrastructure and non-infrastructure assets. Carbon data was introduced later circa 2008 and mirrors the cost model structure for infrastructure and non-infrastructure assets.

Data is collected for each project against two key milestones, Target Cost and Final Actual Cost, and the database currently holds over 6,500 projects totalling £12 billion in value. Projects range from small £100k modifications to £620m large scale construction works. The EES data is checked against final drawings to ensure accuracy with all financial data and validated using TW's corporate financial system.

The TW cost data enables EES to produce robust process model(s) and helps support 3 key areas within the TW business in a repeatable and auditable way.

- High level Estimating for investment purposes.
- Benchmarking 'Value for Money' statements.
- Regulatory 5 yearly pricing – from PR04/AMP3 to PR19/AMP7.

Projects hold a unique index date/figure when imported into the system and when modelled as a group the projects are inflated to a common index date/figure to ensure the model reflects current day prices. These models are periodically updated with new data and older data removed.

The system holds over 6 Million embedded carbon values and each value is held against a common asset structure. As cost data is collected and imported into the system against the milestones stated above, carbon is automatically calculated based upon code, volume, size and/or attributes unique to the project. The EES database includes around 650 unit cost models spanning a wide variety of processes/techniques from sewer/water pipelines to pumping stations and/or large scale treatment works.

TW internally and externally validate our cost/carbon models periodically to ensure accurate costing outputs. Over the years the system has been independently audited by Ofwat (Water industry regulator) and has a proven track record of being a robust and auditable data capture and cost/carbon modelling system.

6.2. Option pricing for T2ST

Quantities for the 6No. T2ST options, including pipeline length and diameter, tunnelled lengths for river crossings, pumping station power capacities, break pressure tank capacities, and water treatment processes were generated for each option using the TW F909 template for subsequent entry into the TW APS (EES) pricing process. The output data from APS, provided capex, opex and carbon data for each option as summarised within the Costs and Carbon Report.

7. Water Resources

7.1. WRSE Regional Plan

As described in Section 6 cost estimates for the 6No. T2ST options at capacities of 50, 80 and 120Mld have been produced using TW's EES price database to inform the WRSE March 2021 upload. Initial output from the WRSE Regional Plan model, for the South East region incorporated all SROs and water company strategic options are expected to be available in July 2021. The model output will help to establish the required need, timing and volume of the T2ST to inform the further develop of the transfer option in Gate 2.

WRSE plan to issue the draft Regional Plan in October 2022 and the final plan in October 2023. Future updates to the T2ST option costs will feed into the WRSE modelling process during this period.

8. Assumptions, Risks and Opportunities

8.1. T2ST Project Need

This report sets out the concept design for six identified options for T2ST as identified during the Options appraisal stage for the T2ST Gate 1 submission. All six options are feasible, but significant uncertainty remains concerning the required need for the transfer, which is dependent on ongoing water resource modelling as part of the WRSE Regional plan and WRMP24 strategic planning by Southern Water and Thames Water.

It is important to recognise that there are a number of potential solutions to the long term water supply needs of the Hampshire supply area as set out in Table 8.1, which will directly affect the scheme need case for T2ST. These include potential transfers from [redacted], SRN desalination and water recycling SROs, and potential water transfers to Hampshire from the West Country South and West Country North SROs. These potential transfers to the Hampshire supply area are also indicated in Figure 8.1.

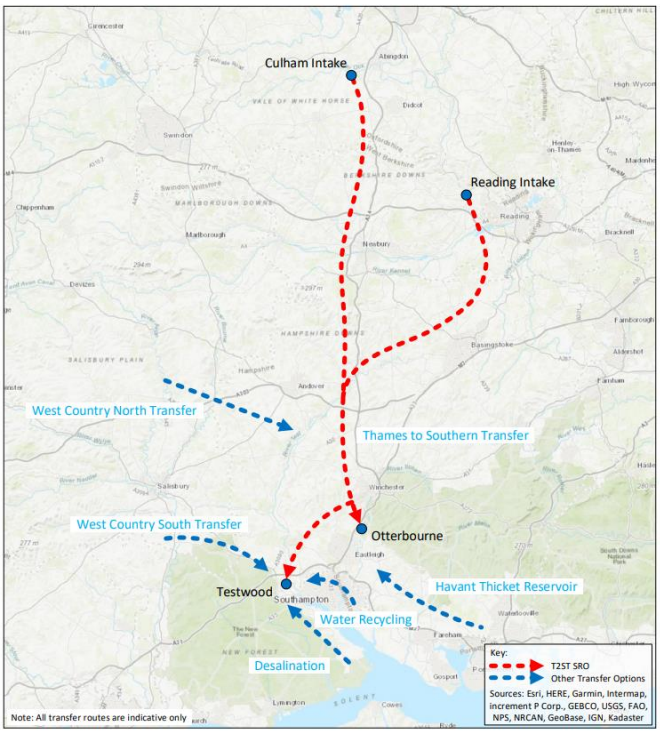
As set out on the scheme delivery section of this report, T2ST must be identified as a preferred long term solution for Hampshire supply area, as part of the WRSE regional plan and WRMP24, to enable design and planning for the transfer to continue. T2ST is also dependent on the construction and commissioning of either SESRO or STT to provide a reliable source of water for transfer to Hampshire.

Table 8.1: T2ST transfer inter-related schemes affecting need and timing T2ST

Scheme	Description	Earliest construction completion	Planning Stage
SESRO (potential water source for T2ST)	South East Strategic Reservoir Option. New reservoir development near Abingdon.	2036-37	SRO Gate 1 July 2021
STT (potential water source for T2ST)	Severn to Thames Transfer.	2033	SRO Gate 1 July 2021
Havant Thicket Reservoir	Treated water transfer [redacted]	SRN WRMP19 option for potential construction within AMP78 by 2027.	SRO Gate 2 September 2021
Desalination	Desalination scheme with transfer to Southampton West Water Resource Zone	SRN WRMP19 option for potential construction within AMP8 by 2027.	SRO Gate 2 September 2021
Water Recycling	Water recycling scheme with transfer to Southampton West Water Resource Zone	SRN WRMP19 option for potential construction within AMP8 by 2027.	SRO Gate 2 September 2021
West Country South SRO	Potential transfer from SWW to Southampton West Water Resource Zone	SRN WRMP19 option	SRO Gate 1 July 2021
West Country North SRO	Potential transfer from WW to SRN Andover zone	SRN WRMP19 option	SRO Gate 1 July 2021
Southampton Link Main	New 45Ml/d potable water main from Testwood to Otterbourne.	SRN WRMP19 option with planned construction by 2027	Non SRO scheme Planning ongoing for submission in AMP7.
Andover to Otterbourne Link Main	25Ml/d potable water main from Testwood to Andover.	SRN WRMP19 option with planned construction by 2027	Non SRO scheme Planning ongoing for submission in AMP7.

In addition to the number of potential water resource solutions for the Hampshire supply area, there is also uncertainty around the long term water resource need in terms of future demand growth and water required to meet environmental ambition targets and ensure sustainable abstraction is achieved in the long term to protect the environment.

Figure 8.1: T2ST transfer inter-related schemes affecting need and timing of T2ST



Given the remaining uncertainty around the long term project need for T2ST it is recommended that work proceeds to completion of Gate 2 of the T2ST SRO in October 2022 when the need case for the transfer will be more substantially defined from ongoing WRSE modelling outputs and TW and SRN water resource planning for WRMP24. An informed decision can then be taken on whether to proceed to Gate 3 or place the work on hold.

8.2. Key Risks and Opportunities

Risks and opportunities for T2ST are included within the scheme risk register as provided within the Cost and Carbon Report. Key risks and opportunities are as follows:

Key Risks

- *T2ST is not supported by WRSE Regional plan and WRMP24. Project need cannot be established*
- *T2ST is dependent on SESRO or STT being commissioned to provide a water source for transfer. Hence the timing of T2ST is tied to SESRO/STT.*
- *Environmental impacts lead to objections from stakeholders, with mitigation to be achieved through careful routeing of pipe corridors away from designated sites and use of trenchless construction.*
- *Risk of transfer of non-native invasive species between river catchments, mitigated by robust water treatment design.*
- *Local planning opposition to development of above ground assets, including water treatment works, pumping stations and storage tanks.*

- *Maintaining water quality for both potable and raw water options given the long transmission length for T2ST and storage volumes*

Key Opportunities

- *Provision of a strategic water transfer providing long term resilience of water supplies within the Hampshire region, including SEW and Portsmouth Water.*
- *Opportunities for improving the resilience of water supplies to TW Kennet Valley*
- *Opportunities during construction for habitat creation, biodiversity net gain and carbon offsetting initiatives.*
- *Potential utilisation of existing treatment works at Otterbourne/Testwood*
- *Potential use of Testwood Lakes or Broadlands Lake for raw water options to provide buffer storage and reduction in transfer capacity requirements*
- *Opportunities for reducing storage volumes once the preferred option is defined*.

8.3. T2ST Preferred Option

The concept design of the 6No. identified options for T2ST has been developed and set out within Section 2 of this report. It is however too early within the scheme development to rule any of the options out at this stage prior to Gate 1. Further development of the options will be required following Gate 1, taking into account output from the WRSE regional plan and ongoing WRMP24 strategic planning, to establish a preferred T2ST option for submission at Gate 2 in October 2022. Key areas for further option development in Gate 2 are set out as follows:

1. T2ST Utilisation	The utilisation of the T2ST is dependent on the outcome of the WRSE regional modelling. At this stage it is expected that the transfer would only be required in periods of extreme drought but increased utilisation of the transfer may be required to meet longer term supply demand balance of the Hampshire region depending on the implementation and timing of other schemes and future environmental ambition targets.
2. Potable or raw water transfer	At this stage of the SRO development potable water transfers for T2ST (Options 1 and 4) have a number of identified advantages over raw water transfers, including greater resilience for the Kennet Valley area (with water treatment located within the Thames supply area); less risk of transferring INNS to Hampshire as water would be treated at source; lower capex due to fewer treatment sites; and potentially reduced maintenance costs associated with transfer of treated water compared to the transfer of higher turbidity raw water/cost of cleaning pipes and tanks. SEW have also indicated that they would prefer to receive a potable water transfer from T2ST rather than a raw water transfer, as part of SEW's non SRO option for a branch connection from T2ST to Basingstoke. However, the Testwood raw water options could still potentially be preferred if existing storage capacity could be utilised at Testwood Lakes, resulting in a reduction in the required T2ST transfer capacity.
3. Culham or Reading abstraction	The water source for T2ST will comprise either an abstraction from SESRO/or connection from STT at Culham, or from a new river intake on the River Thames at Reading (with supported river flows from SESRO/STT).

	The Reading option would result in a reduced length of transfer pipeline compared to Culham but has a higher planning risk than Culham, in that the abstraction and associated water treatment works or pumping station would be a new site located upstream of Reading [redacted] compared to Culham where T2ST would be integral to the proposed SESRO development site. There is also a risk that by abstracting water from the River Thames at Reading for T2ST could restrict the volume of SESRO/STT water available for transfer along the River Thames to London. This is because there is an expected maximum permissible discharge rate into the River Thames at Culham. Further river modelling in Gate 2 is required to model the proposed T2ST abstraction at Reading. There are also potential risks of losses to groundwater along the River Thames between Culham and Reading that will need to be assessed as part of the river modelling work in Gate 2.At this stage it is considered that sweetening flows to maintain the operational readiness of the transfer for the Reading options will be supported by releases from SESRO or STT to avoid any derogation of existing abstractions along the River Thames.
4. Destination of transfer water	The identified options for Gate 1 have considered the transfer of water from Culham or Reading to Otterbourne or Testwood with smaller spur connections to Kingsclere and Andover. A further non SRO option has also been modelled by WRSE for an offtake to SEW at Basingstoke. TW may also potentially require a branch connection from T2ST to provide increased resilience to the Kennet Valley Water resource zone. The preferred destination sites for T2ST will be informed by the output from the WRSE regional modelling and ongoing WRMP24 strategic planning by TW and SRN during Gate 2. As noted above in Section 8.1 there are a number of alternative solutions that may affect the required need and timing of T2ST. It is possible that a proportion of the existing treatment capacity at Otterbourne and Testwood could be utilised for the T2ST, thus reducing the capital works and costs required under T2ST. However, at this time there is uncertainty concerning the future utilisation of Otterbourne and Testwood, which will depend upon the outcome of the WRSE regional modelling and SRN's ongoing strategic planning for the Hampshire area including the potential implementation of desalination, water recycling and Havant Thicket Reservoir transfers to the Hampshire area.
5. Receiving Network improvements	Further work will be required to understand the requirements for distribution of T2ST water within the receiving treated water network and associated costs and associated water quality assessments to ensure there are no residual risks such as taste/odour or corrosivity issues.
6. Site Selection and Route Corridor	Following identification of preferred abstraction and destination sites for T2ST and hence definition of the preferred T2ST option, further work will be required to demonstrate a robust approach is taken in the site selection of all associated infrastructure sites including water treatment works, pumping stations, and break pressure/storage tanks. This is so that a robust case can be made to the LPAs and other stakeholders that all alternative solutions have been adequately assessed in determining the location of all sites.

This will also apply to the routeing of the pipeline corridor. Further detailed work in Gate 2 will be needed to establish the preferred alignment and width of the pipe corridor, demonstrating that all reasonable alternatives have been properly considered and assessed.

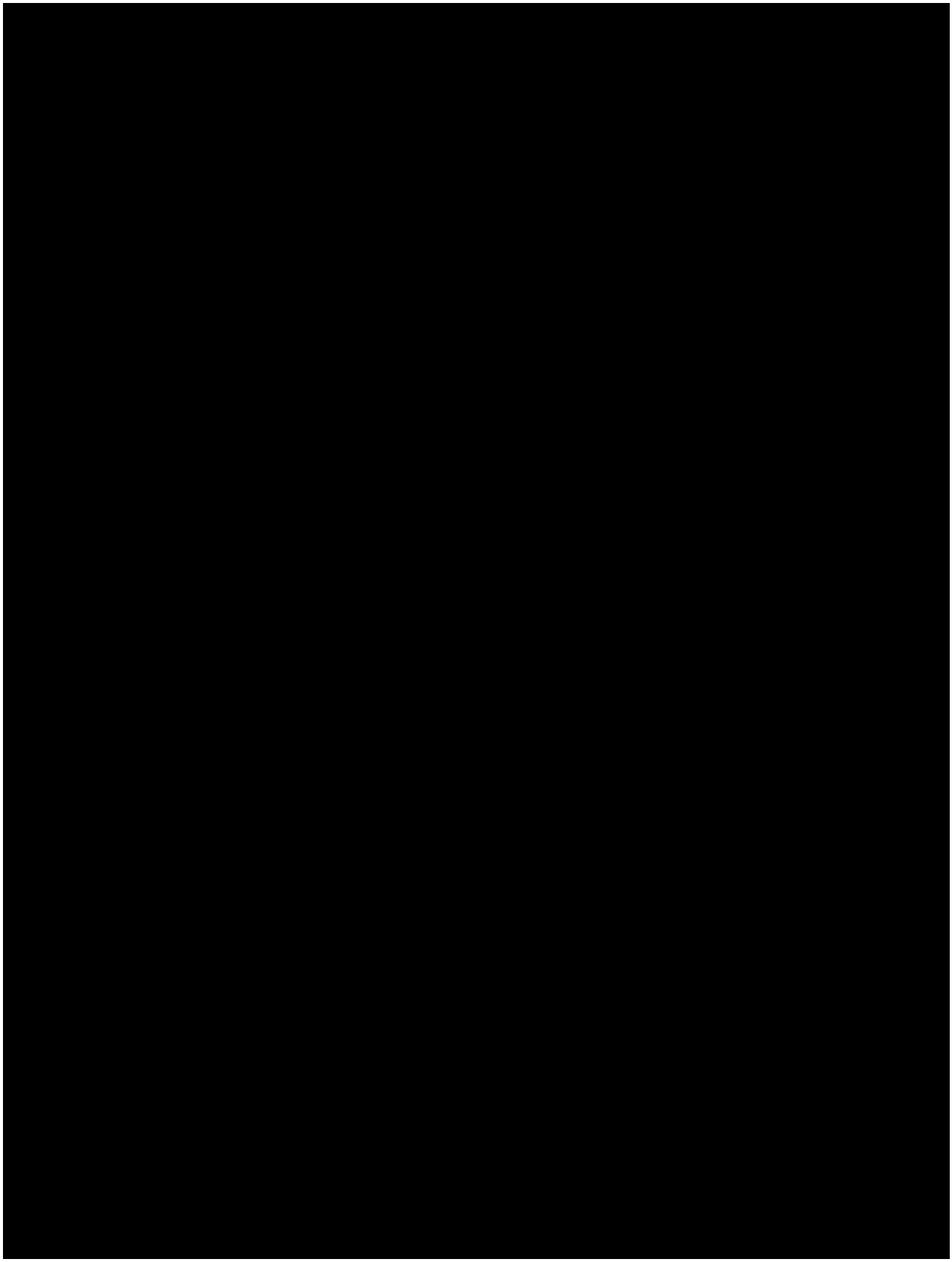
9. Glossary

Acronym	Definition
AA	Appropriate Assessment
ACWG	All Companies Working Group
BNG	Biodiversity Net Gain
BPT	Break Pressure Tanks
CPO	Compulsory Purchase Order
CAP	Competitively Appointed Provider
DCO	Development Consent Order
EA	Environment Agency
EAR	Environment Assessment Report
DAF	Dissolved Air Flotation
DYAA	Dry Year Annual Average
GAC	Granular Activated Carbon
HRA	Habitats Regulations Assessment
INNS	Invasive Non-Native Species
LPA	Local Planning Authority
NC	Natural Capital
NPS	National Planning Specification
NSIP	Nationally Significant Infrastructure Project
PMB	Project Management Board
RAPID	Regulators' Alliance for Progressing Infrastructure Development
RGF	Rapid Gravity Filter
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SESRO	South East Strategic Reservoir Option
SEW	South East Water
SPA	Special Protection Area
SRO	Strategic Resource Option
SSSI	Sites of Special Scientific Interest
STT	Severn Thames Transfer
SWOX	South West Oxfordshire Water Resource Zone
SR	Service Reservoir
T2ST	Thames to Southern Transfer
WFD	Water Framework Directive
WRMP	Water Resources Management Plan
WRSE	Water Resources South East
WSR	Water Supply Reservoir
WTW	Water Supply Works

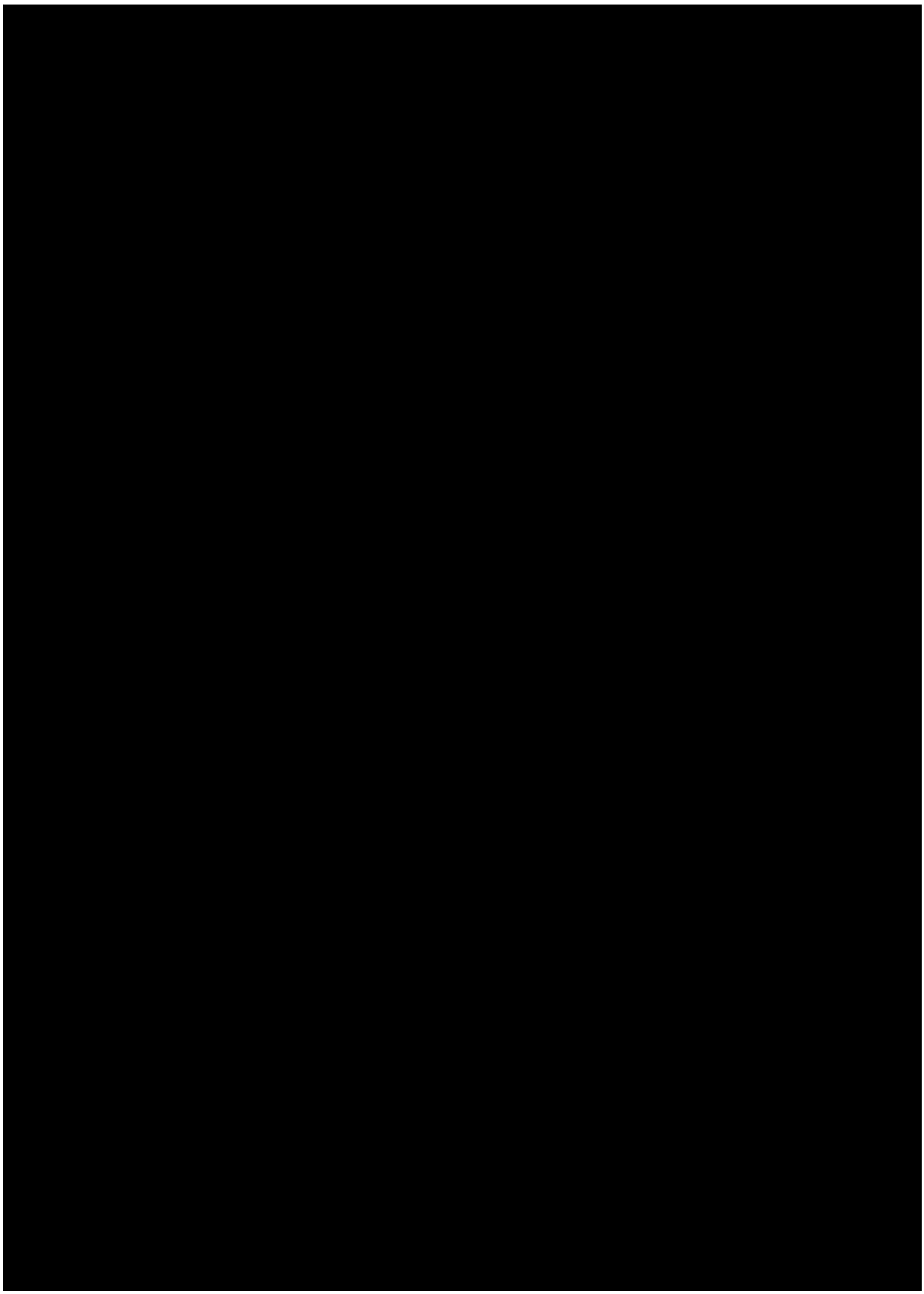
Appendices

Appendix A. Option Maps

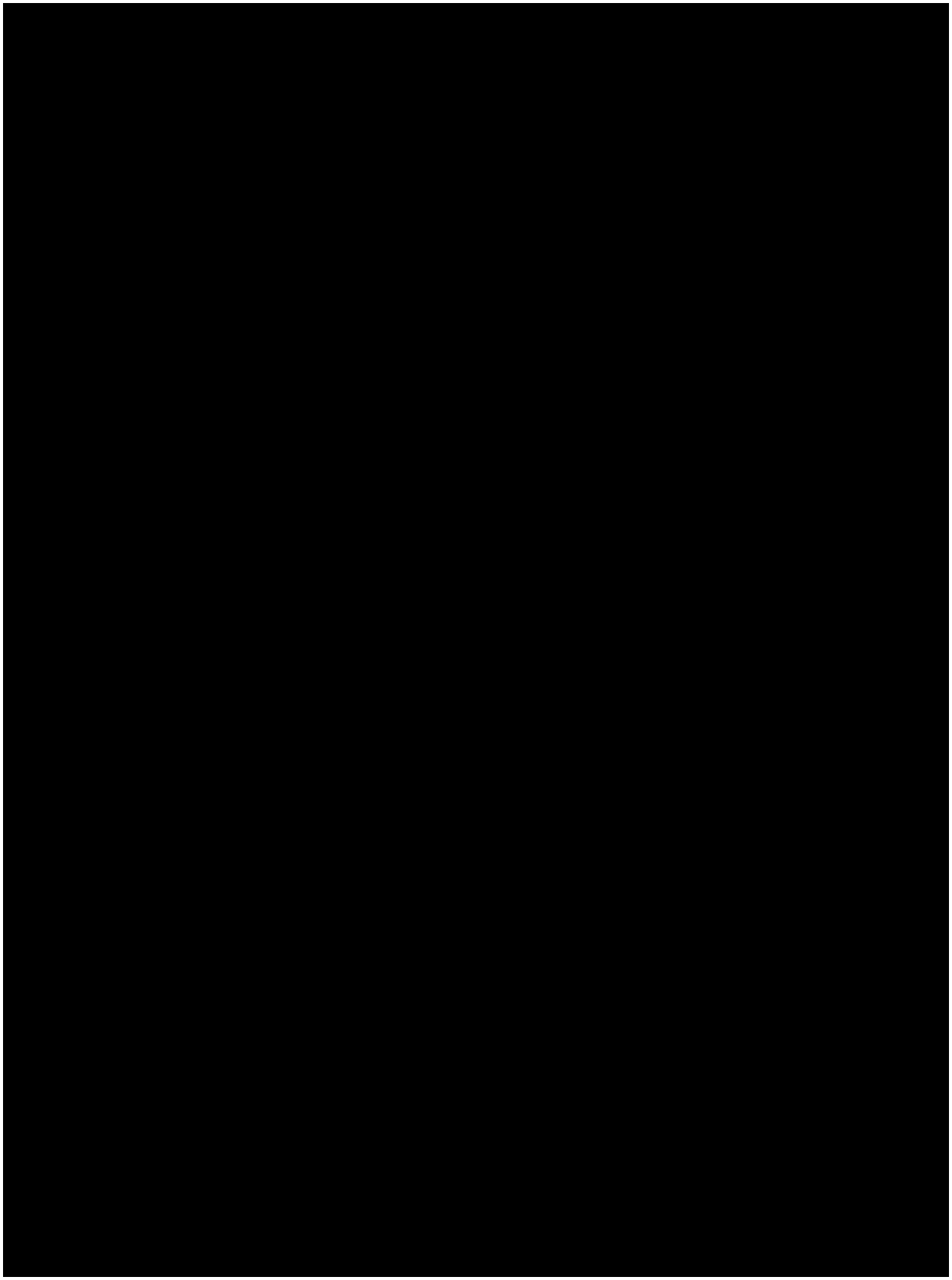
Option 1: Potable Water Transfer from Culham to Otterbourne (Environmental Designations): Figure A1



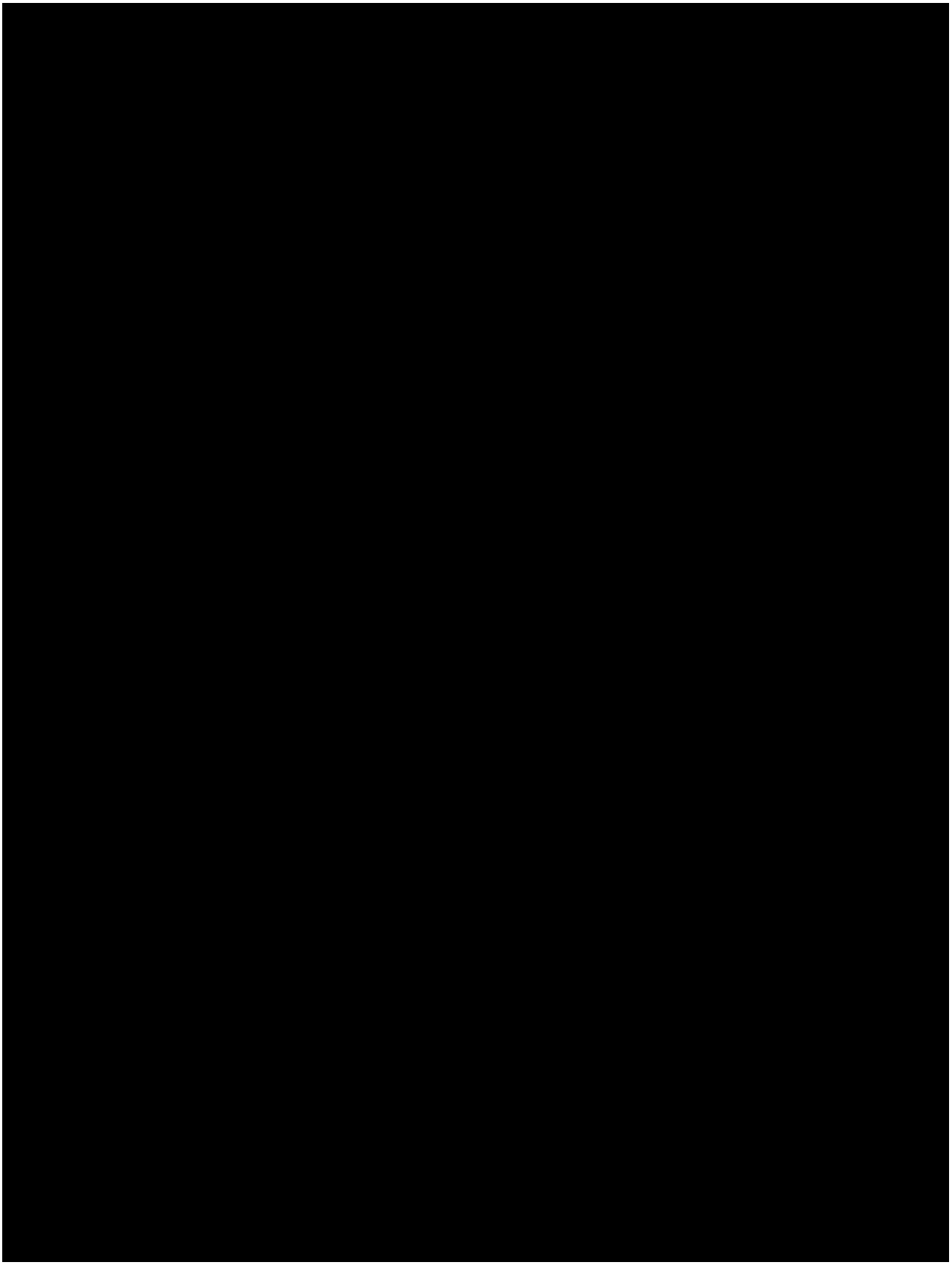
Option 1: Potable Water Transfer from Culham to Otterbourne (Water Resource Zones): Figure A2



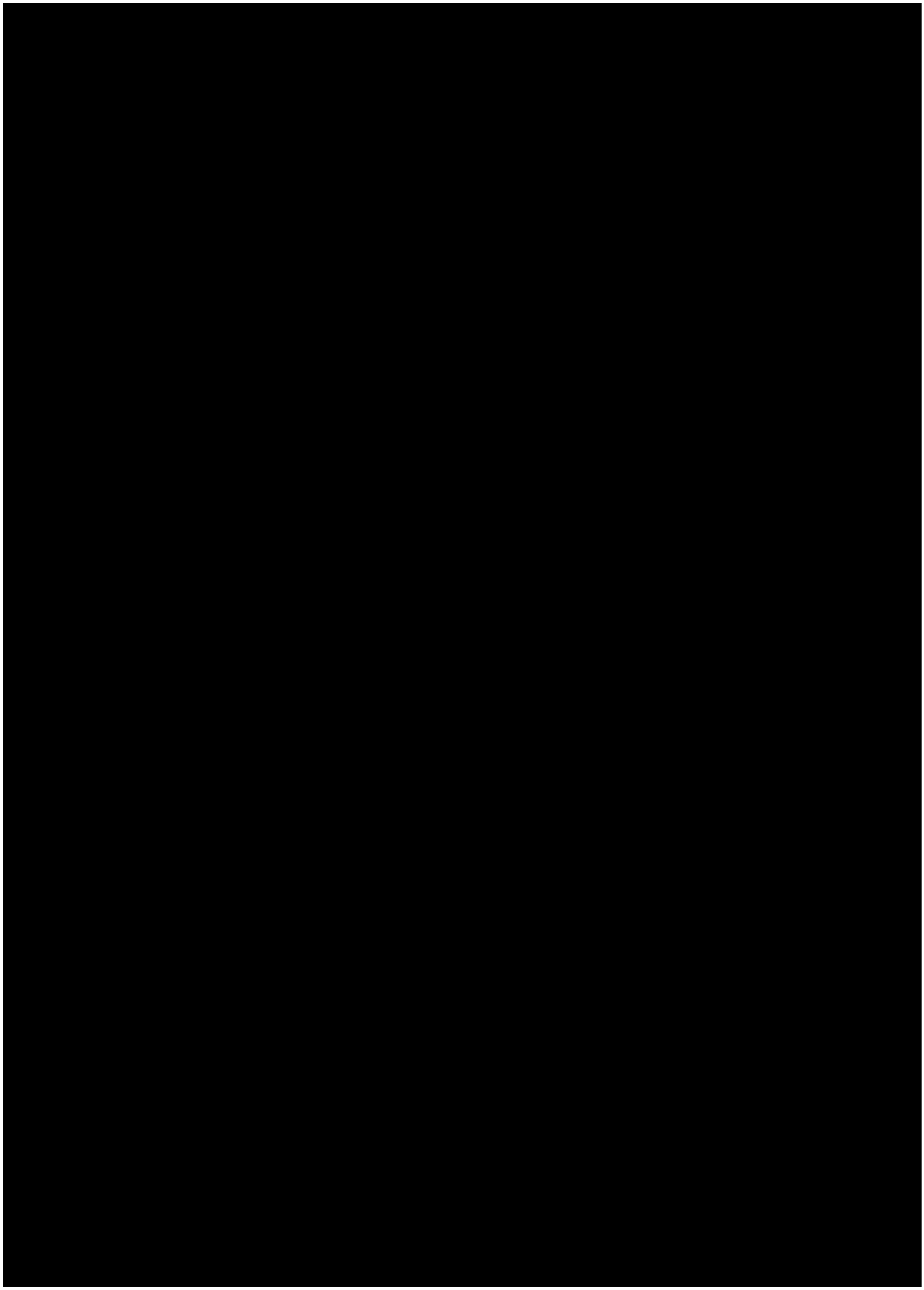
Option 2: Raw Water Transfer from Culham to Otterbourne (Environmental Designations): Figure A3



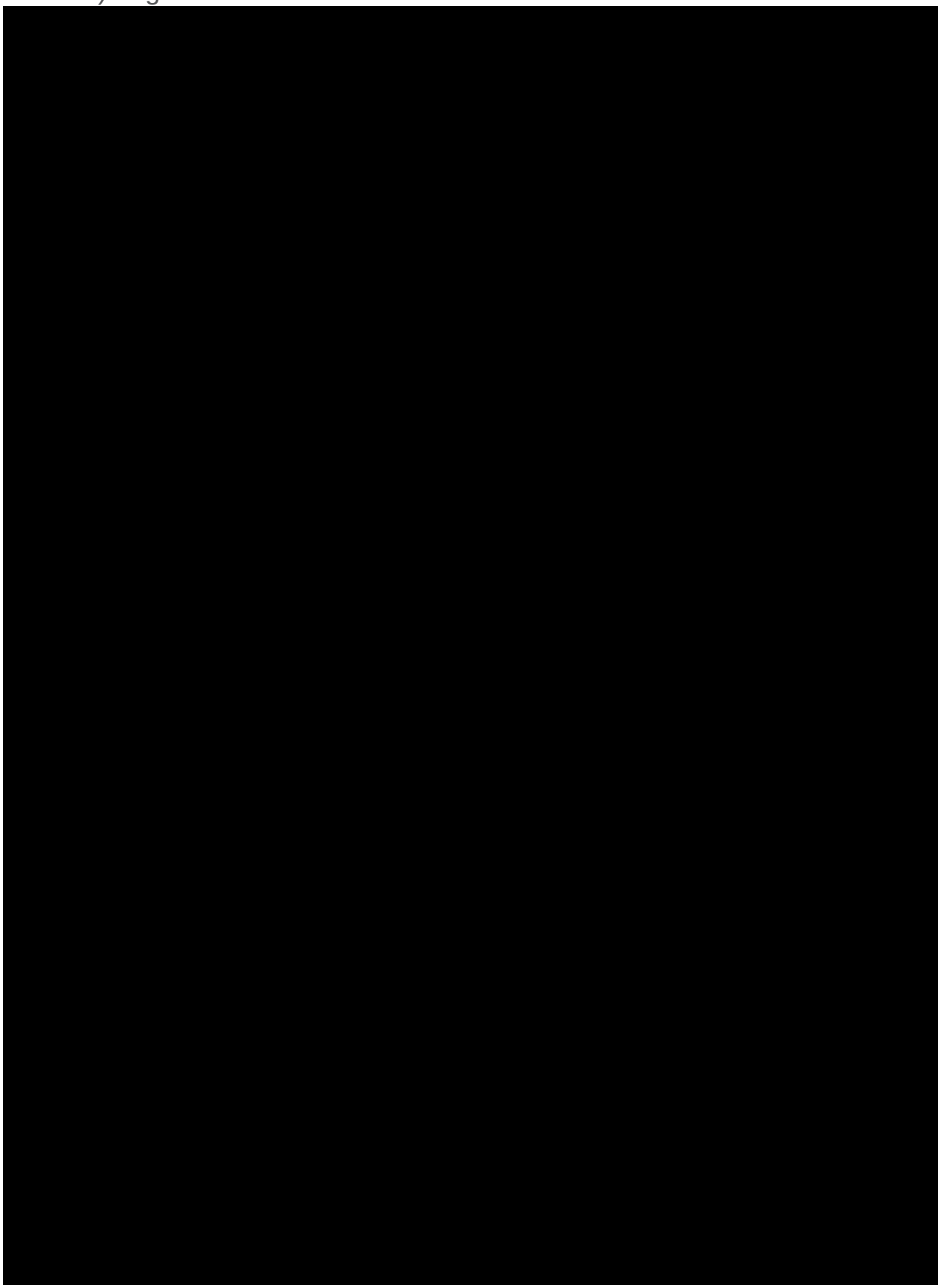
Option 2: Raw Water Transfer from Culham to Otterbourne (Water Resource Zones): Figure A4



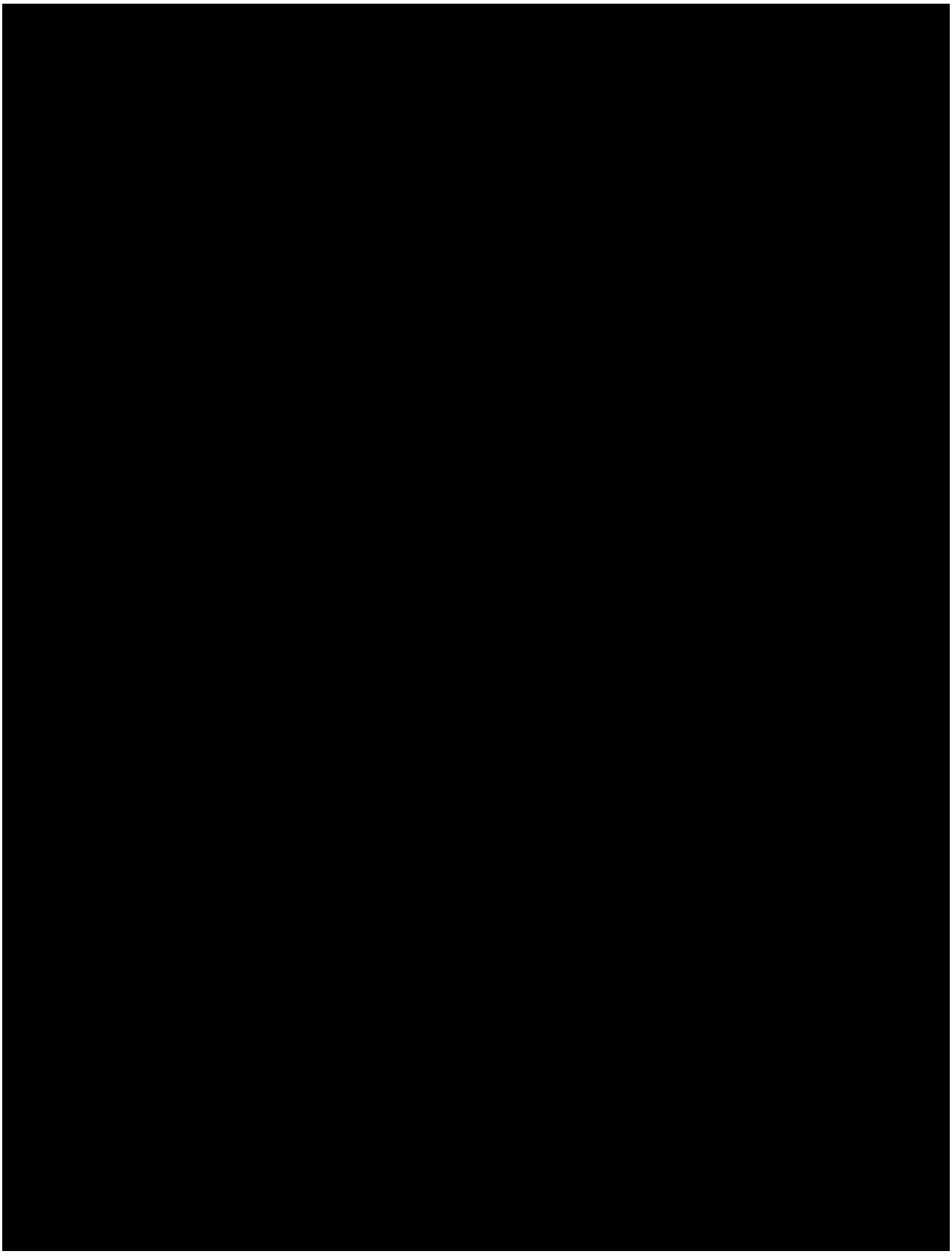
Option 3: Raw Water Transfer from Reading to Otterbourne (Environmental Designations): Figure A5



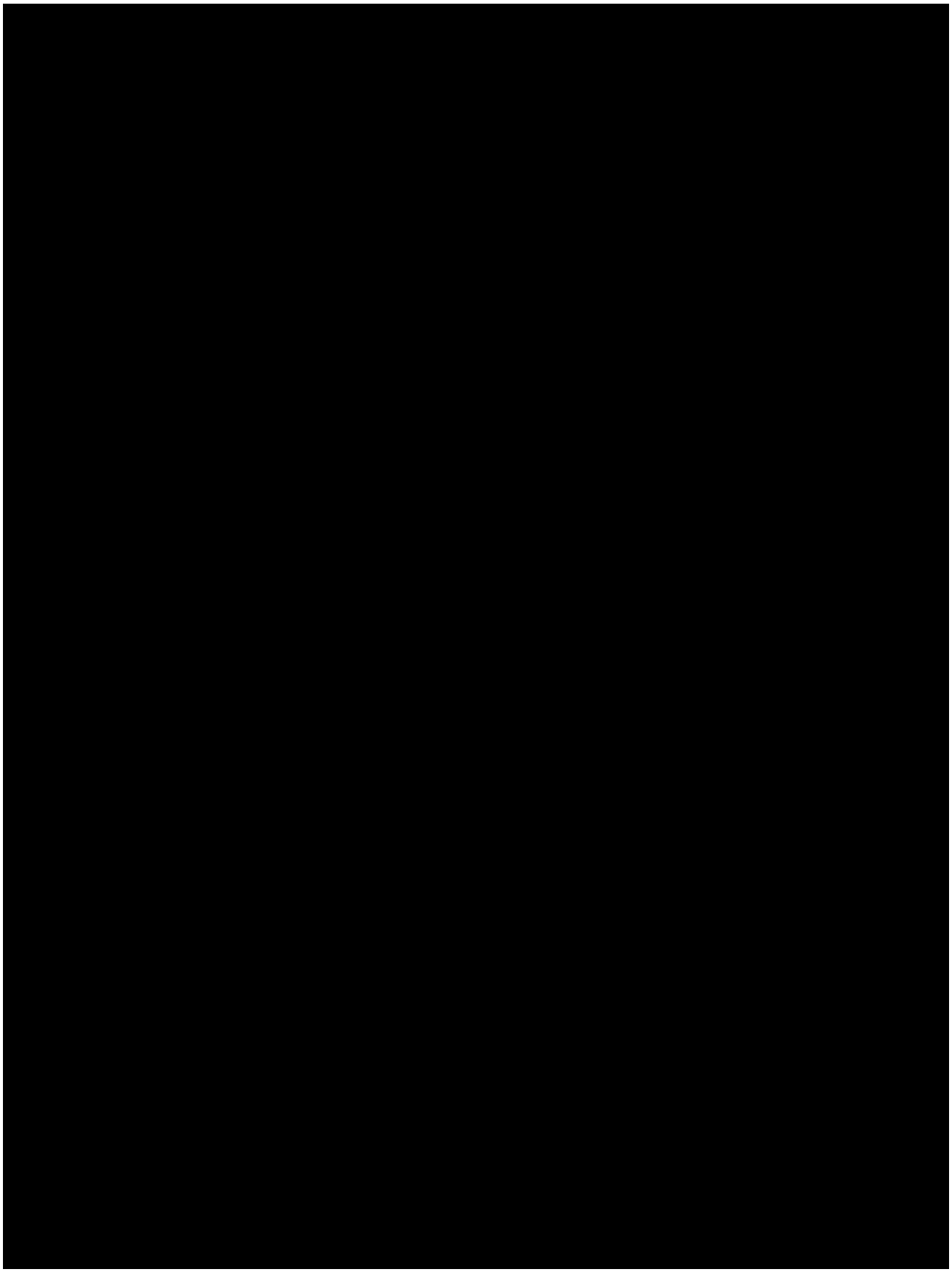
Option 3: Raw Water Transfer from Reading to Otterbourne (Water Resource Zones): Figure A6



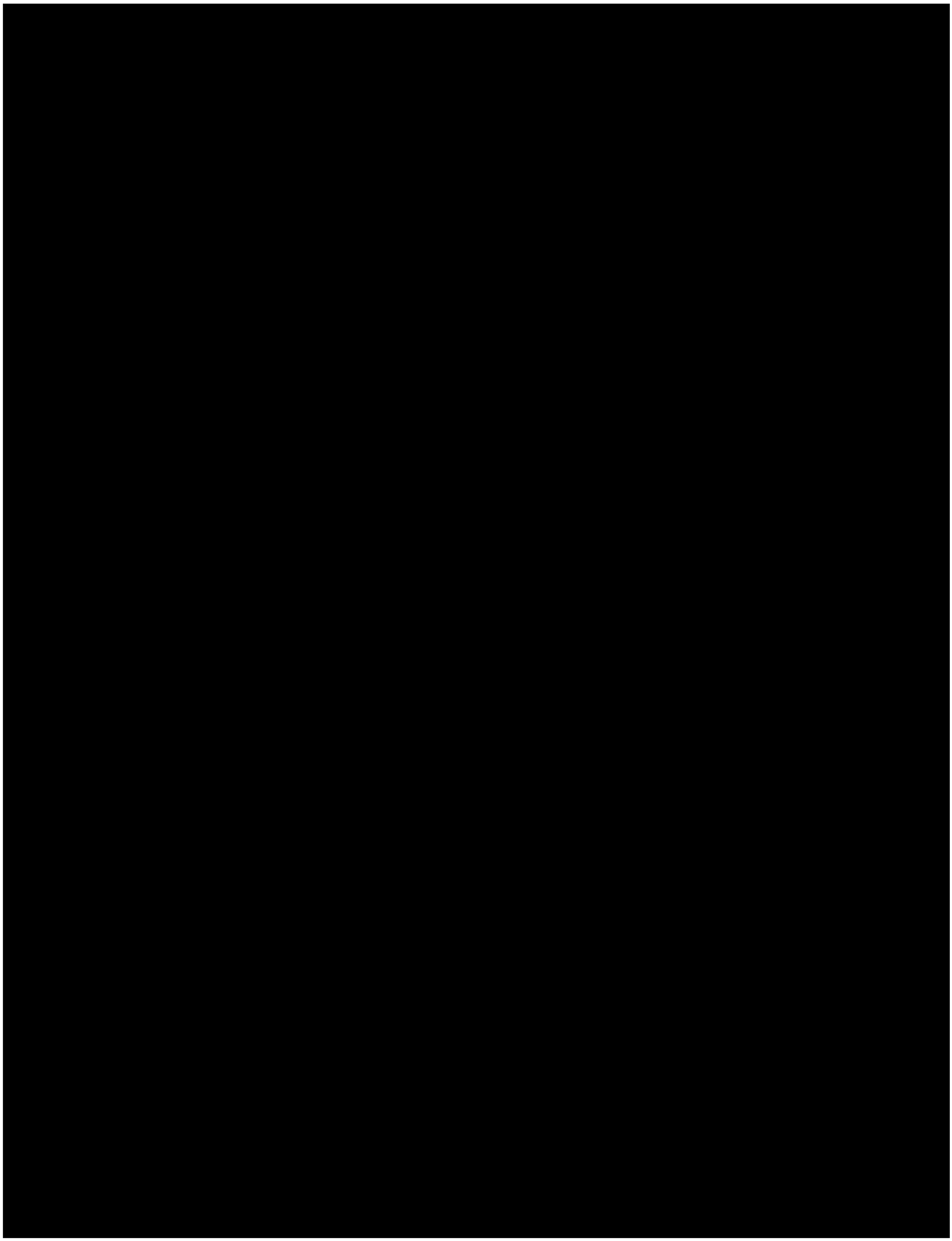
Option 4: Potable Water Transfer from Reading to Otterbourne (Environmental Designations): Figure A7



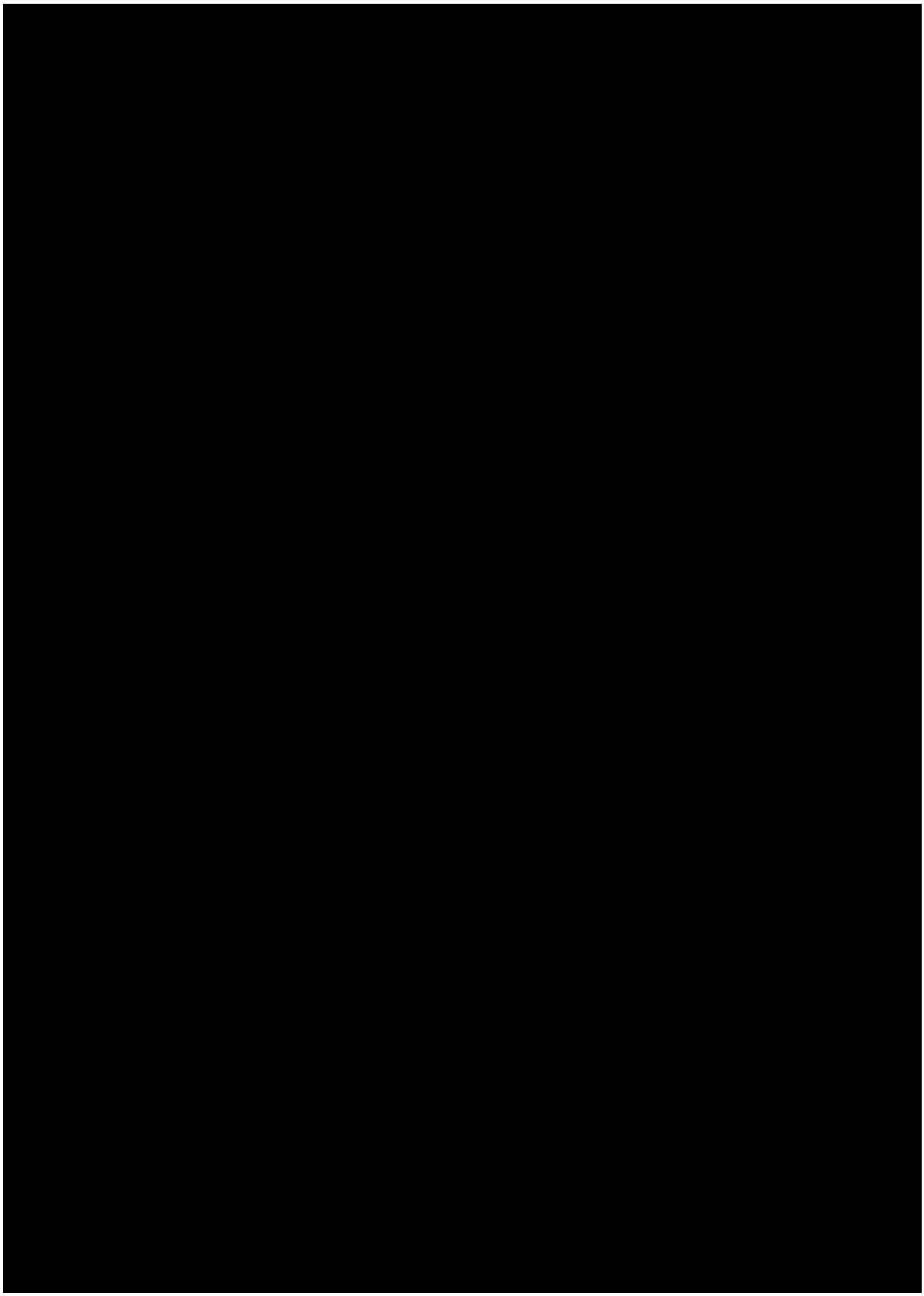
Option 4: Potable Water Transfer from Reading to Otterbourne (Water Resource Zones): Figure A8



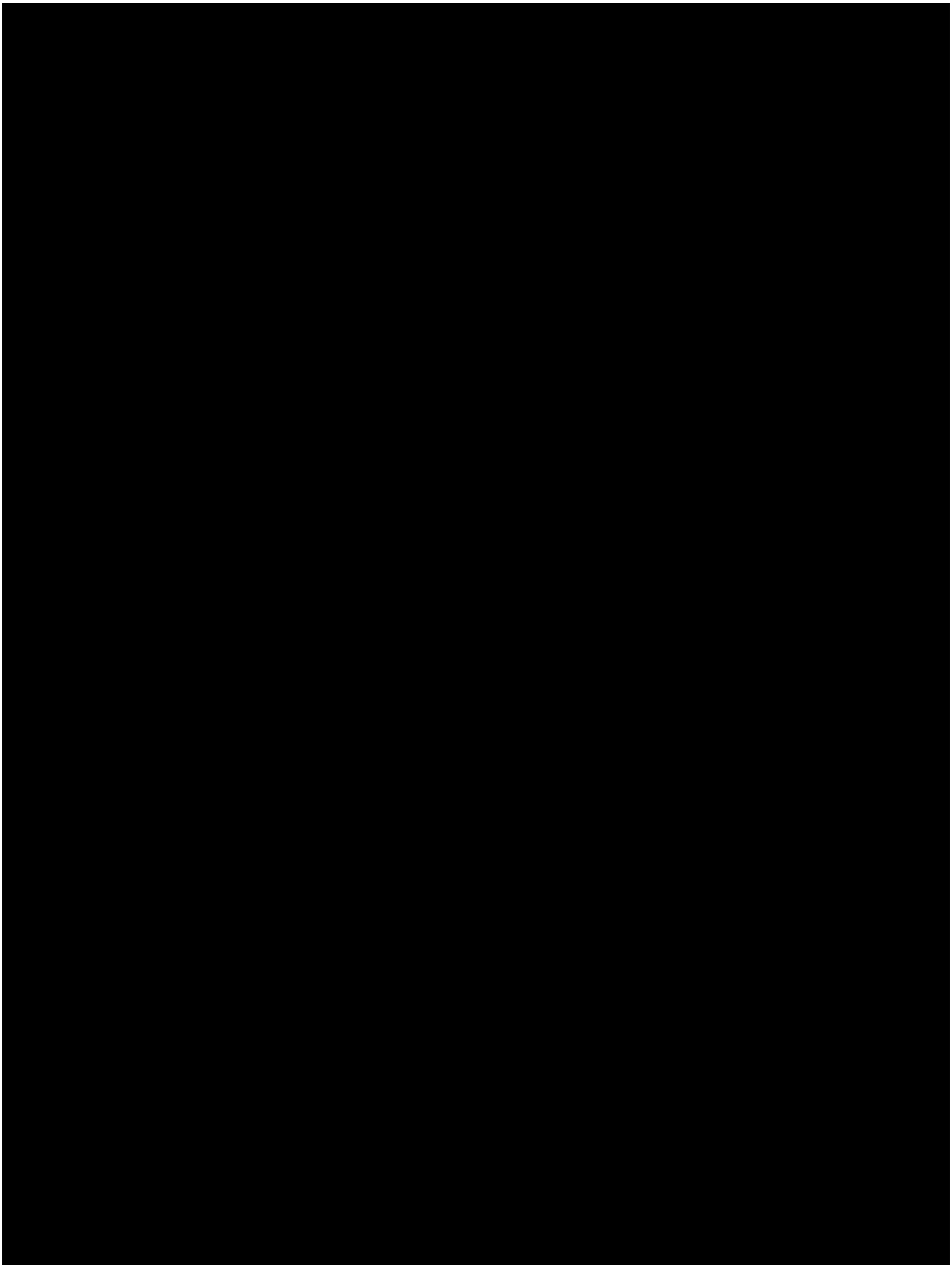
Option 5: Raw Transfer from Culham to Testwood (Environmental Designations): Figure A9



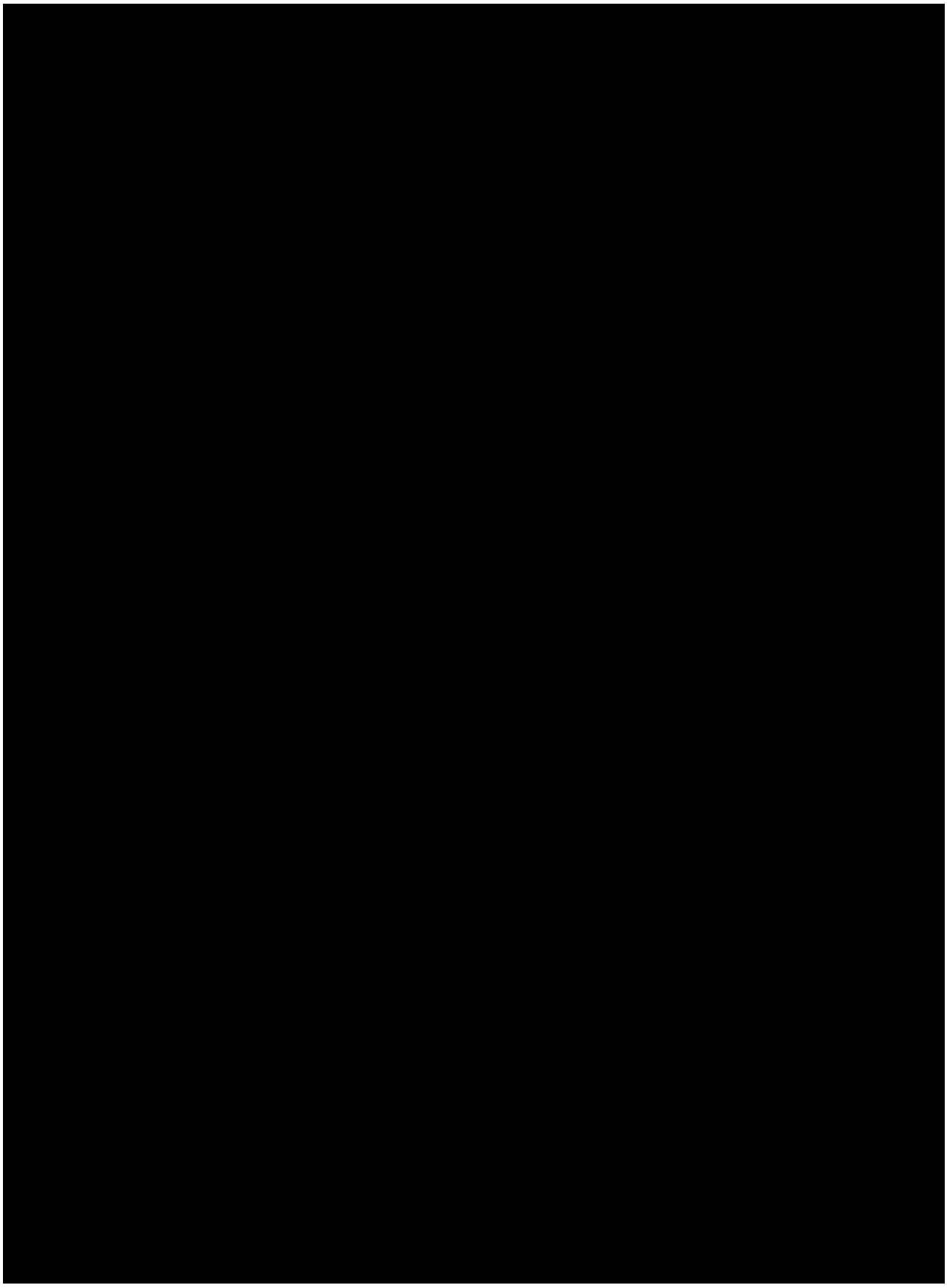
Option 5: Raw Transfer from Culham to Testwood (Water Resource Zones): Figure A10



Option 6: Raw Transfer from Reading to Testwood (Environmental Designations): Figure A11



Option 6: Raw Transfer from Reading to Testwood (Water Resource Zones): Figure A12



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