

# River Severn to River Thames Transfer (STT)

## Strategic regional water resource solution

### Regulatory Assessment Report:

### Water Framework Directive Regulations Compliance Assessment Report

July 2021





## Severn to Thames Transfer SRO

Environmental Assessment Report: Appendix B.4.3 Water Framework Directive (WFD)  
Regulations

Compliance Assessment Report

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Report for United Utilities on behalf of the Severn to  
Thames Transfer Programme

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## Separate Annexes (Excel workbooks)

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| Appendix B4.3 - WFD_Annex_1__Pipeline Conveyance (Full Support)     | Completed ACWG WFD compliance worksheet for STT grouping: 300 MI/d pipeline conveyance, full support system                                       |
| Appendix B4.3 - WFD_Annex_2__Pipeline Conveyance (without Minworth) | Completed ACWG WFD compliance worksheet for STT grouping: 300 MI/d pipeline conveyance, without Minworth WwTW discharge diversion support element |
| Appendix B4.3 - WFD_Annex_3__Canal Conveyance (Full Support)        | Completed ACWG WFD compliance worksheet for STT grouping: 300 MI/d canal conveyance, full support system  |
| Appendix B4.3 - WFD_Annex_4__Canal Conveyance (without Minworth)    | Completed ACWG WFD compliance worksheet for STT grouping: 300 MI/d canal conveyance, without Minworth WwTW discharge diversion support element4   |

## B4.3 WFD Regulations Compliance Assessment Report

### 1 Background and purpose of report

Ofwat, through the PR19 Final Determination, has identified the potential for companies to jointly deliver strategic regional water resources solutions to secure long-term resilience on behalf of customers while protecting the environment and benefiting wider society. As part of the assessment of companies' PR19 business plans, Ofwat introduced proposals to support the delivery of Strategic Regional Water Resource Options (SROs) over the next 5 to 15 years with solutions required to be 'construction ready' for the 2025-2030 period. Ofwat's Final Determination<sup>1</sup> in December 2019 set out a gated process for development of Strategic Resource Options (SROs) for the co-ordination and development of a consistent set of SROs.

This gated process provides a mechanism for the industry, regulators, stakeholders and customers to input into the development and scheduling of these strategic solutions, through a combined set of statutory and regulatory processes. These include the National Framework, Drinking Water Safety Plans, Business Plans and Water Resource Management Plans (WRMPs). The strategic regional working group (consisting of Affinity Water, Anglian Water, Severn Trent Water, Southern Water, South West Water, Thames Water, United Utilities and Wessex Water) published a joint company statement reiterating a commitment to continue working with the Regulators' Alliance for Progressing Infrastructure Development (RAPID), the Environment Agency (EA), Natural Resources Wales (NRW), Ofwat and the Drinking Water Inspectorate (DWI) to make all of the planning processes and statutory timetables a success.

The Severn to Thames Transfer (STT) Scheme has been identified as an SRO in the PR19 Final Determination, with funding allocated equally between Thames Water (TW), United Utilities Water (UU) and Severn Trent Water (STW). show a map of the scheme.

The STT Scheme involves the transfer of raw water from the lower reaches of the River Severn to the River Thames via an Interconnector, this comprising either a pipeline or a partly restored canal and pipeline route. Due to the risk of concurrent droughts in both river catchments additional sources of water (supported flows) apart from those naturally occurring in the River Severn (unsupported flows) have been identified to augment natural flows.

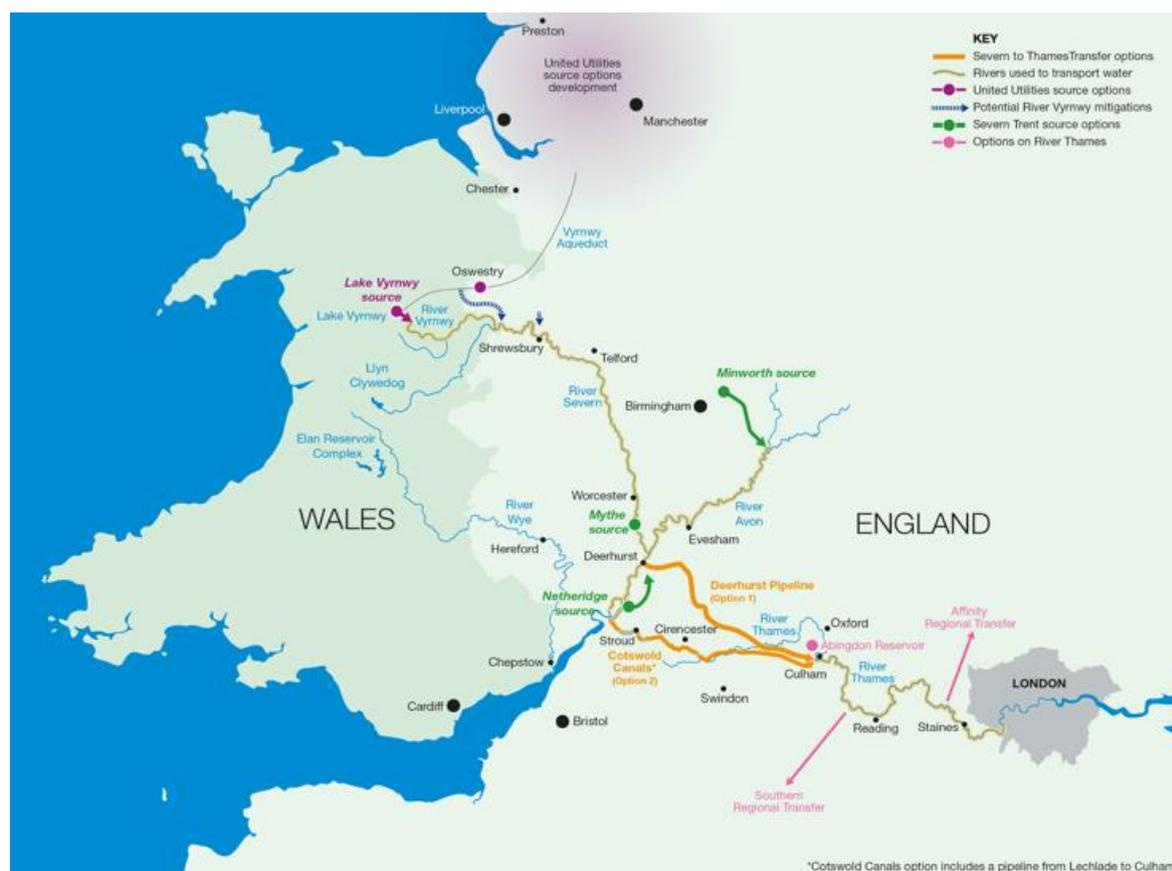
**Figure 1** presents a map illustrating the components of the STT Scheme.

The pipeline route involves the abstraction of water from the lower River Severn at Deerhurst with conveyance of the water for discharge to the middle River Thames at Culham. Another option being considered is for the transfer of raw water via the Cotswold canals. This option would require the restoration of the canals and the transfer of raw water from the River Severn into the Gloucester & Sharpness Canal at Gloucester Docks, the transfer of raw water from the Gloucester & Sharpness Canal to the restored Cotswold canals, the transfer of water from the restored Cotswold canals near Lechlade to a pipeline for conveyance to the River Thames near Culham. With both of these conveyance options the water available in the River Severn for transfer would be supported by the STT Source Support Elements, these comprising:

- regulation of up to 180 Ml/d from the Vyrnwy Reservoir in mid-Wales to the River Severn system;
- the transfer of up to 15 Ml/d of surplus abstraction licence volume from STW's Mythe river intake on the River Severn;
- up to 35 Ml/d treated discharge diversion from Netheridge Wastewater Treatment Works (WwTW) into the River Severn; and
- up to 115 Ml/d of treated discharge piped from Minworth WwTW to the River Avon.

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<sup>1</sup> Ofwat (2019), PR19 Final Determinations, Strategic regional water resource solutions appendix



**Figure 1 The Severn to Thames Transfer (STT) Scheme**

Government and regulators have identified the need for a more integrated planning approach – with the National Framework setting out requirements for five regional plans across England. The aim is to identify best value plans at a regional level that include ambitious demand management, take advantage of local surpluses that may be available and identify the best value SROs for implementation. Ofwat’s PR19 Final Determination identified that to achieve this objective it will be important that key inputs to the regional planning processes are consistent. It therefore set out requirements in the submission for conceptual design reports “*using comparable methodologies and consistent assumptions*” including in relation to costs, deployable outputs, environmental and water quality assessments.

The STT System covers a wide geographical area that includes two regional plan areas across England, namely; Water Resources South East (WRSE) and Water Resources West (WRW). Whilst each regional plan area will develop their own approach to environmental assessment and timescales for development of these plans to meet statutory targets it is important that the environmental assessment of the STT Scheme adopts a consistent approach.

In October 2020, the group of Water Companies involved in developing SROs (known as the All Company Working Group - ACWG), published guidance<sup>2</sup> for environmental assessment methods for SROs which is aligned to the Water Resources Planning Guideline (WRPG)<sup>3</sup> to increase the consistency of environmental assessment and the evaluation of impacts on environmental water quality in particular.

The ACWG guidelines indicate that the process requires Water Companies to provide the following information related to each SRO at the stage outlined (see **Figure 2**).

<sup>2</sup> Mott MacDonald Limited (2020). All Companies Working Group WRMP environmental assessment guidance and applicability with SROs. Published October 2020

<sup>3</sup> Ofwat, NRW & EA (2021), Water Resources Planning Guideline – v9 for Publishing February 2021

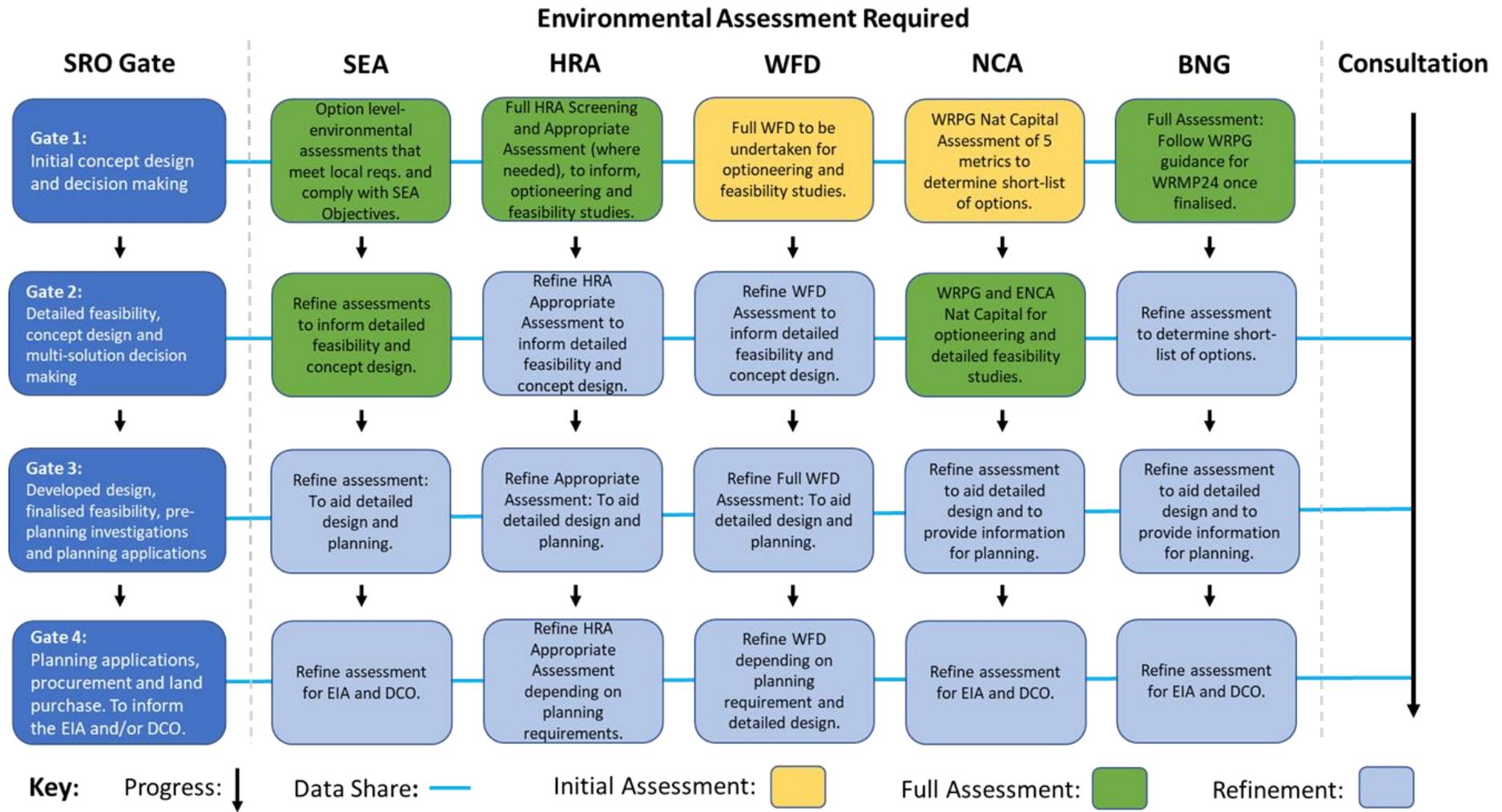


Figure 2 Environmental Assessment Integration with SRO Gates

This report sets out the Water Framework Directive Regulations<sup>4</sup> (WFD) Compliance Assessment for STT at Gate 1. The Water Framework Directive<sup>5</sup> is an EU Directive which, as of 31/12/2020, is no longer applicable to the United Kingdom. Therefore, the principle legal basis is the national legislation which currently mirrors the EU Directive. The Water Framework Directive has been translated into UK legislation as the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 in England and Wales. From this point forward “WFD” refers to the legislation applicable to England and Wales, not the EU Directive.

The WFD compliance assessment of the STT SRO has been undertaken in the context of the ACWG guidance. This approach has been adopted to assess the various components of the STT System, thus determining the environmental risk of the STT SRO in a manner consistent with the assessments that will be undertaken for the regional and individual water company WRMPs.

The assessment work is predicated on the STT System comprising the Interconnector and STT Source Support Elements identified as part of TW’s WRMP19, although some amendments to the scope of the STT Source Support Elements from those assessed in TW’s WRMP19 have been made. These are set out in Table 1.

**Table 1 Amendments to STT Source Support Elements from TW’s WRMP19**

| STT Source Support Element assessed in TW’s WRMP19 | STT Source Support Element assessed in SRO                               |
|--|--|
| Vyrnwy Reservoir release (60 MI/d)                 | Vyrnwy Reservoir release (75 MI/d)                                       |
| Vyrnwy Reservoir release (148 MI/d)                | River Vyrnwy Mitigation - Vyrnwy release (100 MI/d) and Bypass (80 MI/d) |
| Vyrnwy Reservoir release (180 MI/d)                | River Vyrnwy Mitigation – Vyrnwy Bypass release (155 MI/d)               |
| Shrewsbury Redeployment (12 MI/d)                  | River Vyrnwy Mitigation – Vyrnwy Bypass release (180 MI/d)               |
| Shrewsbury Redeployment (30 MI/d)                  | River Vyrnwy Mitigation – Shrewsbury Redeployment (25 MI/d)              |
| Mythe abstraction reduction (15 MI/d)              | Mythe abstraction reduction (15 MI/d)                                    |
| Netheridge WwTW discharge diversion (35 MI/d)      | Netheridge WwTW discharge diversion (35 MI/d) - Deerhurst Pipeline       |
| River Wye to Deerhurst (60 MI/d)                   | Netheridge WwTW discharge diversion (35 MI/d) - Cotswold Canals          |
| Minworth WwTW discharge diversion (115 MI/d)       | Minworth WwTW discharge diversion (115 MI/d)                             |

As set out in Table 1, further to discussions with STW a slight amendment to the availability of water from the Shrewsbury redeployment source support element has been made, and the possibility of water being sourced from the River Wye as was considered in TW’s WRMP19 does not form part of this assessment at Gate 1. A further conveyance route from Netheridge WwTW to the Cotswold Canal Interconnector has been added for assessment at the SRO stage and the pipeline routes from both Netheridge and Minworth WwTW’s have been amended following further design work by ST.

Whilst the provision of regulation of up to 180 MI/d from the Vyrnwy Reservoir in mid-Wales to the River Severn system still forms part of the STT SRO the manner in which this water can enter the River Severn system has changed from that assessed in TW’s WRMP19. In TW’s WRMP19 water from the Vyrnwy Reservoir was assessed as being released from the reservoir down the River Vyrnwy at three different flow volumes, these being 60, 148 and 180 MI/d. In light of consultations undertaken during the development of TW’s WRMP19 and further assessment work the amount of water that is now being proposed to be released directly from the Vyrnwy Reservoir down the River Vyrnwy has been limited to 75 MI/d. This reduction in the volume released down the River Vyrnwy from the reservoir has been undertaken in order to overcome concerns raised, especially by Natural Resources Wales (NRW), over potential adverse environmental effects on the River Vyrnwy immediately downstream of the Vyrnwy Reservoir. In consequence, as part of the STT SRO further feasibility work has been undertaken to identify alternative ways in which to deliver a total of 180 MI/d to the River Severn system from the Vyrnwy Reservoir. This alternative option (River Vyrnwy mitigation option) comprises the development

<sup>4</sup> Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. SI 2017 No. 407

<sup>5</sup> European Union (2000) Directive 2000/60/EC of the European Parliament and of the Council

of a raw water pipeline from the Vyrnwy Aqueduct upstream of Oswestry WTW to the lower reaches of the River Vyrnwy or River Severn.

Where new source support elements other than those identified and progressed through TW's WRMP19 have been identified these elements (the River Vyrnwy Bypass pipeline elements) have also been subject to WFD compliance assessment.

## 1.1 Area under consideration

The area under consideration for the assessment of the STT System reflects the large spatial scope of the SRO option which includes specific areas of the River Thames catchment area (downstream of Culham), the River Severn catchment area (River Severn corridor, from the confluence with the River Vyrnwy to the Severn Estuary; Lake Vyrnwy Reservoir in Powys (Wales); the downstream River Vyrnwy catchment to the River Severn confluence and the Warwickshire River Avon) and part of the River Tame catchment (downstream of the Minworth WwTW discharge).

## 1.2 Structure of this report

The report is divided into the following sections:

- Section 1: This introduction;
- Section 2: Provides a background to the STT System;
- Section 3: Provides the methodology adopted for the WFD Regulations compliance assessment;
- Section 4: Provides the results of the WFD compliance assessment Level 1 screening of STT Scheme options (combined STT Source Support Elements and Interconnector elements);
- Section 5: Provides the results of the WFD compliance assessment Level 2 assessment of STT Scheme options (combined STT Source Support Elements and Interconnector elements);
- Section 6: Conclusions and Recommendations to inform Gate 2 assessments.

## 2 Severn to Thames Transfer System

### 2.1 Introduction

A STT Scheme that conveys raw water from the lower River Severn into the middle River Thames via an interconnector would increase the catchment area from which water resources can be drawn to the south-east of England. In addition to any flows that may be available to be abstracted under licence from the River Severn, a range of raw water Source Support Elements for the STT System have been identified to provide additional resource.

The STT System comprises two principal aspects:

1. An Interconnector to convey the water from the River Severn to the River Thames; and
2. STT Source Support Elements, these comprise water resources that can be added, or not abstracted (redeployed), from the rivers Vyrnwy, Severn and Avon.

In terms of the Interconnector there are two options being considered.

Firstly, a pipeline with a capacity of 300 MI/d, 400 MI/d or 500 MI/d. This involves the abstraction of water from the lower River Severn at Deerhurst, its treatment at a new water treatment plant and then the transferring of the water for discharge to the middle River Thames at Culham.

The alternative option to the pipeline conveyance is for the transfer of raw water to be undertaken via the Cotswold canals. This option would require the restoration of the canals and the transfer of raw water from the River Severn into the Gloucester & Sharpness Canal at Gloucester Docks, the transfer of raw water from the Gloucester & Sharpness Canal to the restored Cotswold canals, the transfer of water from the restored Cotswold canals near Lechlade to a water treatment works, and then a pipeline for conveyance to the River Thames near Culham.

In order for some of the STT Source Support Elements to be able to deliver the water into the STT System, there is a requirement for these water supplies to be replaced with other water sources. The provision of this additional water is covered under separate SROs that provide the facilities to enable supporting flows for the STT. These SROs are STW Sources SRO, STW Minworth SRO, UU Sources SRO and UU Lake Vyrnwy SRO. The environmental effects of providing replacement water to the UU area to enable up to 180 MI/d of regulation to be provided from the Vyrnwy Reservoir in mid-Wales to the River Severn system have been assessed as part of the UU Sources SRO work. Equally the environmental effects of up to 115 MI/d from Minworth WwTW, of being diverted from the River Tame to the River Avon, have been assessed as part of the STW Sources SRO work. These assessment conclusions from these SROs have as yet to be provided to the STT SRO team as such no account of these environmental effects has been taken into account to date when assessing the STT System effects as described in Section 6 of this report.

The STT System comprises the STT SRO and the source SROs which would be required to work as a combined system to deliver the required outputs into the River Thames. **Table 2** illustrates the scope of the STT system and the related UU and STW individual company, source-related elements.

In total, there are eight different STT Source Support Elements at a variety of different capacities that comprise the STT System (see **Table 3**). The current compensation releases from the Vyrnwy Reservoir is 45 MI/d. In consequence, element reference 1a represents the baseline position and as such has not been considered as a separate assessment.

**Table 2 STT Source Support and Interconnector Elements**

| Element Ref | Element ID                | Name   |
|-------------|---------------------------|--|
| 1a          | VyrnwyRelease_45          | Vyrnwy Reservoir release (45 MI/d)                                       |
| 1b          | VyrnwyRelease_75          | Vyrnwy Reservoir release (75 MI/d)                                       |
| 2a          | MiddleVyrnwyBypass_80     | River Vyrnwy Mitigation - Vyrnwy release (100 MI/d) and Bypass (80 MI/d) |
| 2b          | MiddleVyrnwyBypass_155    | River Vyrnwy Mitigation – Vyrnwy Bypass release (155 MI/d)               |
| 2c          | VyrnwyBypass_180          | River Vyrnwy Mitigation – Vyrnwy Bypass release (180 MI/d)               |
| 3           | ShrewsburyRedeployment_25 | River Vyrnwy Mitigation – Shrewsbury Redeployment (25 MI/d)              |
| 4           | Mythe_15                  | Mythe abstraction reduction (15 MI/d)                                    |

| Element Ref | Element ID                     | Name   |
|-------------|--------------------------------|--|
| 5a          | NetheridgePipelineDeerhurst_35 | Netheridge WwTW discharge diversion (35 MI/d) - Deerhurst Pipeline |
| 5b          | NetheridgePipelineCotswold_35  | Netheridge WwTW discharge diversion (35 MI/d) - Cotswold Canals    |
| 6           | Minworth_115                   | Minworth WwTW discharge diversion (115 MI/d)                       |
| 7a          | DeerhurstPipeline_300          | Pipeline conveyance, Deerhurst to Culham (300 MI/d)                |
| 7b          | DeerhurstPipeline_400          | Pipeline conveyance, Deerhurst to Culham (400 MI/d)                |
| 7c          | DeerhurstPipeline_500          | Pipeline conveyance, Deerhurst to Culham (500 MI/d)                |
| 8           | CotswoldCanals_300             | Canal conveyance, including piping to Culham (300 MI/d)            |

As part of the development of the STT Scheme, Jacobs undertook modelling of the STT Source Support Elements to determine the groupings and order in which the support elements would become operational for each of the Interconnector options. The groupings include a conveyance option, UU sources and STW sources. The conveyance option is either pipeline or canal, in either cases sized at 300 MI/d. The UU sources are to a support rate of 180 MI/d, comprising 75 MI/d direct release from Vyrnwy Reservoir (Element 1b), 80 MI/d release into the lower River Vyrnwy via a bypass pipeline (Element 2a) and 25 MI/d redeployment of the current abstraction at Shrewsbury (Element 3). The STW sources include 15 MI/d Mythe abstraction reduction (Element 4), 35 MI/d Netheridge WwTW discharge diversion – (Element 5a/b) with location dependent on conveyance option. In each case there is a sub-group which does not include Element 6, the 115 MI/d Minworth WwTW discharge diversion. The order was determined having regard to a number of factors including cost and resilience. The ordering of bringing online the support elements, for both the Deerhurst to Culham pipeline conveyance and the Canal conveyance, is set out in Table 3.

**Table 3 STT Source Support Element Groupings in order of elements becoming operational**

| Pipeline conveyance |                                | Canal conveyance |                               |
|---------------------|--------------------------------|------------------|-------------------------------|
| Element Ref         | Element ID                     | Element Ref      | Element ID                    |
| 7a                  | DeerhurstPipeline_300          | 8                | CotswoldCanals_300            |
| 4                   | Mythe_15                       | 4                | Mythe_15                      |
| 1b                  | VyrnwyRelease_75               | 5b               | NetheridgePipelineCotswold_35 |
| 5a                  | NetheridgePipelineDeerhurst_35 | 1b               | VyrnwyRelease_75              |
| 3                   | ShrewsburyRedeployment_25      | 3                | ShrewsburyRedeployment_25     |
| 2a                  | MiddleVyrnwyBypass_80          | 2a               | MiddleVyrnwyBypass_80         |
| 6                   | Minworth_115                   | 6                | Minworth_115                  |

On the basis that the ordering of when the different STT Source Support Elements can become operational has been fixed through the work undertaken by Jacobs the environmental assessment of each of these support elements has had regard to the changing baseline position in terms of the receiving water environment. For example, when considering the introduction of the Shrewsbury Redeployment support element the assessment has regard that the water in the River Severn system would include the additional water being made available / provided by the Mythe (15 MI/d); Vyrnwy release (75 MI/d); and Netheridge (35 MI/d) source support elements.

A more detailed description of each element is provided in the sections below.

## 2.2 Pipeline conveyance, Deerhurst to Culham (300, 400 and 500 MI/d) – element 7 a, b, and c

This element comprises a conveyance pipeline from Deerhurst on the lower River Severn to Culham on the middle River Thames initially with the unsupported flow from the River Severn system and then including for additional supported flows with a 300, 400 or 500 MI/d capacity and a total length 88 km. The element includes all engineering works required to transfer the flow to the River Thames. This includes: a river intake structure at Deerhurst including inlet screens and a twin pipeline to a low lift pump station, a raw water low lift pump station and a twin pipeline to the water treatment works, treatment works, a treated water high lift pump station, a rising main; a break pressure tank at the high point, a gravity main to discharge, an outfall at Culham with an actuated valve and an aeration cascade, washouts along the route provided with permanent discharge pipework to adjacent watercourses.

Assessment of the water quality and ecological effects of pipeline transfer on the lower River Severn and River Thames was previously undertaken for TW<sup>6</sup>. The engineering conceptual design of the water treatment works between the River Severn intake and River Thames outfall and the inclusion of aeration prior to discharge, as presented in the Conceptual Design Report, was developed to mitigate the identified environmental water quality risks and assist the management of INNS transfer.

### 2.3 Canal conveyance, including piping to Culham (300 MI/d) – element 8

The concept of canal conveyance is to utilise the historic infrastructure of the Cotswold Canals (Stroudwater Navigation and Thames and Severn Canals), in conjunction with the Gloucester and Sharpness Ship Canal and new pipeline transfer 300 MI/d water from the River Severn to the River Thames. Initially this conveyance element will make use of the unsupported flow from the River Severn system and will then include for additional supported flows with a 300 MI/d capacity. The engineering concept can be split into four broad segments:

1. River Severn (at Gloucester) to Summit Pound. The water will be abstracted from the River Severn at Gloucester via a low head pumping station and discharged into the Gloucester and Sharpness Ship Canal at the Gloucester Docks basin. Water will transfer by gravity along the operational Gloucester and Sharpness Ship Canal for abstraction at Saul Junction. At Saul Junction, water will be transferred by a series of [REDACTED] [REDACTED] to Newtown Pound and [REDACTED] [REDACTED] to Sapperton Tunnel [REDACTED] Long pounds in the existing canal will be used for flow transfer between the discharge structure of one rising main and the intake to the next. The pipe which constitutes each rising main will be laid in the towpath or canal bed or along adjacent roads.
2. Summit Pound. In this section water will be transferred through the existing but currently damaged Sapperton Tunnel, then along the remainder of the summit pound. This will be rehabilitated, both for the water transfer and to allow navigation.
3. Summit Pound to Lechlade. In this section water will be transferred downhill along the canal by gravity, until it meets the River Thames at or near Inglesham. Locks are by-passed by abstracting the transfer water uphill of the lock and transferring it in a short length of pipe to a discharge point just downhill of the lock. This bypass arrangement is required to enable the locks to be used for navigation during the transfer.
4. Lechlade to Culham/ River Thames: Water will be processed at a new water treatment works and a pipeline will convey transfer flows to a discharge location at Culham. Pipeline diameters will be chosen to keep flow velocities below 2.5 M/s, as required by TW Asset Standard.

Assessment of the water quality and ecological effects of canal transfer on the River Thames was previously undertaken for TW<sup>7</sup>. The engineering conceptual design of the water treatment works between the canal offtake prior to Lechlade-on-Thames and River Thames outfall at Culham and the inclusion of aeration prior to discharge, as presented in the Conceptual Design Report, was developed to mitigate the identified environmental water quality risks and assist the management of INNS transfer.

### 2.4 Mythe abstraction reduction (15 MI/d) – Element 4

This element provides support to STT abstraction from the Severn catchment by redeploying the 15 MI/d infrequently used part of the existing STW abstraction licence at its Mythe intake in the lower River Severn. This volume would remain in the River Severn for abstraction downstream at Deerhurst or Gloucester Docks by TW. The Mythe intake is located on the River Severn near Tewkesbury, [REDACTED] northeast of Deerhurst. STW has advised that no construction works would be required to redeploy the portion of the licence volume for abstraction by TW.

To provide sufficient water to support the STT System from the Mythe intake, additional resource may be required within STW's system. It is understood from STW that no specific additional resource to

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<sup>6</sup> HR Wallingford and Cascade Consulting (2016) Severn Thames Transfer: Water Quality and Ecology Assessment - Phase 2. Main Project Report. Report for Thames Water

<sup>7</sup> HR Wallingford and Cascade Consulting (2016) Severn Thames Transfer: Water Quality and Ecology Assessment - Phase 2. Main Project Report. Report for Thames Water

replace this current abstraction licence volume has been determined to date and would require consideration at Gate 2. This assessment would be undertaken as part of the STW Sources SRO.

## 2.5 Vyrnwy Reservoir release (75 MI/d) – Element 1b

This element comprises the release of 75 MI/d water from Lake Vyrnwy Reservoir, an existing reservoir in Mid Wales, into the River Vyrnwy (a tributary of the River Severn) for supporting flow in the River Severn for downstream re-abstraction from the River Severn at Deerhurst or Gloucester Docks (and subsequent transfer into the River Thames to supply TW as well as potential other Water Companies). The reservoir is owned and operated by STW but predominately supplies water to UU who hold the abstraction rights for the reservoir and who have offered the water to TW when required.

As shown in **Table 3**, this element within the STT System would only become operational after the 15 MI/d of the licensed River Severn abstraction at Mythe has been made available. In consequence, this assessment has had regard to the water environment that includes for this additional water being made available for abstraction. Furthermore, to provide for this release of water to support the STT System from the Vyrnwy Reservoir, additional resource will be required within the UU operational area. This additional resource is subject to separate assessment under the UU Sources SRO.

## 2.6 Netheridge WwTW discharge diversion

### 2.6.1 Deerhurst Pipeline (35 MI/d) – Element 5a

Currently treated discharge from STW's Netheridge WwTW is put into the upper Severn Estuary. It is proposed to divert a 35 MI/d portion of this treated water to a new outfall on the freshwater River Severn to support STT abstraction from the River Severn at Deerhurst. The outfall location to the River Severn has been identified, during studies undertaken a Gate 1, to be located just downstream of the proposed intake from the River Severn at Deerhurst. The diversion from Netheridge WwTW would be pumped by a new pumping station, located at the WwTW via a 700 Mm diameter pipeline approximately [REDACTED] long.

The Gate 1 engineering conceptual design of the Netheridge support option states the inclusion of ferrous dosing prior to discharge, as presented in the Conceptual Design Report.

The transfer of WwTW discharge for STT support would not be continuous, only discharging to the freshwater river outfall according to an operating regime when support is required to enable abstraction from the River Severn. The discharge would be a flow replacement for river water abstracted locally upstream. The element will result in a relocation of water of up to 35 MI/d.

As shown in **Table 3**, this element within the STT System would only become operational after both the Mythe abstraction reduction (15 MI/d) support element and the Vyrnwy Reservoir Release (75 MI/d) support element have been made available. In consequence, this assessment has had regard to the water environment that includes for this additional water being made available for abstraction.

### 2.6.2 Netheridge WwTW discharge diversion, Cotswold Canals (35 MI/d) – Element 5b

Currently treated discharge from STW's Netheridge WwTW is put into the upper Severn Estuary. It is proposed to divert a 35 MI/d portion to a new outfall on the freshwater River Severn to support STT abstraction from the River Severn at Gloucester and Sharpness Canal. The discharge location puts water into the East Channel of the River Severn, just downstream of the proposed abstraction into Gloucester & Sharpness Canal. The diversion from Netheridge WwTW would be pumped by a new pumping station, located at the WwTW via a 700 Mm diameter pipeline approximately [REDACTED] long.

The Gate 1 engineering conceptual design of the Netheridge support option states the inclusion of ferrous dosing prior to discharge, as presented in the Conceptual Design Report. At present in Gate 1 there is limited evidence on the receiving water flows or quality in the eastern channel of the River Severn.

WwTW discharge transfer for STT support would not be continuous, only discharging to the freshwater river outfall according to an operating regime when support is required to enable abstraction from the River Severn. The discharge would be a flow replacement for river water abstracted locally upstream. The element will result in a relocation of up to 35 MI/d.

As shown in **Table 3**, this element within the STT System would only become operational after the Mythe abstraction reduction (15 MI/d) support element has been made available. In consequence, this assessment has had regard to the water environment that includes for this additional water being made available for abstraction.

## 2.7 River Vyrnwy Mitigation

Sustained high volume releases from the Vyrnwy Reservoir into the River Vyrnwy in support of the STT System has been identified as being of particular concern by NRW. A number of potential mitigation measures have been investigated to overcome potential unacceptable environmental impacts on the River Vyrnwy yet still providing up to 180 MI/d from the Vyrnwy Reservoir. One option is to suspend the abstraction licence at Shrewsbury, which would have a commensurate reduction of up to 25 MI/d in supply from Vyrnwy Reservoir, as Shrewsbury would then be supplied from the Vyrnwy Reservoir. A further mitigation option to the is the development of a River Vyrnwy Bypass pipeline that will be capable of transferring part of the Lake Vyrnwy Reservoir raw water releases from the Vyrnwy Aqueduct into the lower reaches of the River Vyrnwy or after its confluence with the River Severn.

As part of the Lake Vyrnwy Reservoir source, four potential source supply elements that could be used as environmental mitigation for Lake Vyrnwy Reservoir regulation releases directly into the River Vyrnwy have been identified. These being:

1. River Vyrnwy Mitigation - Shrewsbury redeployment (25 MI/d);
2. River Vyrnwy Mitigation – Middle River Vyrnwy Bypass (80 MI/d);
3. River Vyrnwy Mitigation – Middle River Vyrnwy Bypass (155 MI/d);
4. River Vyrnwy Mitigation – River Vyrnwy Bypass (180 MI/d).

### 2.7.1 Shrewsbury redeployment (25 MI/d) – Element 3

This element comprises additional redeployment of the existing River Severn abstraction at Shrewsbury, which will require the construction of a number of booster and pumping stations and process enhancements at Shelton water treatment works (WTW). Abstraction at Shrewsbury currently serves STW customers in Shrewsbury and Oswestry. UU and WwTW have offered to provide a supply to both Shrewsbury and Oswestry from Lake Vyrnwy Reservoir using the existing aqueduct and a new pipeline to Shrewsbury. This would reduce abstraction from the upper River Severn by 25 MI/d at Shrewsbury and leave water in the river for abstraction at Deerhurst or Gloucester Docks (and subsequent transfer into the River Thames to supply TW as well as potential other Water Companies).

As shown in **Table 3**, this element within the STT System would only become operational after the 75 MI/d Vyrnwy Reservoir Release support element, the 35 MI/d Netheridge WwTW discharge diversion support element and the 15 MI/d Mythe support element have been made available for abstraction at Deerhurst, or Gloucester Docks. In consequence, this assessment has had regard to the water environment that includes for this additional water being in the River Severn.

### 2.7.2 Middle River Vyrnwy Bypass (80 MI/d) - Element 2a

This element comprises a raw water pipeline which will transport up to 80 MI/d from the Vyrnwy Aqueduct, (which feeds Oswestry WTW) to the lower reaches of the River Vyrnwy. The pipeline is a mitigation measure for the impact of a support release the Vyrnwy Reservoir element on the reaches of the River Vyrnwy between the Reservoir and the confluence with the River Banwy.

As shown in **Table 3**, this element within the STT System would only become operational after the 75 MI/d Vyrnwy Reservoir Release support element, the 35 MI/d Netheridge WwTW discharge diversion support element, the 25 MI/d Shrewsbury Redeployment support element and the 15 MI/d Mythe support element have been made available for abstraction at Deerhurst, or Gloucester Docks. In

consequence, this assessment has had regard to the water environment that includes for all this additional water being in the River Severn.

The contribution of 25 MI/d from the abstraction reduction at Shrewsbury (element 3) and 75 MI/d from the Vyrnwy Reservoir release (element 1b), provides a total of 180 MI/d to the STT scheme from the Vyrnwy Reservoir.

### 2.7.3 Vyrnwy Bypass release (155 MI/d) – Element 2b

This element comprises a raw water pipeline which will transport 155 MI/d from the Vyrnwy Aqueduct, (which feeds Oswestry WTW) to the River Vyrnwy. The pipeline is a mitigation measure for the impact of a support release the Vyrnwy Reservoir element on the reaches of the River Vyrnwy between the Reservoir and the confluence with the River Banwy.

Operationally, this element also includes a contribution of 25 MI/d from the abstraction reduction at Shrewsbury (element 3) to contribute a total of 180 MI/d to the STT scheme. In addition to the above support elements this option would only become operational after the 35 MI/d Netheridge WwTW discharge diversion support element and the 15 MI/d Mythe support element have been made available for abstraction at Deerhurst, or Gloucester Docks. In consequence, this assessment has had regard to the water environment that includes for all this additional water being in the River Severn.

### 2.7.4 Vyrnwy Bypass release (180 MI/d) – Element 2c

This element comprises a raw water pipeline which will transport 180 MI/d from the Vyrnwy Aqueduct, (which feeds Oswestry WTW) to the River Severn. The pipeline is a mitigation measure for the impact of a support release the Vyrnwy Reservoir element on the reaches of the River Vyrnwy between the Reservoir and the confluence with the River Banwy.

This option would only become operational after the 35 MI/d Netheridge WwTW discharge diversion support element and the 15 MI/d Mythe support element have been made available for abstraction at Deerhurst, or Gloucester Docks. In consequence, this assessment has had regard to the water environment that includes for all this additional water being in the River Severn.

## 2.8 Minworth WwTW discharge diversion (115 MI/d) – Element 6

Currently treated discharge from STW's Minworth WwTW is input to the River Tame, a tributary of the River Trent. It is proposed to divert a 115 MI/d portion of this treated discharge to a new outfall on the River Avon and hence into the River Severn catchment to support STT abstraction from the River Severn at Deerhurst or Gloucester Docks.

There would be a new extended treatment facility and pumping station at Minworth WwTW. The Gate 1 engineering conceptual design of the Minworth support option states the inclusion of ferric dosing, cloth filter filtration, UV irradiation and granular activated carbon (GAC) prior to discharge, as presented in the Conceptual Design Report. The conceptual design at Gate 1 is without comprehensive coverage of evidence of chemicals in either Minworth WwTW discharge or the River Avon at the outfall location. The conceptual design notes that GAC is not commonly applied to wastewater effluent and a pilot plant would be required to demonstrate required efficacy.

The pipeline from Minworth WwTW to the River Avon outfall would be some [REDACTED] in length. The outfall location has been identified, during studies undertaken a Gate 1, and would be located on the River Avon to the south of Warwick.

WwTW discharge transfer for STT support would not be continuous – only discharging to the River Avon according to an operating regime when support is required to enable abstraction from the River Severn. The discharge would be a regulating release augmenting flows in the downstream Rivers Avon and Severn to the STT abstraction location at Deerhurst or Gloucester Docks.

As shown in **Table 3**, this element within the STT System would only become operational after the 75 MI/d Vyrnwy Reservoir Release support element, the Vyrnwy 80 MI/d support element, the 35 MI/d

Netheridge WwTW discharge diversion support element, the 25 MI/d Shrewsbury Redeployment support element and the 15 MI/d Mythe support element have all been made available for abstraction at Deerhurst, or Gloucester Docks. In consequence, this assessment has had regard to the water environment that includes for this additional water being in the River Severn.

## 3 Methodology

### 3.1 Methodology for Gate 1

#### 3.1.1 Overall approach

The ACWG guidelines set out an assessment approach and accompanying reporting spreadsheet for undertaking the constraint test of WFD Regulations compliance that is required for SRO. The ACWG guidelines identify three WFD objectives for assessing WFD constraints. These are established from Regulation 13 of the WFD Regulation as follows:

1. To prevent deterioration<sup>8</sup> of any WFD element of any water body.- in line with Regulation 13(2)a and 13(5)a
2. To prevent the introduction of impediments to the attainment of ‘Good’ WFD status or potential for any water body. It is accepted that for some water bodies achievement of Good status or potential is currently technically infeasible or disproportionately costly. Where this is the case, the test is applied to the currently agreed objectives for that water body rather than against Good status/potential.- in line with Regulation 13(2)b and 13(5)c.
3. To ensure that the legally binding planned programme of water body measures in the second cycle of River Basin Management Planning (RBMP2) to protect and enhance the status of water bodies are not compromised.-

These are the WFD compliance objectives that have been tested for constraints for the four STT groupings.

Following the ACWG guidelines, each STT grouping has been assessed using the Level 1 basic screening to identify potentially affected WFD water bodies and possible impacts based on activities. Using relevant EA guidance<sup>9</sup> most construction activities have been screened out at Level 1 as these would not lead to WFD non-compliance. For each of the WFD water bodies screened into the Level 2 assessment for each STT grouping the ACWG reporting spreadsheet has been completed and is available as a separate annex, see **Table 4**.

**Table 4 Accompanying ACWG assessment spreadsheets to this report**

| Filename  | Content   |
|---|---|
| Appendix B4.3 - WFD_Annex_1__Pipeline Conveyance (Full Support)     | Completed ACWG WFD compliance worksheet for STT grouping: 300 MI/d pipeline conveyance, full support system                                       |
| Appendix B4.3 - WFD_Annex_2__Pipeline Conveyance (without Minworth) | Completed ACWG WFD compliance worksheet for STT grouping: 300 MI/d pipeline conveyance, without Minworth WwTW discharge diversion support element |
| Appendix B4.3 - WFD_Annex_3__Canal Conveyance (Full Support)        | Completed ACWG WFD compliance worksheet for STT grouping: 300 MI/d canal conveyance, full support system  |
| Appendix B4.3 - WFD_Annex_4__Canal Conveyance (without Minworth)    | Completed ACWG WFD compliance worksheet for STT grouping: 300 MI/d canal conveyance, without Minworth WwTW discharge diversion support element4   |

Level 2 is a detailed screening for impact on each status element and RBMP2 programme of measures. For each WFD water body, the ACWG reporting spreadsheet sets out the published RBMP2 (2015) status of each WFD status element - for assessing elements included in status classification, not supporting elements. This provides the baseline for no deterioration to be established; therefore, supports the assessment of WFD Objective 1. This information also informs the assessment of WFD Objective 2 – for status elements already achieving Good status or their published RBMP3 target Objective 2 is not required to be tested. The spreadsheet also identifies the published Reasons for Not

<sup>8</sup> As defined in Section 1.3

<sup>9</sup> Environment Agency Operational Instruction OI 488\_10\_SD01 WFD compliance assessment for new physical modifications

Achieving Good status assessments undertaken by the EA. The spreadsheet will be used to record the published RBMP2 programme of measures for the water body for the assessment of WFD Objective 3.

For construction and operation activity types, such as “new or increased surface water abstraction”, the ACWG guideline has established a checklist of potential impact types such as “changes in flow velocity”. This has been used to inform the change in pressure on status elements. The Reasons for Not Achieving Good status assessments has been used to guide the understanding of existing pressures on the WFD status element in that water body. In the assessment, the spreadsheet documents the impact of each action’s potential impact type on WFD status elements and shows the impact score for each status element using the -2 (very beneficial) to +3 (high adverse impact) ACWG guideline’s scale. Compliance with WFD Objectives has been reported for each WFD status element and RBMP2 measure. Assessments have been undertaken proportionate to Gate 1, noting the level of confidence in the assessment and the level of design certainty.

The Level 1 basic screening of the four STT groupings is summarised in Section 4. The Level 2 assessment of the four STT groupings is summarised in Section 5. The Gate 1 Environmental Assessment Reports (Appendix B3) provides the supporting physical environment, water quality and aquatic ecology assessments that underpin the WFD compliance assessment.

### 3.1.2 Specific commentary on completion of the ACWG template

The ACWG template has been completed four times. Each of the accompanying Excel workbooks is specific to one of the four STT scheme groupings. The WFD compliance assessment of each grouping includes the Level 1 screening, the selection of Level 2 activities and the Level 2 assessment. The summary worksheets are auto-generated in the template for consistency in summary across SROs. In each case the assessment is of all the elements in the group together, rather than an element based assessment. This enables a WFD compliance assessment for each STT SRO grouping.

#### 3.1.2.1 Level 1 WFD screening

The Level 1 screening has been completed for all in-river construction works and the combined operating effects of the SRO grouping.

For construction activities this includes any intake and outfall construction. The screening does not include pipeline activities. It is noted that within the Level 2 activities assessment that all pipeline activities are scored as 0 or 1 and therefore no pipeline activities pass-forward to the detailed assessment. For the STT SRO there are many river water bodies which would include part of a pipeline corridor; for the Vyrnwy bypass pipeline, for the Minworth discharge transfer pipeline, for the Netheridge discharge transfer pipeline, and for the pipeline part of the conveyance. It is noted that both the pipeline conveyance and the canal conveyance include pipelines. For completeness, the relevant river water bodies associated with the pipeline corridors are listed in Section 4 below.

A bespoke hydrological assessment of each of the groupings has been undertaken, reported in the Gate 1 *Environmental Assessment Report Appendix B3.1 Modelling - Physical Environment Evidence*. That reach-based assessment along the flow pathway of the STT has been used to identify which waterbodies are subject to a major, moderate, minor or negligible flow change when compared with normal conditions. That assessment reviewed river flows over a 30-year period (1990-2019) to characterise river flow into bands from exceptionally low flow to exceptionally high flow on a given date. An indicative operational pattern specific to this grouping was established for the 10-year period (01/01/2010-31/12/2019) and compared with river flows under normal conditions in those years. The Level 1 screening considers those water bodies where a supporting element or the main transfer to the Thames catchment adds flow. The Level 1 screening also considers those water bodies downstream of these changes along the flow pathway. Those water bodies with a major or moderate flow change have been passed forward from Level 1 screen as requiring further WFD consideration based on flow changes. A secondary screen based on potential water quality changes has been used to select additional water bodies to pass forward from the Level 1 screen as requiring further WFD consideration. All other water bodies have been screened out at Level 1 as these would not lead to WFD non-compliance.

The ACWG approach lists activities relevant to river regulation releases as “High volume discharge of water with a quality element of the same/of a lower WFD status as the receiving water body”. In assessment we identify effects mostly associated with flow changes as “the same WFD status”, in acknowledgement either: that where the flow discharged is of water originating locally (e.g. Vyrnwy support options); or that it has been appropriately treated prior to discharge with high confidence in design (e.g. River Thames discharge). In assessment we identify effects associated with flow and/or quality changes as “a lower WFD status” where there is not, at Gate 1, high confidence in the design of the treatment prior to discharge (e.g. Minworth support option). The STT does not include any activities relevant to the consideration of WFD groundwater bodies.

### 3.1.2.2 Level 2 WFD assessment

Within the ACWG template, we note the following style guide to how we have documented the WFD assessment:

- Assessment has been undertaken against published RBMP2 (2015) status, RBMP2 mitigation measures, and RBMP3 published status targets. The embedded data in the ACWG template also includes status in other years, these are not applicable and have not been assessed against;
- The ACWG template includes the objective “Assists attainment of water body objectives”. That objectives is outside the ACWG guidelines and has not been used in the assessment of STT SRO groupings;
- For WFD status elements, in the upper section of the worksheet, the relevant WFD objectives that have been assessed against are “Deterioration between status classes” (Objective 1) and “Impediments to GES/GEP” (Objective 2);
- Where RBMP2 (2015) reported status is High or Good, Objective 2 is not applicable and has not been assessed against;
- Where RBMP2 (2015) reported status is at the RBMP3 target status, and that is noted as lower than High or Good, Objective 2 is not applicable and has not been assessed against;
- For RBMP2 mitigation measures, in the lower section of the worksheet, the relevant WFD objective that has been assessed against is “Compromise WB objectives” (Objective 3);
- The relevant WFD status elements for assessment of Objective 1 and Objective 2 in river water bodies<sup>10</sup> are those in the Water Framework Directive (WFD) Directions<sup>11</sup>, as listed in **Table 5**. It is noted that the ACWG template includes hydro-morphological supporting elements and these are not applicable and have not been assessed against;
- The ACWG template includes data from the EA “Reasons for Not Achieving Good” [status] database. These are not applicable to Objectives 1, 2, or 3 and have not been assessed against;
- For proportionality of assessment, the ACWG template “potential impacts of asset” have been collated for each “activity” with one consolidated assessment undertaken for each WFD status element;
- All assessment have been undertaken using the mitigation measures designed into the STT scheme, as documented in the Conceptual Design Reports. Furthermore this includes the assumptions/ mitigations as set out in the ACWG template which recognise compliance with regulations and good design practice. As such, there is no difference between the “impact” and “post mitigation impact” in the Level 2 assessment worksheet. Where there is potential for WFD objective non-compliance, additional mitigation actions that may reduce this potential and lead to WFD compliance is indicated in the narrative summary in Section 5 below, but not included in the WFD compliance assessment as it is not currently committed to or costed into STT design.

The 2015 Directions note the reporting of additional substances from 2018. These are not status elements in RBMP2 and do not currently have a formal status. Although an interim status position has

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<sup>10</sup> It is noted that only river water bodies have been passed forward to the Level 2 WFD assessment of STT SRO.

<sup>11</sup> Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

been documented by EA for 2019, it is not considered appropriate at this time to include these substances in a WFD compliance assessment. It is noted that the gated process will continue beyond RBMP3 publication, at which point these additional substances will have a formal status and a target status for 2027 from which to update the WFD compliance assessment.

**Table 5 Relevant WFD status elements from which to assess compliance in river water bodies**

| <b>Ecological status</b>  |                                      |              |                           |
|---|--------------------------------------|--------------|---------------------------|
| Biological status elements  | Fish                                 |              |                           |
|   | Invertebrates                        |              |                           |
|   | Macrophytes & phytobenthos combined  |              |                           |
| Physio-chemical   | Water temperature                    |              |                           |
|   | pH                                   |              |                           |
|   | Dissolved oxygen                     |              |                           |
|   | Ammonia                              |              |                           |
| Specific pollutants   | Reactive phosphorus (orthophosphate) |              |                           |
|   | 2,4-dichlorophenol                   | Copper       | Mecoprop                  |
|   | 2,4-dichlorophenoxyacetic acid       | Cyanide      | Methiocarb                |
|   | 3,4 dichloroaniline                  | Cypermethrin | Pendimethalin             |
|   | Arsenic                              | Diazinon     | Permethrin                |
|   | Benzyl butyl phthalate               | Dimethoate   | Phenol                    |
|   | Carbendazim                          | Glyphosate   | Tetrachloroethane         |
|   | Chlorothalonil                       | Iron         | Toluene                   |
|   | Chromium (III) (VI)                  | Linuron      | Triclosan                 |
|   | Chlorine                             | Manganese    | Zinc                      |
| <b>Chemical status</b>  |                                      |              |                           |
| Priority Substances, Priority Hazardous Substances and Other pollutants contributing to chemical status | Alachlor                             |              | Fluoranthene              |
|   | Anthracene                           |              | Hexachloro-benzene        |
|   | Atrazine                             |              | Hexachloro-butadiene      |
|   | Benzene                              |              | Hexachloro-cyclohexane    |
|   | Benzo(a)-pyrene (BaP)                |              | Indeno(1,2,3-cd)-pyrene   |
|   | Benzo(b)-fluor-anthene               |              | Isoproturon               |
|   | Benzo(k)-fluor-anthene               |              | Lead and its compounds    |
|   | Benzo(g,h,i)-perylene                |              | Mercury and its compounds |
|   | Brominated diphenylether             |              | Naphthalene               |
|   | Cadmium and its compounds            |              | Nickel and its compounds  |
|   | Carbon tetrachloride                 |              | Nonylphenol               |
|   | Chlorfenvinphos                      |              | Octylphenol               |
|   | C10-13 chloroalkanes                 |              | Pentachloro-benzene       |
|   | Chlorpyrifos                         |              | Pentachloro-phenol        |
|   | Cyclodiene pesticides isodrin        |              | Simazine                  |
|   | DDT total                            |              | Tetrachloro-ethylene      |
|   | Para-para-DDT                        |              | Tributyltin compounds     |
|   | 1,2-dichloro-ethane                  |              | Trichloro-benzenes        |
|   | Dichloro-methane                     |              | Trichloro-ethylene        |
|   | Di(2-ethylhexyl)-phthalate (DEHP)    |              | Trichloro-methane         |
|   | Diuron                               |              | Trifluralin               |
|   | Endosulphan                          |              |                           |

## 4 Summary of basic Level 1 WFD screening of STT groupings

### 4.1 Introduction

For each of the STT SRO groupings, the ACWG template Level 1 screening comprises the following worksheets completed by Ricardo:

“1. List relevant waterbodies” – these are the waterbodies in the study area as set out in the conceptualisation below

“2. Level 1 activities” – completed for construction activities and operational activities as set out below

A third worksheet “3. Level 1 summary” is auto-generated by the template to summarise those water bodies to be carried forward to the level 2 assessment.

As the ACWG template does not have specific sections for documenting the reasoning behind the selection of water bodies or activities, relevant description is set out below.

### 4.2 300 Ml/d pipeline conveyance, full support system

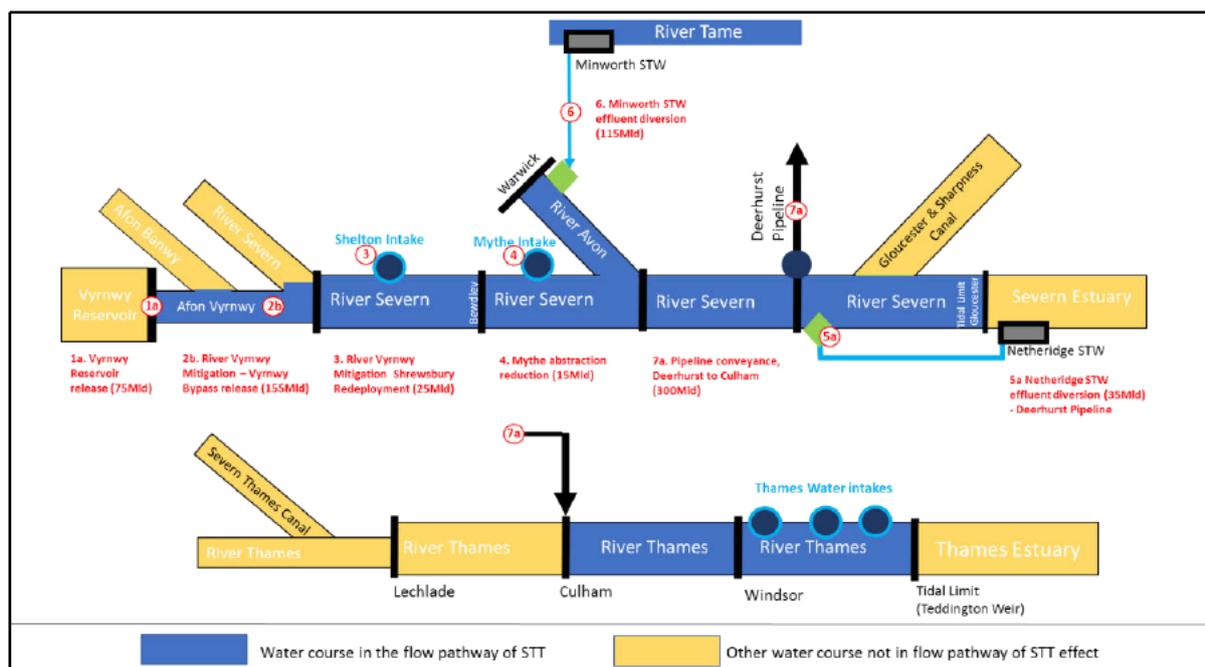
#### 4.2.1 Conceptualisation of study area

Without the support system, abstraction would reduce flow in the River Severn below the Deerhurst intake. As unsupported abstraction would be limited by hands-off flow conditions in the River Severn, flow reductions are deemed minor and the zone of influence to not extend beyond the tidal limit.

With the full support system, the flow pathway zone of influence of the STT in the River Severn catchment would extend from Vyrnwy Reservoir, along the River Vyrnwy to the River Severn then along the River Severn to the Deerhurst intake. Additionally, the zone of influence includes the River Avon from Warwick to the River Severn confluence. With the support system in operation there would be flow increase throughout the River Severn catchment flow pathway zone of influence. At these times there would also be flow decrease in the River Tame catchment from the Minworth WwTW outfall to the River Trent confluence.

With pipeline conveyance, the flow pathway zone of influence in the River Thames catchment extends from Culham to the tidal limit. With the STT system in operation there would be flow increase throughout the River Thames catchment flow pathway zone of influence.

The aquatic study area of the pipeline conveyance, full support system, is stylised in [Figure 3](#).



**Figure 3 Aquatic Study Area of the STT Pipeline Conveyance, Full Support System**

#### 4.2.2 In-river hydrological effects from operation

The Gate 1 Environmental Assessment Report “Appendix B3.1 Modelling - Physical Environment Evidence” has indicated a scenario of flow changes in the study area for the period 2010-2019. The assessed scenario described transfer would be operational for water resources purposes approximately 19% of the study period, clustered in six of the 10 years and within the months May to November. These range from continuous periods in June to September 2015 (87 dates) and July to December 2018 (151 dates), to intermittent periods in 2011 (overall 119 dates) and 2019 (overall 108 dates). In the scenario, supporting flow would be required to ensure abstraction for approximately 15% of the study period. In addition, for Gate 1, a low rate of transfer has been assumed at all other times to maintain the quality of water in the pipeline system.

Indicative flow changes in the study reaches are summarised in Table 6 listing the WFD water body and assessment of the magnitude of flow change. The hydrological zone of influence is considered to not extent into either the Severn Estuary or the estuarine Thames Tideway and no transitional water bodies are included in the assessment. For the Severn Estuary this is on the understanding that the hands-off flow conditions provided by the EA for unsupported abstraction management is ecologically sustainable. For the Thames Tideway this is on the understanding that current license conditions for abstraction management would result in no change in pass-forward flows to the transitional water.

**Table 6 Relevant reaches and associated indicative flow changes from operation of the 300 MI/d pipeline conveyance, full support system STT grouping**

| Study reach   | WFD water body  | Flow change during operation | Assessed magnitude of flow change |
|---|---|------------------------------|-----------------------------------|
| River Vyrnwy from the Vyrnwy Reservoir to the confluence with the River Banwy                 | Vyrnwy - Lake Vyrnwy to conf Afon Cownwy (GB109054049880)<br>Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy (GB109054049720) | +75 MI/d                     | Major                             |
| River Vyrnwy from the confluence with the River Banwy to the confluence with the River Severn | Afon Vyrnwy DS of Banwy confluence (GB109054049852)<br>Afon Vyrnwy - conf Afon Tanat to conf R Severn (GB109054049800)          | +75 MI/d<br>+155 MI/d        | Minor<br>Moderate (below bypass)  |
| River Severn from the confluence with the River   | Severn - conf Bele Bk to conf Sundorne Bk (GB109054049142)  | +155 MI/d (to lower reach)   | Minor                             |

| Study reach  | WFD water body   | Flow change during operation   | Assessed magnitude of flow change |
|--|--|--|-----------------------------------|
| Vyrnwy to downstream of Shrewsbury   |  |  |                                   |
| River Severn from downstream of Shrewsbury to the confluence with the River Avon | Severn - Sundorne Bk to conf M Wenlock-Farley Bk (GB109054049141)  | +180 MI/d  | Minor                             |
|  | Severn conf M Wenlock-Farley Bk to conf R Worfe (GB109054049143)   | +180 MI/d  | Negligible                        |
|  | Severn - conf R Worfe to conf R Stour (GB109054049145)   |  |                                   |
|  | Severn - conf R Stour to conf River Teme (GB109054049144)  |  |                                   |
|  | Severn - conf R Teme to conf R Avon (GB109054039760).  |  |                                   |
| River Avon from downstream Warwick to the confluence with the River Severn       | Avon (Wark) conf R Leam to Tramway Br, Stratford (GB109054044402)  | +115 MI/d  | Major                             |
|  | Avon- Tramway Br Stratford to Workman Br Evesham (GB109054044401)  |  |                                   |
|  | Avon conf Workman Br, Evesham to conf R Severn (GB109054044403)  | +115 MI/d  | Minor                             |
| River Severn from the confluence with the River Avon to the tidal limit          | Severn - conf R Avon to conf Upper Parting (GB109054044404)<br>Severn (E Channel) – Horsebere Bk to Severn Estuary (GB109054032750)  | +295 MI/d supported u/s Deerhurst;<br>-300 MI/d unsupported d/s Deerhurst noting Hands-off flow conditions | Negligible                        |
| River Thames from Culham to Windsor  | Thames (Evenlode to Thame) (GB106039030334)<br>Thames Wallingford to Caversham (GB106039030331)<br>Thames (Reading to Cookham) (GB106039023233)<br>Thames (Cookham to Egham) (GB106039023231). | +300 MI/d supported/ unsupported   | Moderate                          |
| River Thames from Windsor to Teddington  | Thames (Egham to Teddington) (GB106039023232)  |  |                                   |
| River Tame from Minworth to the confluence with the River Trent                  | Tame from R Rea to R Blythe (GB104028046841)<br>Tame from R Blythe to River Anker (GB104028046440)<br>Tame from River Anker to River Trent (GB104028047050)                                    | -115 MI/d  | Minor                             |

#### 4.2.2.1 Water bodies and activities deemed WFD compliant and not passed forward from Level 1 screen

No STT construction activities have been passed forward from the Level 1 screen. The range of in-river construction activities associated with this grouping have been documented in the Level 1 spreadsheet:

- Outfall headworks for Element 2b Middle Vyrnwy Bypass in the lower River Vyrnwy
- Outfall headworks for Element 5a Netheridge WwTW discharge diversion in the River Severn at Deerhurst
- Outfall headworks for Element 6 Minworth WwTW discharge diversion in the River Avon south of Warwick
- Intake headworks for Element 7a Deerhurst pipeline in the River Severn at Deerhurst
- Outfall headwork for Element 7a Deerhurst pipeline in the River Thames at Culham.

No STT pipeline construction activities have been passed forward from the Level 1 screen. It is noted that within the Level 2 activities assessment that all pipeline activities are scored as 0 or 1 and therefore no pipeline activities pass-forward to the detailed assessment. That assessment within the ACWG template includes the following assumed mitigation for pipeline construction activities, trenching and

laying of pipelines involving watercourse crossings:

- Assumed that bedding material for pipelines will be constructed such that they do not form preferential pathways for groundwater flow
- Assumed that watercourse crossings will be carried out using directional drilling or if the watercourse needs to be temporarily diverted, appropriate measures will be in place to protect ecology and watercourse will be returned back to its natural state
- Flood risk assessment will be carried out to ensure that new in channel features will not adversely impact on flood risk.

For this grouping, pipeline activities would occur in 41 river water bodies, identified as:

- GB109054055070 Morda - source to conf unnamed trib
- GB109054049930 Morda - conf unnamed trib to conf Afon Vyrn
- GB109054050010 Oswestry Bk
- GB109054049980 Morda trib - Morton Common
- GB109054049800 Afon Vyrnwy - conf Afon Tanat to conf R Severn
- GB109054049940 Weir Bk - source to conf R Severn
- GB109054049142 Severn - conf Bele Bk to conf Sundorne Bk
- GB109054044404 Severn - conf R Avon to conf Upper Parting
- GB109054032810 Chelt - M5 to conf R Severn
- GB109054032801 Hatherley Bk - source to conf R Severn
- GB109054032760 Horsebere Bk - source to conf R Severn
- GB109054032761 Wotton Bk - source to conf Horsebere Bk
- GB109054032750 Severn (E Channel) - Horsebere Bk to Severn Est
- GB109054032701 Sud Bk - source to conf R Severn
- GB104028046841 Tame - R Rea to R Blythe
- GB104028042420 Cole from Hatchford-Kingshurst Brook to R Blythe
- GB104028042572 Blythe from Patrick Bridge to R Tame
- GB104028042380 Temple Balsall Brook from Source to R Blythe
- GB104028042571 Blythe from Temple Balsall Brook to Patrick Bridge
- GB109054044470 Finham Bk - source to conf Canley Bk
- GB109054043810 Claverdon Bk - source to conf R Alne
- GB109054043800 Gog Bk - source to conf R Avon
- GB109054044402 Avon (Wark) conf R Leam to Tramway Br, Stratford
- GB109054039780 Swilgate - source to conf R Avon
- GB109054039770 Leigh Bk - source to conf R Chelt
- GB109054039810 Tirl Brook - source to the conf River Swilgate
- GB106039029991 Coln (Source to Coln Rogers)
- GB109054039631 Isbourne - source to conf R Avon
- GB106039030040 Leach (Source to Thames)
- GB106039029992 Coln (from Coln Rogers) and Thames (Coln to Leach)
- GB106039029760 Thornhill Ditch and tributaries at Cotswolds Water Park
- GB106039030232 Broadwell Brook
- GB106039030231 Radcot Cut
- GB106039023770 Wadley Stream (Source to Thames at Duxford)
- GB106039030333 Thames (Leach to Evenlode)
- GB106039023380 Childrey Brook and Norbrook at Common Barn
- GB106039030334 Thames (Evenlode to Thame)
- GB106039023360 Cow Common Brook and Portobello Ditch
- GB106039023430 Ock and tributaries (Land Brook confluence to Thames)
- GB106039023730 Cole (Bower Bridge to Thames) including Coleshill
- GB106039022990 Thames (Churn to Coln)

No STT pipeline washout activities have been passed forward from the Level 1 screen as these are considered to be not intended for routine use and therefore not consistent with WFD assessment

periods.

#### 4.2.2.2 Water bodies and activities passed forward from Level 1 screen as requiring further consideration

For the Gate 1 pipeline conveyance, full support system STT grouping the hydrological assessment identified ten WFD river water bodies passed forward from Level 1 screen as requiring further consideration based on major or moderate hydrological effects. The Avon conf Workman Br, Evesham to conf R Severn (GB109054044403) water body was also included for water quality considerations. The Tame from R Rea to R Blythe (GB104028046841) water body was also included on a precautionary basis to review potential effects in the River Tame catchment from flow reduction there.

Water bodies and relevant activities from the ACWG list and the relevant STT element are summarised in **Table 7**.

**Table 7 Water bodies and activities passed forward from Level 1 screen as requiring further consideration for the 300 Ml/d pipeline conveyance, full support system STT grouping**

| Water body   | ACWG listed activity  | VyrnwyRelease_75 | MiddleVyrnwyBypass_80 | ShrewsburyRedeployment_25 | Mythe_15 | NetheridgePipelineDeerhurst_35 | Minworth_115 | DeerhurstPipeline_300 |
|--|---|------------------|-----------------------|---------------------------|----------|--------------------------------|--------------|-----------------------|
| Vyrnwy - Lake Vyrnwy to conf Afon Cownwy (GB109054049880)          | High volume discharge of water with a quality element of the same WFD status as the receiving water body  | ✓                |                       |                           |          |                                |              |                       |
| Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy (GB109054049720) | Transfer of water via a river, canal or aqueduct  | ✓                |                       |                           |          |                                |              |                       |
| Afon Vyrnwy - conf Afon Tanat to conf R Severn (GB109054049800)    | High volume discharge of water with a quality element of the same WFD status as the receiving water body  | ✓                | ✓                     |                           |          |                                |              |                       |
| Avon (Wark) conf R Leam to Tramway Br, Stratford (GB109054044402)  | High volume discharge of water with a quality element of a lower WFD status than the receiving water body |                  |                       |                           |          |                                | ✓            |                       |
| Avon- Tramway Br Stratford to Workman Br Evesham (GB109054044401)  | Transfer of water via a river, canal or aqueduct  |                  |                       |                           |          |                                | ✓            |                       |
| Avon conf Workman Br, Evesham to conf R Severn (GB109054044403)    | Transfer of water via a river, canal or aqueduct  |                  |                       |                           |          |                                | ✓            |                       |
| Thames (Evenlode to Thame) (GB106039030334)                        | High volume discharge of water with a quality element of the same WFD status as the receiving water body  |                  |                       |                           |          |                                |              | ✓                     |
| Thames Wallingford to Caversham (GB106039030331)                   | Transfer of water via a river, canal or aqueduct  |                  |                       |                           |          |                                |              | ✓                     |
| Thames (Reading to Cookham) (GB106039023233)                       | Transfer of water via a river, canal or aqueduct  |                  |                       |                           |          |                                |              | ✓                     |
| Thames (Cookham to Egham) (GB106039023231)                         | Transfer of water via a river, canal or aqueduct<br>New or increased surface water abstraction            |                  |                       |                           |          |                                |              | ✓                     |
| Thames (Egham to Teddington) (GB106039023232)                      | Transfer of water via a river, canal or aqueduct<br>New or increased surface water abstraction            |                  |                       |                           |          |                                |              | ✓                     |
| Tame from R Rea to R Blythe (GB104028046841)                       | Cessation of existing discharge to a watercourse  |                  |                       |                           |          |                                | ✓            |                       |

## 4.3 300 Ml/d pipeline conveyance, without Minworth WwTW discharge diversion support element

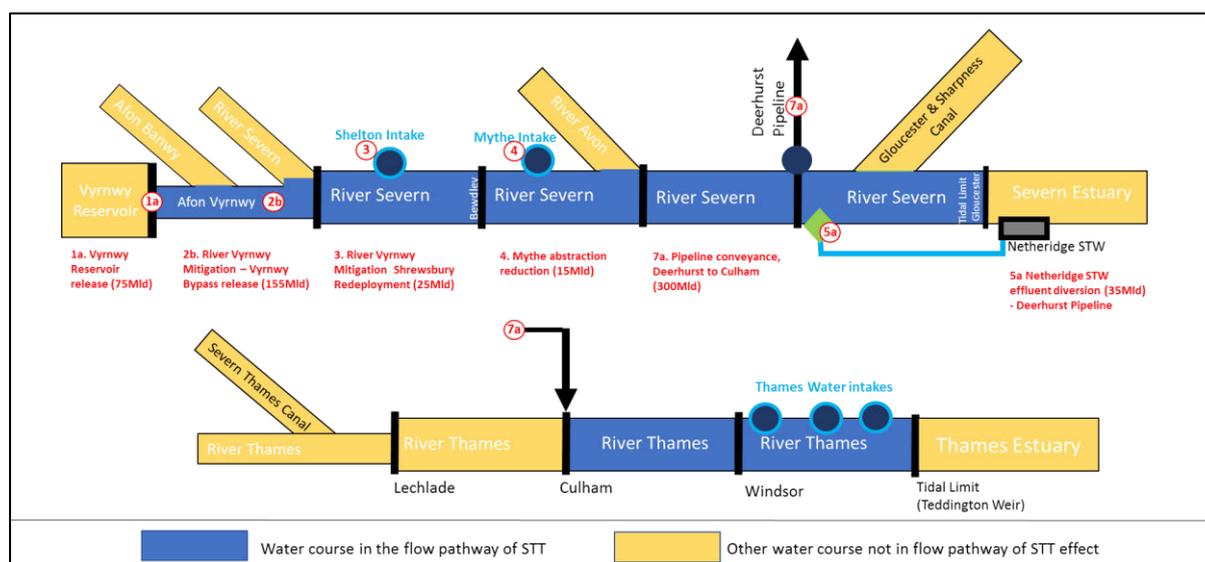
### 4.3.1 Conceptualisation of study area

Without the support system, abstraction would reduce flow in the River Severn below the Deerhurst intake. As unsupported abstraction would be limited by hands-off flow conditions in the River Severn, flow reductions are deemed minor and the zone of influence to not extend beyond the tidal limit.

With the full support system, the flow pathway zone of influence of the STT in the River Severn catchment would extend from Vyrnwy Reservoir, along the River Vyrnwy to the River Severn then along the River Severn to the Deerhurst intake. With the support system in operation there would be a flow increase throughout the River Severn catchment flow pathway zone of influence.

With pipeline conveyance, the flow pathway zone of influence of the STT in the River Thames catchment extends from Culham to the tidal limit. With the STT system in operation there would be a flow increase throughout the River Thames catchment flow pathway zone of influence.

The aquatic study area of the pipeline conveyance, full support system is stylised in **Figure 4**.



**Figure 4 Aquatic Study Area of the STT Pipeline Conveyance, without Minworth WwTW discharge diversion support element**

#### 4.3.1.1 In-river hydrological effects from operation

The Gate-1 Environmental Assessment Report Appendix B3.1 Modelling - Physical Environment Evidence has indicated a scenario of flow changes in the study area for the period 2010-2019. The assessed scenario described transfer would be operational for water resources purposes approximately 19% of the study period, clustered in six of the 10 years and within the months May to November. These range from continuous periods in June to September 2015 (87 dates) and July to December 2018 (151 dates), to intermittent periods in 2011 (overall 119 dates) and 2019 (overall 108 dates). In the scenario, supporting flow would be required to ensure abstraction for approximately 15% of the study period. In addition, for Gate 1, a low rate of transfer has been assumed at all other times to maintain the quality of water in the pipeline system.

Indicative flow changes in the study reaches are summarised in Table 8 listing the WFD water body and assessment of the magnitude of flow change. The hydrological zone of influence is considered to not extent into either the Severn Estuary or the estuarine Thames Tideway and no transitional water bodies are included in the assessment. For the Severn Estuary this is on the understanding that the hands-off flow conditions provided by the EA for unsupported abstraction management is ecologically sustainable. For the Thames Tideway this is on the understanding that current license conditions for

abstraction management would result in no change in pass-forward flows to the transitional water.

**Table 8 Relevant reaches and associated indicative flow changes from operation of the 300 MI/d pipeline conveyance, without Minworth WwTW discharge diversion support element STT grouping**

| Study reach   | WFD water body  | Flow change during operation   | Assessed magnitude of flow change |
|---|---|--|-----------------------------------|
| River Vyrnwy from the Vyrnwy Reservoir to the confluence with the River Banwy                 | Vyrnwy - Lake Vyrnwy to conf Afon Cownwy (GB109054049880)<br>Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy (GB109054049720)   | +75 MI/d   | Major                             |
| River Vyrnwy from the confluence with the River Banwy to the confluence with the River Severn | Afon Vyrnwy DS of Banwy confluence (GB109054049852)<br>Afon Vyrnwy - conf Afon Tanat to conf R Severn (GB109054049800)  | +75 MI/d<br>+155 MI/d  | Minor<br>Moderate (below bypass)  |
| River Severn from the confluence with the River Vyrnwy to downstream of Shrewsbury            | Severn - conf Bele Bk to conf Sundorne Bk (GB109054049142)  | +155 MI/d (to lower reach)   | Minor                             |
| River Severn from downstream of Shrewsbury to the confluence with the River Avon              | Severn - Sundorne Bk to conf M Wenlock-Farley Bk (GB109054049141)<br>Severn conf M Wenlock-Farley Bk to conf R Worfe (GB109054049143)<br>Severn - conf R Worfe to conf R Stour (GB109054049145)<br>Severn - conf R Stour to conf River Teme (GB109054049144)<br>Severn - conf R Teme to conf R Avon (GB109054039760). | +180 MI/d<br>+180 MI/d   | Minor<br>Negligible               |
| River Severn from the confluence with the River Avon to the tidal limit                       | Severn - conf R Avon to conf Upper Parting (GB109054044404)<br>Severn (E Channel) – Horsebere Bk to Severn Estuary (GB109054032750)   | +180 MI/d supported u/s Deerhurst;<br>-300 MI/d unsupported d/s Deerhurst noting Hands-off flow conditions | Negligible                        |
| River Thames from Culham to Windsor   | Thames (Evenlode to Thame) (GB106039030334)<br>Thames Wallingford to Caversham (GB106039030331)<br>Thames (Reading to Cookham) (GB106039023233)<br>Thames (Cookham to Egham) (GB106039023231).  | +300 MI/d supported/ unsupported   | Moderate                          |
| River Thames from Windsor to Teddington   | Thames (Egham to Teddington) (GB106039023232)   |  |                                   |

#### 4.3.1.2 Water bodies and activities deemed WFD compliant and not passed forward from Level 1 screen

No STT construction activities have been passed forward from the Level 1 screen. The range of in-river construction activities associated with this grouping have been documented in the Level 1 spreadsheet:

- Outfall headworks for Element 2b Middle Vyrnwy Bypass in the lower River Vyrnwy
- Outfall headworks for Element 5a Netheridge WwTW discharge diversion in the River Severn at Deerhurst
- Intake headworks for Element 7a Deerhurst pipeline in the River Severn at Deerhurst
- Outfall headwork for Element 7a Deerhurst pipeline in the River Thames at Culham.

No STT pipeline construction activities have been passed forward from the Level 1 screen. It is noted that within the Level 2 activities assessment that all pipeline activities are scored as 0 or 1 and therefore

no pipeline activities pass-forward to the detailed assessment. That assessment within the ACWG template includes the following assumed mitigation for pipeline construction activities, trenching and laying of pipelines involving watercourse crossings:

- Assumed that bedding material for pipelines will be constructed such that they do not form preferential pathways for groundwater flow
- Assumed that watercourse crossings will be carried out using directional drilling or if the watercourse needs to be temporarily diverted, appropriate measures will be in place to protect ecology and watercourse will be returned back to its natural state
- Flood risk assessment will be carried out to ensure that new in channel features will not adversely impact on flood risk.

For this grouping, pipeline activities would occur in 27 river water bodies, identified as:

- GB109054055070 Morda - source to conf unnamed trib
- GB109054049930 Morda - conf unnamed trib to conf Afon Vyrn
- GB109054050010 Oswestry Bk
- GB109054049980 Morda trib - Morton Common
- GB109054049930 Morda - conf unnamed trib to conf Afon Vyrn
- GB109054049800 Afon Vyrnwy - conf Afon Tanat to conf R Severn
- GB109054049940 Weir Bk - source to conf R Severn
- GB109054049142 Severn - conf Bele Bk to conf Sundorne Bk
- GB109054044404 Severn - conf R Avon to conf Upper Parting
- GB109054039780 Swilgate - source to conf R Avon
- GB109054039770 Leigh Bk - source to conf R Chelt
- GB109054039810 Tirl Brook - source to the conf River Swilgate
- GB106039029991 Coln (Source to Coln Rogers)
- GB109054039631 Isbourne - source to conf R Avon
- GB106039030040 Leach (Source to Thames)
- GB106039029992 Coln (from Coln Rogers) and Thames (Coln to Leach)
- GB106039029760 Thornhill Ditch and tributaries at Cotswolds Water Park
- GB106039030232 Broadwell Brook
- GB106039030231 Radcot Cut
- GB106039023770 Wadley Stream (Source to Thames at Duxford)
- GB106039030333 Thames (Leach to Evenlode)
- GB106039023380 Childrey Brook and Norbrook at Common Barn
- GB106039030334 Thames (Evenlode to Thame)
- GB106039023360 Cow Common Brook and Portobello Ditch
- GB106039023430 Ock and tributaries (Land Brook confluence to Thames)
- GB106039023730 Cole (Bower Bridge to Thames) including Coleshill
- GB106039022990 Thames (Churn to Coln)

No STT pipeline washout activities have been passed forward from the Level 1 screen as these are considered to be not intended for routine use and therefore not consistent with WFD assessment periods.

#### 4.3.1.3 Water bodies and activities passed forward from Level 1 screen as requiring further consideration

For the Gate 1 pipeline conveyance, full support system STT grouping the hydrological assessment identified eight WFD river water bodies passed forward from Level 1 screen as requiring further consideration based on major or moderate hydrological effects.

Water bodies and relevant activities from the ACWG list and the relevant STT element are summarised in Table 9.

**Table 9 Water bodies and activities passed forward from Level 1 screen as requiring further consideration for the 300 Ml/d pipeline conveyance, without Minworth WwTW discharge diversion support element STT grouping**

| Water body   | ACWG listed activity   | VyrnwyRelease_75 | MiddleVyrnwyBypass_80 | ShrewsburyRedeployment_25 | Mythe_15 | NetheridgePipelineDeerhurst_35 | DeerhurstPipeline_300 |
|--|--|------------------|-----------------------|---------------------------|----------|--------------------------------|-----------------------|
| Vyrnwy - Lake Vyrnwy to conf Afon Cownwy (GB109054049880)          | High volume discharge of water with a quality element of the same WFD status as the receiving water body | ✓                |                       |                           |          |                                |                       |
| Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy (GB109054049720) | Transfer of water via a river, canal or aqueduct   | ✓                |                       |                           |          |                                |                       |
| Afon Vyrnwy - conf Afon Tanat to conf R Severn (GB109054049800)    | High volume discharge of water with a quality element of the same WFD status as the receiving water body | ✓                | ✓                     |                           |          |                                |                       |
| Thames (Evenlode to Thame) (GB106039030334)                        | High volume discharge of water with a quality element of the same WFD status as the receiving water body |                  |                       |                           |          |                                | ✓                     |
| Thames Wallingford to Caversham (GB106039030331)                   | Transfer of water via a river, canal or aqueduct   |                  |                       |                           |          |                                | ✓                     |
| Thames (Reading to Cookham) (GB106039023233)                       | Transfer of water via a river, canal or aqueduct   |                  |                       |                           |          |                                | ✓                     |
| Thames (Cookham to Egham) (GB106039023231)                         | Transfer of water via a river, canal or aqueduct<br>New or increased surface water abstraction           |                  |                       |                           |          |                                | ✓                     |
| Thames (Egham to Teddington) (GB106039023232)                      | Transfer of water via a river, canal or aqueduct<br>New or increased surface water abstraction           |                  |                       |                           |          |                                | ✓                     |

#### 4.4 300 Ml/d canal conveyance, full support system

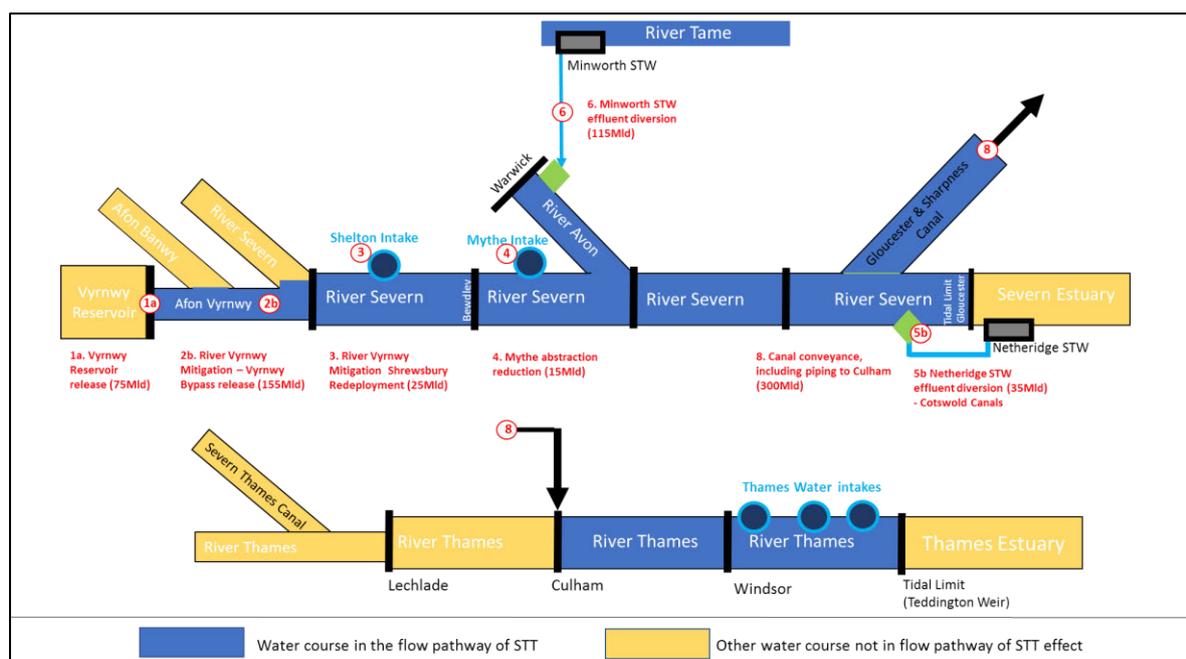
##### 4.4.1 Conceptualisation of study area

Without the support system, abstraction would reduce flow in the River Severn below the Gloucester Docks intake. As unsupported abstraction would be limited by hands-off flow conditions in the River Severn, flow reductions are deemed minor, and the zone of influence does not extend beyond the tidal limit. It is noted that much of the canal network required for conveyance is disused or no longer present and that only the Gloucester & Sharpness Canal is currently listed as a WFD water body.

With the full support system, the flow pathway zone of influence of the STT in the River Severn catchment would extend from Vyrnwy Reservoir, along the River Vyrnwy to the River Severn then along the River Severn to the Gloucester Docks intake. Additionally, the zone of influence also includes the River Avon from Warwick to the River Severn confluence. With the support system in operation there would be a flow increase throughout the River Severn catchment flow pathway zone of influence of the STT. At these times there would also be a flow decrease in the River Tame catchment from Minworth WwTW outfall to the River Trent confluence.

With canal conveyance, the flow pathway zone of influence in the River Thames catchment extends from Culham to the tidal limit. With the STT system in operation there would be a flow increase throughout the River Thames catchment flow pathway zone of influence.

The aquatic study area of the canal conveyance, full support system is stylised in [Figure 5](#).



**Figure 5 Aquatic Study Area of the STT Canal Conveyance, Full Support System**

#### 4.4.1.1 In-river hydrological effects from operation

The Gate 1 Environmental Assessment Report Appendix B3.1 Modelling - Physical Environment Evidence has indicated a scenario of flow changes in the study area for the period 2010-2019. The assessed scenario described transfer would be operational for water resources purposes approximately 19% of the study period, clustered in six of the 10 years and within the months May to November. These range from continuous periods in June to September 2015 (87 dates) and July to December 2018 (151 dates), to intermittent periods in 2011 (overall 119 dates) and 2019 (overall 108 dates). In the scenario, supporting flow would be required to ensure abstraction for approximately 15% of the study period. In addition, for Gate 1, a low rate of transfer has been assumed at all other times to maintain the quality of water in the canal and pipeline systems.

Indicative flow changes in the study reaches are summarised in Table 10 listing the WFD water body and assessment of the magnitude of flow change. The hydrological zone of influence is considered to not extent into either the Severn Estuary or the estuarine Thames Tideway and no transitional water bodies are included in the assessment. For the Severn Estuary this is on the understanding that the hands-off flow conditions provided by the EA for unsupported abstraction management is ecologically sustainable. For the Thames Tideway this is on the understanding that current license conditions for abstraction management would result in no change in pass-forward flows to the transitional water.

#### 4.4.1.2 Water bodies and activities deemed WFD compliant and not passed forward from Level 1 screen

No STT construction activities have been passed forward from the Level 1 screen. The range of in-river construction activities associated with this grouping have been documented in the Level 1 spreadsheet:

- Outfall headworks for Element 2b Middle Vyrnwy Bypass in the lower River Vyrnwy
- Outfall headworks for Element 5b Netheridge WwTW discharge diversion in the River Severn River Severn downstream Gloucester Docks
- Outfall headworks for Element 6 Minworth WwTW discharge diversion in the River Avon south of Warwick
- Intake headworks for Element 8 Canal conveyance in the River Severn at Deerhurst
- Outfall headwork for Element 8 Canal conveyance's pipeline in the River Thames at Culham.

No STT pipeline construction activities have been passed forward from the Level 1 screen. It is noted

that within the Level 2 activities assessment that all pipeline activities are scored as 0 or 1 and therefore no pipeline activities pass-forward to the detailed assessment. That assessment within the ACWG template includes the following assumed mitigation for pipeline construction activities, trenching and laying of pipelines involving watercourse crossings:

- Assumed that bedding material for pipelines will be constructed such that they do not form preferential pathways for groundwater flow
- Assumed that watercourse crossings will be carried out using directional drilling or if the watercourse needs to be temporarily diverted, appropriate measures will be in place to protect ecology and watercourse will be returned back to its natural state
- Flood risk assessment will be carried out to ensure that new in channel features will not adversely impact on flood risk.

For this grouping, pipeline activities would occur in 31 river water bodies, identified as:

- GB109054055070 Morda - source to conf unnamed trib
- GB109054049930 Morda - conf unnamed trib to conf Afon Vyrn
- GB109054050010 Oswestry Bk
- GB109054049980 Morda trib - Morton Common
- GB109054049800 Afon Vyrnwy - conf Afon Tanat to conf R Severn
- GB109054049940 Weir Bk - source to conf R Severn
- GB109054049142 Severn - conf Bele Bk to conf Sundorne Bk
- GB109054044404 Severn - conf R Avon to conf Upper Parting
- GB109054032810 Chelt - M5 to conf R Severn
- GB109054032801 Hatherley Bk - source to conf R Severn
- GB109054032760 Horsebere Bk - source to conf R Severn
- GB109054032761 Wotton Bk - source to conf Horsebere Bk
- GB109054032750 Severn (E Channel) - Horsebere Bk to Severn Est
- GB109054032701 Sud Bk - source to conf R Severn
- GB104028046841 Tame - R Rea to R Blythe
- GB104028042420 Cole from Hatchford-Kingshurst Brook to R Blythe
- GB104028042572 Blythe from Patrick Bridge to R Tame
- GB104028042380 Temple Balsall Brook from Source to R Blythe
- GB104028042571 Blythe from Temple Balsall Brook to Patrick Bridge
- GB109054044470 Finham Bk - source to conf Canley Bk
- GB109054043810 Claverdon Bk - source to conf R Alne
- GB109054043800 Gog Bk - source to conf R Avon
- GB109054044402 Avon (Wark) conf R Leam to Tramway Br, Stratford
- GB109054039780 Swilgate - source to conf R Avon
- GB106039030333 Thames (Leach to Evenlode)
- GB106039023380 Childrey Brook and Norbrook at Common Barn
- GB106039030334 Thames (Evenlode to Thame)
- GB106039023360 Cow Common Brook and Portobello Ditch
- GB106039023430 Ock and tributaries (Land Brook confluence to Thames)
- GB106039023730 Cole (Bower Bridge to Thames) including Coleshill
- GB106039022990 Thames (Churn to Coln).

No STT canal construction activities have been passed forward from the Level 1 screen. For this grouping, canal restoration activities would occur in eight river water bodies, identified as:

- GB10GB106039029750 Churn (Baunton to Cricklade)
- GB106039023800 Cerney Wick Brook (source to Thames)
- GB106039023110 Dudgrove Brook
- GB106039022990 Thames (Churn to Coln)
- GB106039029992 Coln (from Coln Rogers) and Thames (Coln to Leach)
- GB106039023760 Thames (Kemble to Waterhay Bridge)

- GB106039023860 Marston Meysey Brook
- GB106039030300 Ampney and Poulton Brooks (Source to Thames).

#### 4.4.1.3 Water bodies and activities passed forward from Level 1 screen as requiring further consideration

For the Gate 1 canal conveyance, full support system STT grouping the hydrological assessment identified ten WFD river water bodies passed forward from Level 1 screen as requiring further consideration based on major or moderate hydrological effects. The Avon conf Workman Br, Evesham to conf R Severn (GB109054044403) water body and the Severn (E Channel) – Horsebere Bk to Severn Estuary (GB109054032750) were also included for water quality considerations. The Tame from R Rea to R Blythe (GB104028046841) water body was also included on a precautionary basis to review potential effects in the River Tame catchment from flow reduction there. The Gloucester & Sharpness Canal water body (GB70910509) was also included on a precautionary basis.

Water bodies and relevant activities from the ACWG list and the relevant STT element are summarised in Table 11.

**Table 10 Relevant reaches and associated indicative flow changes from operation of the 300 MI/d canal conveyance, full support system STT grouping**

| Study reach   | WFD water body   | Flow change during operation   | Assessed magnitude of flow change |
|---|--|--|-----------------------------------|
| River Vyrnwy from the Vyrnwy Reservoir to the confluence with the River Banwy                 | Vyrnwy - Lake Vyrnwy to conf Afon Cownwy (GB109054049880)<br>Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy (GB109054049720)      | +75 MI/d   | Major                             |
| River Vyrnwy from the confluence with the River Banwy to the confluence with the River Severn | Afon Vyrnwy DS of Banwy confluence (GB109054049852)  | +75 MI/d   | Minor                             |
|   | Afon Vyrnwy - conf Afon Tanat to conf R Severn (GB109054049800)  | +155 MI/d  | Moderate (below bypass)           |
| River Severn from the confluence with the River Vyrnwy to downstream of Shrewsbury            | Severn - conf Bele Bk to conf Sundorne Bk (GB109054049142)   | +155 MI/d (to lower reach)   | Minor                             |
| River Severn from downstream of Shrewsbury to the confluence with the River Avon              | Severn - Sundorne Bk to conf M Wenlock-Farley Bk (GB109054049141)  | +180 MI/d  | Minor                             |
|   | Severn conf M Wenlock-Farley Bk to conf R Worfe (GB109054049143)   | +180 MI/d  | Negligible                        |
|   | Severn - conf R Worfe to conf R Stour (GB109054049145)   |  |                                   |
|   | Severn - conf R Stour to conf River Teme (GB109054049144)  |  |                                   |
|   | Severn - conf R Teme to conf R Avon (GB109054039760).  |  |                                   |
| River Avon from downstream Warwick to the confluence with the River Severn                    | Avon (Wark) conf R Leam to Tramway Br, Stratford (GB109054044402)  | +115 MI/d  | Major                             |
|   | Avon- Tramway Br Stratford to Workman Br Evesham (GB109054044401)<br>Avon conf Workman Br, Evesham to conf R Severn (GB109054044403) | +115 MI/d  | Minor                             |
| River Severn from the confluence with the River Avon to the tidal limit                       | Severn - conf R Avon to conf Upper Parting (GB109054044404)<br>Severn (E Channel) – Horsebere Bk to Severn Estuary (GB109054032750)  | +295 MI/d supported u/s Gloucester;<br>-300 MI/d unsupported d/s Gloucester noting Hands-off flow conditions | Negligible                        |
| River Thames from Culham to Windsor   | Thames (Evenlode to Thame) (GB106039030334)<br>Thames Wallingford to Caversham (GB106039030331)                                      | +300 MI/d supported/ unsupported   | Moderate                          |

| Study reach   | WFD water body  | Flow change during operation     | Assessed magnitude of flow change |
|---|---|----------------------------------|-----------------------------------|
| River Thames from Windsor to Teddington                         | Thames (Reading to Cookham) (GB106039023233)  |                                  |                                   |
|   | Thames (Cookham to Egham) (GB106039023231).   |                                  |                                   |
|   | Thames (Egham to Teddington) (GB106039023232)   |                                  |                                   |
| River Tame from Minworth to the confluence with the River Trent | Tame from R Rea to R Blythe (GB104028046841)<br>Tame from R Blythe to River Anker (GB104028046440)<br>Tame from River Anker to River Trent (GB104028047050) | -115 MI/d                        | Minor                             |
| Gloucester and Sharpness Canal                                  | Gloucester and Sharpness Canal (GB70910509)   | +300 MI/d supported/ unsupported | Not assessed                      |

Table 11 Water bodies and activities passed forward from Level 1 screen as requiring further consideration for the 300 MI/d canal conveyance, full support system STT grouping

| Water body   | ACWG listed activity   | VyrnwyRelease_75 | MiddleVyrnwyBypass_80 | ShrewsburyRedeployment_25 | Mythe_15 | NetheridgeCanalDeerhurst_35 | Minworth_115 | Canal_300 |
|--|--|------------------|-----------------------|---------------------------|----------|-----------------------------|--------------|-----------|
|  |  |                  |                       |                           |          |                             |              |           |
| Vyrnwy - Lake Vyrnwy to conf Afon Cownwy (GB109054049880)            | High volume discharge of water with a quality element of the same WFD status as the receiving water body   | ✓                |                       |                           |          |                             |              |           |
| Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy (GB109054049720)   | Transfer of water via a river, canal or aqueduct   | ✓                |                       |                           |          |                             |              |           |
| Afon Vyrnwy - conf Afon Tanat to conf R Severn (GB109054049800)      | High volume discharge of water with a quality element of the same WFD status as the receiving water body   | ✓                | ✓                     |                           |          |                             |              |           |
| Avon (Wark) conf R Leam to Tramway Br, Stratford (GB109054044402)    | High volume discharge of water with a quality element of a lower WFD status than the receiving water body  |                  |                       |                           |          |                             | ✓            |           |
| Avon- Tramway Br Stratford to Workman Br Evesham (GB109054044401)    | Transfer of water via a river, canal or aqueduct   |                  |                       |                           |          |                             | ✓            |           |
| Avon conf Workman Br, Evesham to conf R Severn (GB109054044403)      | Transfer of water via a river, canal or aqueduct   |                  |                       |                           |          |                             | ✓            |           |
| Severn (E Channel) – Horsebere Bk to Severn Estuary (GB109054032750) | New or increased surface water abstraction<br>High volume discharge of water with a quality element of the same WFD status as the receiving water body |                  |                       |                           |          | ✓                           |              |           |
| Thames (Evenlode to Thame) (GB106039030334)                          | High volume discharge of water with a quality element of the same WFD status as the receiving water body   |                  |                       |                           |          |                             |              | ✓         |

| Water body                                       | ACWG listed activity   | VyrnwyRelease_75 | MiddleVyrnwyBypass_80 | ShrewsburyRedeployment_25 | Mythe_15 | NetheridgeCanalDeerhurst_35 | Minworth_115 | Canal_300 |
|--|--|------------------|-----------------------|---------------------------|----------|-----------------------------|--------------|-----------|
| Thames Wallingford to Caversham (GB106039030331) | Transfer of water via a river, canal or aqueduct   |                  |                       |                           |          |                             |              | ✓         |
| Thames (Reading to Cookham) (GB106039023233)     | Transfer of water via a river, canal or aqueduct   |                  |                       |                           |          |                             |              | ✓         |
| Thames (Cookham to Egham) (GB106039023231)       | Transfer of water via a river, canal or aqueduct<br>New or increased surface water abstraction |                  |                       |                           |          |                             |              | ✓         |
| Thames (Egham to Teddington) (GB106039023232)    | Transfer of water via a river, canal or aqueduct<br>New or increased surface water abstraction |                  |                       |                           |          |                             |              | ✓         |
| Tame from R Rea to R Blythe (GB104028046841)     | Cessation of existing discharge to a watercourse   |                  |                       |                           |          |                             | ✓            |           |
| Gloucester and Sharpness Canal (GB70910509)      | Transfer of water via a river, canal or aqueduct   |                  |                       |                           |          |                             |              | ✓         |

#### 4.5 300 Ml/d canal conveyance, without Minworth WwTW discharge diversion support element

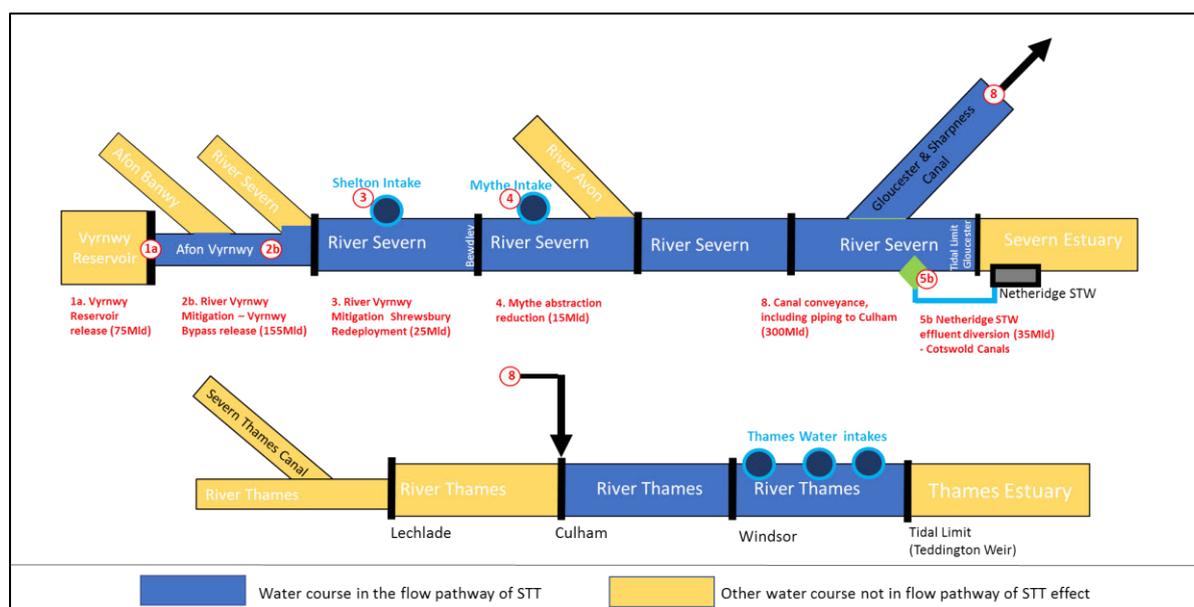
##### 4.5.1 Conceptualisation of study area

Without the support system, abstraction would reduce flow in the River Severn below the Deerhurst intake. As unsupported abstraction would be limited by hands-off flow conditions in the River Severn, flow reductions are deemed minor and the zone of influence to not extend beyond the tidal limit. It is noted that much of the canal network required for conveyance is disused or no longer present and that only the Gloucester & Sharpness Canal is currently listed as a WFD water body.

With the full support system, the flow pathway zone of influence of the STT in the River Severn catchment would extend from Vyrnwy Reservoir, along the River Vyrnwy to the River Severn then along the River Severn to the Deerhurst intake. With the support system in operation there would be a flow increase throughout the River Severn catchment flow pathway zone of influence.

With canal conveyance, the flow pathway zone of influence of the STT in the River Thames catchment extends from Culham to the tidal limit. With the STT system in operation there would be a flow increase throughout the River Thames catchment flow pathway zone of influence.

The aquatic study area of the canal conveyance, full support system is stylised in [Figure 6](#)



**Figure 6 Aquatic Study Area of the STT Canal Conveyance, without Minworth WwTW discharge diversion support element**

#### 4.5.1.1 Water bodies and activities deemed WFD compliant and not passed forward from Level 1 screen

No STT construction activities have been passed forward from the Level 1 screen. The range of in-river construction activities associated with this grouping have been documented in the Level 1 spreadsheet:

- Outfall headworks for Element 2b Middle Vyrnwy Bypass in the lower River Vyrnwy
- Outfall headworks for Element 5b Netheridge WwTW discharge diversion in the River Severn downstream Gloucester Docks
- Intake headworks for Element 8 Canal conveyance in the River Severn at Deerhurst
- Outfall headwork for Element 8 Canal conveyance's pipeline in the River Thames at Culham.

No STT pipeline construction activities have been passed forward from the Level 1 screen. It is noted that within the Level 2 activities assessment that all pipeline activities are scored as 0 or 1 and therefore no pipeline activities pass-forward to the detailed assessment. That assessment within the ACWG template includes the following assumed mitigation for pipeline construction activities, trenching and laying of pipelines involving watercourse crossings:

- Assumed that bedding material for pipelines will be constructed such that they do not form preferential pathways for groundwater flow
- Assumed that watercourse crossings will be carried out using directional drilling or if the watercourse needs to be temporarily diverted, appropriate measures will be in place to protect ecology and watercourse will be returned back to its natural state
- Flood risk assessment will be carried out to ensure that new in channel features will not adversely impact on flood risk.

For this grouping, pipeline activities would occur in 19 river water bodies, identified as:

- GB109054055070 Morda - source to conf unnamed trib
- GB109054049930 Morda - conf unnamed trib to conf Afon Vyrn
- GB109054050010 Oswestry Bk
- GB109054049980 Morda trib - Morton Common
- GB109054049930 Morda - conf unnamed trib to conf Afon Vyrn
- GB109054049800 Afon Vyrnwy - conf Afon Tanat to conf R Severn
- GB109054049940 Weir Bk - source to conf R Severn
- GB109054049142 Severn - conf Bele Bk to conf Sundorne Bk

- GB109054044404 Severn - conf R Avon to conf Upper Parting
- GB109054039780 Swilgate - source to conf R Avon
- GB106039030231 Radcot Cut
- GB106039023770 Wadley Stream (Source to Thames at Duxford)
- GB106039030333 Thames (Leach to Evenlode)
- GB106039023380 Childrey Brook and Norbrook at Common Barn
- GB106039030334 Thames (Evenlode to Thame)
- GB106039023360 Cow Common Brook and Portobello Ditch
- GB106039023430 Ock and tributaries (Land Brook confluence to Thames)
- GB106039023730 Cole (Bower Bridge to Thames) including Coleshill
- GB106039022990 Thames (Churn to Coln)

No STT canal construction activities have been passed forward from the Level 1 screen. For this grouping, canal restoration activities would occur in eight river water bodies, identified as:

- GB10GB106039029750 Churn (Baunton to Cricklade)
- GB106039023800 Cerney Wick Brook (source to Thames)
- GB106039023110 Dudgrove Brook
- GB106039022990 Thames (Churn to Coln)
- GB106039029992 Coln (from Coln Rogers) and Thames (Coln to Leach)
- GB106039023760 Thames (Kemble to Waterhay Bridge)
- GB106039023860 Marston Meysey Brook

GB106039030300 Ampney and Poulton Brooks (Source to Thames).

#### 4.5.1.2 In-river hydrological effects from operation

The Gate 1 Environmental Assessment Report Appendix B3.1 Modelling - Physical Environment Evidence has indicated a scenario of flow changes in the study area for the period 2010-2019. The assessed scenario described transfer would be operational for water resources purposes approximately 19% of the study period, clustered in six of the 10 years and within the months May to November. These range from continuous periods in June to September 2015 (87 dates) and July to December 2018 (151 dates), to intermittent periods in 2011 (overall 119 dates) and 2019 (overall 108 dates). In the scenario, supporting flow would be required to ensure abstraction for approximately 15% of the study period. In addition, for Gate 1, a low rate of transfer has been assumed at all other times to maintain the quality of water in the canal and pipeline systems.

Indicative flow changes in the study reaches are summarised in Table 12 listing the WFD water body and assessment of the magnitude of flow change. The hydrological zone of influence is considered to not extent into either the Severn Estuary or the estuarine Thames Tideway and no transitional water bodies are included in the assessment. For the Severn Estuary this is on the understanding that the hands-off flow conditions provided by the EA for unsupported abstraction management is ecologically sustainable. For the Thames Tideway this is on the understanding that current license conditions for abstraction management would result in no change in pass-forward flows to the transitional water.

**Table 12 Relevant reaches and associated indicative flow changes from operation of the 300 MI/d canal conveyance, without Minworth WwTW discharge diversion support element STT grouping**

| Study reach   | WFD water body  | Flow change during operation | Assessed magnitude of flow change |
|---|---|------------------------------|-----------------------------------|
| River Vyrnwy from the Vyrnwy Reservoir to the confluence with the River Banwy                 | Vyrnwy - Lake Vyrnwy to conf Afon Cownwy (GB109054049880)<br>Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy (GB109054049720) | +75 MI/d                     | Major                             |
| River Vyrnwy from the confluence with the River Banwy to the confluence with the River Severn | Afon Vyrnwy DS of Banwy confluence (GB109054049852)<br>Afon Vyrnwy - conf Afon Tanat to conf R Severn (GB109054049800)          | +75 MI/d<br>+155 MI/d        | Minor<br>Moderate (below bypass)  |

| Study reach  | WFD water body   | Flow change during operation   | Assessed magnitude of flow change |
|--|--|--|-----------------------------------|
| River Severn from the confluence with the River Vyrnwy to downstream of Shrewsbury | Severn - conf Bele Bk to conf Sundorne Bk (GB109054049142)   | +155 MI/d (to lower reach)   | Minor                             |
| River Severn from downstream of Shrewsbury to the confluence with the River Avon   | Severn - Sundorne Bk to conf M Wenlock-Farley Bk (GB109054049141)  | +180 MI/d  | Minor                             |
|  | Severn conf M Wenlock-Farley Bk to conf R Worfe (GB109054049143)   | +180 MI/d  | Negligible                        |
|  | Severn - conf R Worfe to conf R Stour (GB109054049145)   |  |                                   |
|  | Severn - conf R Stour to conf River Teme (GB109054049144)  |  |                                   |
| River Severn from the confluence with the River Avon to the tidal limit            | Severn - conf R Teme to conf R Avon (GB109054039760).  |  |                                   |
|  | Severn - conf R Avon to conf Upper Parting (GB109054044404)<br>Severn (E Channel) – Horsebere Bk to Severn Estuary (GB109054032750)  | +180 MI/d supported u/s Gloucester;<br>-300 MI/d unsupported d/s Gloucester noting Hands-off flow conditions | Negligible                        |
| River Thames from Culham to Windsor  | Thames (Evenlode to Thame) (GB106039030334)<br>Thames Wallingford to Caversham (GB106039030331)<br>Thames (Reading to Cookham) (GB106039023233)<br>Thames (Cookham to Egham) (GB106039023231). | +300 MI/d supported/ unsupported   | Moderate                          |
| River Thames from Windsor to Teddington  | Thames (Egham to Teddington) (GB106039023232)  |  |                                   |
| Gloucester and Sharpness Canal   | Gloucester and Sharpness Canal (GB70910509)  | +300 MI/d supported/ unsupported   | Not assessed                      |

#### 4.5.1.3 Water bodies and activities passed forward from Level 1 screen as requiring further consideration

For the Gate 1 canal conveyance, full support system STT grouping the hydrological assessment identified nine WFD river water bodies passed forward from Level 1 screen as requiring further consideration based on major or moderate hydrological effects. The Gloucester & Sharpness Canal water body (GB70910509) was also included on a precautionary basis.

Water bodies and relevant activities from the ACWG list and the relevant STT element are summarised in Table 13.

**Table 13 Water bodies and activities passed forward from Level 1 screen as requiring further consideration for the 300 MI/d canal conveyance, without Minworth WwTW discharge diversion support element STT grouping**

| Water body   | ACWG listed activity   | VyrnwyRelease_75 | MiddleVyrnwyBypass_80 | ShrewsburyRedeployment_25 | Mythe_15 | NetheridgeCanalDeerhurst_35 | Canal_300 |
|--|--|------------------|-----------------------|---------------------------|----------|-----------------------------|-----------|
| Vyrnwy - Lake Vyrnwy to conf Afon Cownwy (GB109054049880)            | High volume discharge of water with a quality element of the same WFD status as the receiving water body | ✓                |                       |                           |          |                             |           |
| Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy (GB109054049720)   | Transfer of water via a river, canal or aqueduct   | ✓                |                       |                           |          |                             |           |
| Afon Vyrnwy - conf Afon Tanat to conf R Severn (GB109054049800)      | High volume discharge of water with a quality element of the same WFD status as the receiving water body | ✓                | ✓                     |                           |          |                             |           |
| Severn (E Channel) – Horsebere Bk to Severn Estuary (GB109054032750) | New or increased surface water abstraction   |                  |                       |                           |          |                             |           |
|  | High volume discharge of water with a quality element of the same WFD status as the receiving water body |                  |                       |                           |          | ✓                           |           |
| Thames (Evenlode to Thame) (GB106039030334)                          | High volume discharge of water with a quality element of the same WFD status as the receiving water body |                  |                       |                           |          |                             | ✓         |
| Thames Wallingford to Caversham (GB106039030331)                     | Transfer of water via a river, canal or aqueduct   |                  |                       |                           |          |                             | ✓         |
| Thames (Reading to Cookham) (GB106039023233)                         | Transfer of water via a river, canal or aqueduct   |                  |                       |                           |          |                             | ✓         |
| Thames (Cookham to Egham) (GB106039023231)                           | Transfer of water via a river, canal or aqueduct   |                  |                       |                           |          |                             | ✓         |
|  | New or increased surface water abstraction   |                  |                       |                           |          |                             | ✓         |
| Thames (Egham to Teddington) (GB106039023232)                        | Transfer of water via a river, canal or aqueduct   |                  |                       |                           |          |                             | ✓         |
|  | New or increased surface water abstraction   |                  |                       |                           |          |                             | ✓         |
| Gloucester and Sharpness Canal (GB70910509)                          | Transfer of water via a river, canal or aqueduct   |                  |                       |                           |          |                             | ✓         |

## 5 Summary of Level 2 WFD assessment of STT groupings

### 5.1 Introduction

For each of the STT SRO groupings, the ACWG template Level 2 assessment comprises the following worksheets completed by Ricardo:

“4. *Assign Level2 WB Impacts*” – these are the specific activities to be assessed per water body. For consistency, these have been selected as those reported in worksheet “2. Level 1 activities” and set out in Section 4 above.

“5. *Level 2 assessment template*” – a copy of this template has been set out for each of the water bodies carried forward to the Level 2 assessment and these are renamed as the water body ID code.

A third worksheet “6. Level 2 summary” is auto-generated by the template to summarise the per water body level 2 assessments.

Using the information presented in the spreadsheets, a narrative description of the WFD compliance assessment for each grouping is provided below. In particular, the narrative provides information on the confidence in the assessment – the data confidence and the design certainty. Where the assessment reports the potential for WFD objective non-compliance, additional mitigation actions that may reduce this potential and lead to WFD compliance is indicated in the narrative summary.

### 5.2 300 MI/d pipeline conveyance, full support system

The STT pipeline conveyance with full support system has been assessed as with the potential to not comply with WFD objectives. As summarised in **Table 14** this is in six specific water bodies.

#### 5.2.1 Potential non-compliance with WFD objectives in the River Vyrnwy

In the River Vyrnwy there is potential for status deterioration of fish in three waterbodies.

In operation there would be 75 MI/d release from Vyrnwy Reservoir direct into the River Vyrnwy at times when transfer is required below HoF conditions in the River Severn. An additional 80 MI/d would be released into the lower River Vyrnwy on most but not all of the dates of direct release from the reservoir. Operational control rules for releases are at an early stage of design. The Gate 1 assessment has used an indicative release pattern in the 2010-2019 period using information provided by TW on transfer requirements and EA river flow data in gauged in the lower River Severn in association with hands-off flow conditions and abstraction limits provided by the EA to TW. As such STT releases have been assessed irrespective of any other regulation releases or management releases from Vyrnwy Reservoir. The hydrological information to inform the assessment is considered of suitable quality.

Specific aquatic habitat surveys were undertaken in Gate 1 during trial flow releases and reference conditions in the middle River Vyrnwy in the water bodies GB109054049720 (Vyrnwy - Lake Vyrnwy to conf Afon Cownwy) and GB109054049852 (Afon Vyrnwy - conf Afon Conwy to conf Afon Banwy). Assessment of those bespoke data identified the risk of velocities and water depths exceeding the flow thresholds of critical life stages of the protected fish species at certain times. Those certain times, as agreed in discussion with NRW, are the times when 75 MI/d STT releases are made at the same time as regulation releases to support River Severn flows through the Severn Regulation. It is noted that the Severn Regulation releases are considered by NRW to be analogous to STT releases as the water is required to support flow contributions to the Severn Estuary and cannot be re-abstracted by STT at Deerhurst below HoF conditions. The hydro-ecological evidence to inform the assessment is considered of suitable quality.

**Table 14 WFD compliance assessment summary for the 300 MI/d pipeline conveyance, full support system STT grouping**

| Water body   | WFD compliant against assessed WFD objectives | Potential non compliant issue  |
|--|---|--|
| Vyrnwy - Lake Vyrnwy to conf Afon Cownwy (GB109054049880)          | No (high confidence)                          | • Fish (Objective 1 status deterioration)  |
| Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy (GB109054049720) | No (high confidence)                          | • Fish (Objective 1 status deterioration)  |
| Afon Vyrnwy - conf Afon Tanat to conf R Severn (GB109054049800)    | No (low confidence)                           | • Fish (Objective 1 status deterioration)  |
| Avon (Wark) conf R Leam to Tramway Br, Stratford (GB109054044402)  | No (medium confidence)                        | <ul style="list-style-type: none"> <li>• Fish (Objective 1 status deterioration)</li> <li>• Macroinvertebrates (Objective 1 status deterioration)</li> <li>• Macrophytes &amp; phytobenthos (Objective 2, introducing impediments)</li> <li>• Phosphate (Objective 2, introducing impediments)</li> <li>• Specific pollutants/ chemical status (Objective 1 status deterioration)</li> </ul> |
| Avon- Tramway Br Stratford to Workman Br Evesham (GB109054044401)  | No (low confidence)                           | <ul style="list-style-type: none"> <li>• Fish (Objective 1 status deterioration)</li> <li>• Macroinvertebrates (Objective 1 status deterioration)</li> <li>• Macrophytes &amp; phytobenthos (Objective 1 status deterioration)</li> <li>• Phosphate (Objective 2, introducing impediments)</li> <li>• Specific pollutants/ chemical status (Objective 1 status deterioration)</li> </ul>     |
| Avon conf Workman Br, Evesham to conf R Severn (GB109054044403)    | No (low confidence)                           | <ul style="list-style-type: none"> <li>• Phosphate (Objective 2, introducing impediments)</li> <li>• Specific pollutants/ chemical status (Objective 1 status deterioration)</li> </ul>  |
| Thames (Evenlode to Thame) (GB106039030334)                        | Yes (high confidence)                         | NA   |
| Thames Wallingford to Caversham (GB106039030331)                   | Yes (high confidence)                         | NA   |
| Thames (Reading to Cookham) (GB106039023233)                       | Yes (high confidence)                         | NA   |
| Thames (Cookham to Egham) (GB106039023231)                         | Yes (high confidence)                         | NA   |
| Thames (Egham to Teddington) GB106039023232                        | Yes (high confidence)                         | NA   |
| Tame from R Rea to R Blythe (GB104028046841)                       | Yes (medium confidence)                       | NA   |

Review of hydrological evidence alone in Gate 1 identified that in the lower River Vyrnwy, below the Vyrnwy bypass identified a moderate impact on normal flow patterns. The river in this reach, part of GB109054049800 Afon Vyrnwy - conf Afon Tanat to conf R Severn water body, has a different character to the middle Vyrnwy reach that was subject to Gate 1 bespoke survey. In the absence of specific evidence on the range of usable fish habitats in this reach and how these would change with STT releases, data confidence is low and WFD compliance for fisheries not certain. Specific aquatic habitat surveys are planned for Gate 2.

Further development of operating rules may lead to an assessment of WFD compliance for this STT grouping in the River Vyrnwy. This may include appropriate operating rules to ensure gradual reservoir release start-up and shut-down to avoid sudden changes in flow velocities. In addition operating rules to limit the use of the scheme during Severn Regulation releases. These operating rules will be developed further in Gate 2.

### 5.2.1.1 Potential non-compliance with WFD objectives in the River Avon

In the River Avon there is potential for status deterioration or introducing impediments to target status in three waterbodies.

In operation there would be a 115 Ml/d transfer from Minworth WwTW into the River Avon in GB109054044402 Avon (Wark) conf R Leam to Tramway Br, Stratford. Hydrologically this has been assessed in Gate 1 using suitable quality data as a major flow change. As such there would be direct change to wetted usable habitat for aquatic ecology together with potential for water quality effects. In the absence of specific evidence on the range of usable fish habitats and invertebrate habitat quality in this reach and how these would change with STT releases, data confidence is medium and WFD compliance for fisheries and macroinvertebrates not certain. Specific aquatic habitat surveys are planned for Gate 2.

There would be a new extended treatment facility and pumping station at Minworth WwTW. The Gate 1 engineering conceptual design of the Minworth support option states the inclusion of ferric dosing, cloth filter filtration, UV irradiation and granular activated carbon (GAC) prior to discharge, as presented in the Conceptual Design Report. The conceptual design at Gate 1 is without comprehensive coverage of evidence of chemicals in either Minworth WwTW discharge or the River Avon at the outfall location. The conceptual design notes that GAC is not commonly applied to wastewater effluent and a pilot plant would be required to demonstrate required efficacy. A viable SRO element would be required to achieve a discharge permit, and a discharge permit would need to demonstrate that it is WFD compliant. Although much is known of the quality of Minworth WwTW from the Chemical Investigations Programme and other monitoring by ST, there is currently only limited data on the quality of the River Avon around Warwick. Water quality data in the River Avon identify Poor status for reactive phosphate and only stringent treatment of Minworth WwTW discharge prior to discharge would not introduce an impediment to target status (Good by 2027). The nutrient quality of the river is currently a reason for not achieving target Good status for macrophytes & phytobenthos combined. Other chemicals may also prove difficult to treat prior to discharge and the risk of in river status deterioration is apparent. A bespoke SRO monitoring programme, which commenced in Gate 1, at both Minworth WwTW and in the River Avon will improve data confidence in Gate 2. An algal monitoring programme in the River Avon has also commenced in Gate 1 and will improve data confidence in Gate 2.

These same WFD compliance issues also pass-forward to the next water body, GB109054044401 Avon- Tramway Br Stratford to Workman Br Evesham. Flow effects in this reach from STT remain major and the potential direct effects on fish and macroinvertebrates remain not certain. The nutrient quality of the River Avon remains Poor status and the risk of introducing impediments to target status remains apparent. Macrophytes & phytobenthos are Good status in this reach and there is risk of status deterioration without improvement in nutrient quality. Any chemical status deterioration in the upstream water body are also likely to continue in this reach. Water quality modelling in Gate 2 will increase confidence in these assessments.

Many of these same WFD compliance issues also pass-forward to the next water body, GB109054044403 Avon conf Workman Br, Evesham to conf R Severn. Flow effects in this reach from STT reduce to minor depending on operating pattern and the potential direct effects on fish and macroinvertebrates are limited and not considered a WFD status deterioration risk. The nutrient quality of the River Avon remains Poor status and the risk of introducing impediments to target status remains apparent, albeit with low confidence. Any chemical status deterioration in the upstream water body are also likely to continue in this reach. Water quality modelling in Gate 2 will increase confidence in these assessments.

### 5.2.1.2 Compliance with WFD objectives in the River Thames

In the 100km reach of the River Thames from the transfer outfall to Windsor, where re-abstraction would commence, the flow effect of the STT transfer releases would be a moderate negative flow effect. This effect would remain a moderate negative flow effect in the 27km reach of the lower River Thames from Windsor to the tidal limit at Teddington and in the estuarine Thames Tideway flow effects would be

neutral. Previous study for TW<sup>12</sup> identified that flow changes from STT of up to 300 MI/d under low river flow conditions in the River Thames would not have significant adverse effect on water level as this is maintained for navigation, or consequently on channel width or marginal habitats. Flow velocity effects under these low flow conditions would also be not significantly adverse to the ecology of the main channel. The management of the ramping up and down of flow releases to ensure no sudden ecological effects would be subject to an operating agreement with EA. Therefore, the assessment is of compliance with WFD objectives in the River Thames with high confidence in ecological status WFD compliance following previous detailed assessment. Additional bespoke water quality data are being collected from Gate 1 and these will inform the continued suitability of the treatment unit to ensure chemical status compliance with WFD or lead to refinement of design.

### 5.2.1.3 Compliance with WFD objectives in the River Tame

Hydrological assessment of effects of discharge reduction from Minworth WwTW on the downstream River Tame as minor negative flow effect. In this context and with the assumption at Gate 1 of the same water quality discharged the assessment is of compliance with WFD objectives, with medium confidence on account of the evidenced magnitude of flow change.

## 5.3 300 MI/d pipeline conveyance, without Minworth WwTW discharge diversion support element

The STT pipeline conveyance with full support system has been assessed as with the potential to not comply with WFD objectives. As summarised in **Table 15** this is in three specific water bodies.

**Table 15 WFD compliance assessment summary for the 300 MI/d pipeline conveyance, without Minworth WwTW discharge transfer STT grouping**

| Water body   | WFD compliant against assessed WFD objectives | Potential non compliance issue            |
|--|---|---|
| Vyrnwy - Lake Vyrnwy to conf Afon Cownwy (GB109054049880)          | No (high confidence)                          | • Fish (Objective 1 status deterioration) |
| Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy (GB109054049720) | No (high confidence)                          | • Fish (Objective 1 status deterioration) |
| Afon Vyrnwy - conf Afon Tanat to conf R Severn (GB109054049800)    | No (low confidence)                           | • Fish (Objective 1 status deterioration) |
| Thames (Evenlode to Thame) (GB106039030334)                        | Yes (high confidence)                         | NA  |
| Thames Wallingford to Caversham (GB106039030331)                   | Yes (high confidence)                         | NA  |
| Thames (Reading to Cookham) (GB106039023233)                       | Yes (high confidence)                         | NA  |
| Thames (Cookham to Egham) (GB106039023231)                         | Yes (high confidence)                         | NA  |
| Thames (Egham to Teddington) (GB106039023232)                      | Yes (high confidence)                         | NA  |

### 5.3.1 Potential non compliance with WFD objectives in the River Vyrnwy

In the River Vyrnwy there is potential for status deterioration of fish in three waterbodies.

In operation there would be 75 MI/d release from Vyrnwy Reservoir direct into the River Vyrnwy at times when transfer is required below HoF conditions in the River Severn. An additional 80 MI/d would be released into the lower River Vyrnwy on most but not all of the dates of direct release from the reservoir. Operational control rules for releases are at an early stage of design. The Gate 1 assessment has used an indicative release pattern in the 2010-2019 period using information provided by TW on transfer

<sup>12</sup> HR Wallingford and Cascade Consulting (2016) Severn Thames Transfer: Water Quality and Ecology Assessment - Phase 2. Main Project Report. Report for Thames Water

requirements and EA river flow data in gauged in the lower River Severn in association with hands-off flow conditions and abstraction limits provided by the EA to TW. As such STT releases have been assessed irrespective of any other regulation releases or management releases from Vyrnwy Reservoir. The hydrological information to inform the assessment is considered of suitable quality.

Specific aquatic habitat surveys were undertaken in Gate 1 during trial flow releases and reference conditions in the middle River Vyrnwy in the water bodies GB109054049720 (Vyrnwy - Lake Vyrnwy to conf Afon Cownwy) and GB109054049852 (Afon Vyrnwy - conf Afon Conwy to conf Afon Banwy). Assessment of those bespoke data identified the risk of velocities and water depths exceeding the flow thresholds of critical life stages of the protected fish species at certain times. Those certain times, as agreed in discussion with NRW, are the times when 75 MI/d STT releases are made at the same time as regulation releases to support River Severn flows through the Severn Regulation. It is noted that the Severn Regulation releases are considered by NRW to be analogous to STT releases as the water is required to support flow contributions to the Severn Estuary and cannot be re-abstracted by STT at Deerhurst below HoF conditions. The hydro-ecological evidence to inform the assessment is considered of suitable quality.

Review of hydrological evidence alone in Gate 1 identified that in the lower River Vyrnwy, below the Vyrnwy bypass identified a moderate impact on normal flow patterns. The river in this reach, part of GB109054049800 Afon Vyrnwy - conf Afon Tanat to conf R Severn water body, has a different character to the middle Vyrnwy reach that was subject to Gate 1 bespoke survey. In the absence of specific evidence on the range of usable fish habitats in this reach and how these would change with STT releases, data confidence is low and WFD compliance for fisheries not certain. Specific aquatic habitat surveys are planned for Gate 2.

Further development of operating rules may lead to an assessment of WFD compliance for this STT grouping in the River Vyrnwy. This may include appropriate operating rules to ensure gradual reservoir release start-up and shut-down to avoid sudden changes in flow velocities. In addition operating rules to limit the use of the scheme during Severn Regulation releases. These operating rules will be developed further in Gate 2.

### 5.3.1.1 Compliance with WFD objectives in the River Thames

In the 100km reach of the River Thames from the transfer outfall to Windsor, where re-abstraction would commence, the flow effect of the STT transfer releases would be a moderate negative flow effect. This effect would remain a moderate negative flow effect in the 27km reach of the lower River Thames from Windsor to the tidal limit at Teddington and in the estuarine Thames Tideway flow effects would be neutral. Previous study for TW<sup>13</sup> identified that flow changes from STT of up to 300 MI/d under low river flow conditions in the River Thames would not have significant adverse effect on water level as this is maintained for navigation, or consequently on channel width or marginal habitats. Flow velocity effects under these low flow conditions would also be not significantly adverse to the ecology of the main channel. The management of the ramping up and down of flow releases to ensure no sudden ecological effects would be subject to an operating agreement with EA. Therefore, the assessment is of compliance with WFD objectives in the River Thames with high confidence in ecological status WFD compliance following previous detailed assessment. Additional bespoke water quality data are being collected from Gate 1 and these will inform the continued suitability of the treatment unit to ensure chemical status compliance with WFD or lead to refinement of design.

## 5.4 300 MI/d canal conveyance, full support system

The STT canal conveyance with full support system has been assessed as with the potential to not comply with WFD objectives. As summarised in **Table 16** this is in seven specific water bodies.

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<sup>13</sup> HR Wallingford and Cascade Consulting (2016) Severn Thames Transfer: Water Quality and Ecology Assessment - Phase 2. Main Project Report. Report for Thames Water

**Table 16 WFD compliance assessment summary for the 300 MI/d canal conveyance, full support system STT grouping**

| Water body   | WFD compliant against assessed WFD objectives | Potential non compliant issue  |
|--|---|--|
| Vyrnwy - Lake Vyrnwy to conf Afon Cownwy (GB109054049880)            | No (high confidence)                          | • Fish (Objective 1 status deterioration)  |
| Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy (GB109054049720)   | No (high confidence)                          | • Fish (Objective 1 status deterioration)  |
| Afon Vyrnwy - conf Afon Tanat to conf R Severn (GB109054049800)      | No (low confidence)                           | • Fish (Objective 1 status deterioration)  |
| Avon (Wark) conf R Leam to Tramway Br, Stratford (GB109054044402)    | No (medium confidence)                        | <ul style="list-style-type: none"> <li>• Fish (Objective 1 status deterioration)</li> <li>• Macroinvertebrates (Objective 1 status deterioration)</li> <li>• Macrophytes &amp; phytobenthos (Objective 2, introducing impediments)</li> <li>• Phosphate (Objective 2, introducing impediments)</li> <li>• Specific pollutants/ chemical status (Objective 1 status deterioration)</li> </ul> |
| Avon- Tramway Br Stratford to Workman Br Evesham (GB109054044401)    | No (low confidence)                           | <ul style="list-style-type: none"> <li>• Fish (Objective 1 status deterioration)</li> <li>• Macroinvertebrates (Objective 1 status deterioration)</li> <li>• Macrophytes &amp; phytobenthos (Objective 1 status deterioration)</li> <li>• Phosphate (Objective 2, introducing impediments)</li> <li>• Specific pollutants/ chemical status (Objective 1 status deterioration)</li> </ul>     |
| Avon conf Workman Br, Evesham to conf R Severn (GB109054044403)      | No (low confidence)                           | <ul style="list-style-type: none"> <li>• Phosphate (Objective 2, introducing impediments)</li> <li>• Specific pollutants/ chemical status (Objective 1 status deterioration)</li> </ul>  |
| Severn (E Channel) – Horsebere Bk to Severn Estuary (GB109054032750) | No High confidence                            | <ul style="list-style-type: none"> <li>• Fish (Objective 1 status deterioration)</li> <li>• Macroinvertebrates (Objective 1 status deterioration or Objective 2 introducing impediments)</li> </ul>  |
| Thames (Evenlode to Thame) (GB106039030334)                          | Yes (high confidence)                         | NA   |
| Thames Wallingford to Caversham (GB106039030331)                     | Yes (high confidence)                         | NA   |
| Thames (Reading to Cookham) (GB106039023233)                         | Yes (high confidence)                         | NA   |
| Thames (Cookham to Egham) (GB106039023231)                           | Yes (high confidence)                         | NA   |
| Thames (Egham to Teddington) GB106039023232                          | Yes (high confidence)                         | NA   |
| Tame from R Rea to R Blythe (GB104028046841)                         | Yes (medium confidence)                       | NA   |
| Gloucester and Sharpness Canal (GB70910509)                          | Yes (medium confidence)                       | NA   |

#### 5.4.1.1 Potential non-compliance with WFD objectives in the River Vyrnwy

In the River Vyrnwy there is potential for status deterioration of fish in three waterbodies.

In operation there would be 75 MI/d release from Vyrnwy Reservoir direct into the River Vyrnwy at times when transfer is required below HoF conditions in the River Severn. An additional 80 MI/d would be released into the lower River Vyrnwy on most but not all of the dates of direct release from the reservoir. Operational control rules for releases are at an early stage of design. The Gate 1 assessment has used an indicative release pattern in the 2010-2019 period using information provided by TW on transfer requirements and EA river flow data in gauged in the lower River Severn in association with hands-off flow conditions and abstraction limits provided by the EA to TW. As such STT releases have been

assessed irrespective of any other regulation releases or management releases from Vyrnwy Reservoir. The hydrological information to inform the assessment is considered of suitable quality.

Specific aquatic habitat surveys were undertaken in Gate 1 during trial flow releases and reference conditions in the middle River Vyrnwy in the water bodies GB109054049720 (Vyrnwy - Lake Vyrnwy to conf Afon Cownwy) and GB109054049852 (Afon Vyrnwy - conf Afon Conwy to conf Afon Banwy). Assessment of those bespoke data identified the risk of velocities and water depths exceeding the flow thresholds of critical life stages of the protected fish species at certain times. Those certain times, as agreed in discussion with NRW, are the times when 75 MI/d STT releases are made at the same time as regulation releases to support River Severn flows through the Severn Regulation. It is noted that the Severn Regulation releases are considered by NRW to be analogous to STT releases as the water is required to support flow contributions to the Severn Estuary and cannot be re-abstracted by STT at Gloucester Docks below HoF conditions. The hydro-ecological evidence to inform the assessment is considered of suitable quality.

Review of hydrological evidence alone in Gate 1 identified that in the lower River Vyrnwy, below the Vyrnwy bypass identified a moderate impact on normal flow patterns. The river in this reach, part of GB109054049800 Afon Vyrnwy - conf Afon Tanat to conf R Severn water body, has a different character to the middle Vyrnwy reach that was subject to Gate 1 bespoke survey. In the absence of specific evidence on the range of usable fish habitats in this reach and how these would change with STT releases, data confidence is low and WFD compliance for fisheries not certain. Specific aquatic habitat surveys are planned for Gate 2.

Further development of operating rules may lead to an assessment of WFD compliance for this STT grouping in the River Vyrnwy. This may include appropriate operating rules to ensure gradual reservoir release start-up and shut-down to avoid sudden changes in flow velocities. In addition operating rules to limit the use of the scheme during Severn Regulation releases. These operating rules will be developed further in Gate 2.

#### 5.4.1.2 Potential non compliance with WFD objectives in the River Avon

In the River Avon there is potential for status deterioration or introducing impediments to target status in three waterbodies.

In operation there would be 115 MI/d transfer from Minworth WwTW into the River Avon in GB109054044402 Avon (Wark) conf R Leam to Tramway Br, Stratford. Hydrologically this has been assessed in Gate 1 using suitable quality data as a major flow change. As such there would be direct change to wetted usable habitat for aquatic ecology together with potential for water quality effects. In the absence of specific evidence on the range of usable fish habitats and invertebrate habitat quality in this reach and how these would change with STT releases, data confidence is medium and WFD compliance for fisheries and macroinvertebrates not certain. Specific aquatic habitat surveys are planned for Gate 2.

There would be a new extended treatment facility and pumping station at Minworth WwTW. The Gate 1 engineering conceptual design of the Minworth support option states the inclusion of ferric dosing, cloth filter filtration, UV irradiation and granular activated carbon (GAC) prior to discharge, as presented in the Conceptual Design Report. The conceptual design at Gate 1 is without comprehensive coverage of evidence of chemicals in either Minworth WwTW discharge or the River Avon at the outfall location. The conceptual design notes that GAC is not commonly applied to wastewater effluent and a pilot plant would be required to demonstrate required efficacy. A viable SRO element would be required to achieve a discharge permit, and a discharge permit would need to demonstrate that it is WFD compliant. Although much is known of the quality of Minworth WwTW from the Chemical Investigations Programme and other monitoring by ST, there is currently only limited data on the quality of the River Avon around Warwick. Water quality data in the River Avon identify Poor status for reactive phosphate and only stringent treatment of Minworth WwTW discharge prior to discharge would not introduce an impediment to target status (Good by 2027). The nutrient quality of the river is currently a reason for not achieving target Good status for macrophytes & phytobenthos combined. Other chemicals may also prove difficult to treat prior to discharge and the risk of in river status deterioration is apparent. A bespoke SRO monitoring programme, which commenced in Gate 1, at both Minworth WwTW and in the River Avon

will improve data confidence in Gate 2. An algal monitoring programme in the River Avon has also commenced in Gate 1 and will improve data confidence in Gate 2.

These same WFD compliance issues also pass-forward to the next water body, GB109054044401 Avon- Tramway Br Stratford to Workman Br Evesham. Flow effects in this reach from STT remain major and the potential direct effects on fish and macroinvertebrates remain. The nutrient quality of the River Avon remains Poor status and the risk of introducing impediments to target status remains apparent. Macrophytes & phytobenthos are Good status in this reach and there is risk of status deterioration. Any chemical status deterioration in the upstream water body are also likely to continue in this reach. Water quality modelling in Gate 2 will increase confidence in these assessments.

Many of these same WFD compliance issues also pass-forward to the next water body, GB109054044403 Avon conf Workman Br, Evesham to conf R Severn. Flow effects in this reach from STT reduce to minor depending on operating pattern and the potential direct effects on fish and macroinvertebrates are limited and not considered a WFD status deterioration risk. The nutrient quality of the River Avon remains Poor status and the risk of introducing impediments to target status remains apparent, albeit with low confidence. Any chemical status deterioration in the upstream water body are also likely to continue in this reach. Water quality modelling in Gate 2 will increase confidence in these assessments.

#### 5.4.1.3 Potential non-compliance with WFD objectives in the River Severn

In the River Severn there is potential for status deterioration or introducing impediments to target status in one waterbody.

Water body GB109054032750 Severn (E Channel) – Horsebere Bk to Severn Estuary is currently Bad status for macroinvertebrate status and Poor status for reactive phosphate. The target status for macroinvertebrate status is Poor in 2021 and for reactive phosphate remains Poor. No other biological status elements have a reported status in this heavily modified water body.

In operation there would be 35 Ml/d transferred from Netheridge WwTW into the River Severn in GB109054032750 Severn (E Channel) – Horsebere Bk to Severn Estuary. Hydrologically there is no data on flow in this former navigation cut bifurcation of the lower River Severn. However, this is not the main flow channel and with STT operation, flow would be put preferentially into Gloucester Docks. Further information would be required in Gate 2 to establish the buffering capacity of the remaining river to accommodate 35 Ml/d of tertiary treated water.

The Gate 1 engineering conceptual design of the Netheridge support option states the inclusion of ferrous dosing prior to discharge, as presented in the Conceptual Design Report. At present in Gate 1 there is limited evidence on the receiving water flows or quality in the eastern channel of the River Severn. A viable SRO element would be required to achieve a discharge permit, and a discharge permit would need to demonstrate that it is WFD compliant. The nutrient quality of the receiving river is currently Poor and without a betterment target. It is unlikely that a tertiary treated discharge would deteriorate status to Bad.

The water body is currently Bad status for macroinvertebrate status, with a target status of Poor in 2021. No other biological status elements have a reported status in this heavily modified water body. The flow change in the water body, potentially a large replacement of river flow with tertiary treated WwTW discharge is considered, with high confidence, to impact fish and macroinvertebrate status.

This STT element has been subject to limited design to date and requires further investigation in Gate 2.

#### 5.4.1.4 Compliance with WFD objectives in the River Thames

In the 100km reach of the River Thames from the transfer outfall to Windsor, where re-abstraction would commence, the flow effect of the STT transfer releases would be a moderate negative flow effect. This effect would remain a moderate negative flow effect in the 27km reach of the lower River Thames from Windsor to the tidal limit at Teddington and in the estuarine Thames Tideway flow effects would be

neutral. Previous study for TW<sup>14</sup> identified that flow changes from STT of up to 300 Ml/d under low river flow conditions in the River Thames would not have significant adverse effect on water level as this is maintained for navigation, or consequently on channel width or marginal habitats. Flow velocity effects under these low flow conditions would also be not significantly adverse to the ecology of the main channel. The management of the ramping up and down of flow releases to ensure no sudden ecological effects would be subject to an operating agreement with EA. Therefore, the assessment is of compliance with WFD objectives in the River Thames with high confidence in ecological status WFD compliance following previous detailed assessment. Additional bespoke water quality data are being collected from Gate 1 and these will inform the continued suitability of the treatment unit to ensure chemical status compliance with WFD or lead to refinement of design.

#### 5.4.1.5 Compliance with WFD objectives in the River Tame

Hydrological assessment of effects of discharge reduction from Minworth WwTW on the downstream River Tame as minor negative flow effect. In this context and with the assumption at Gate 1 of the same water quality discharged the assessment is of compliance with WFD objectives, with medium confidence on account of the evidenced magnitude of flow change.

### 5.5 300 Ml/d canal conveyance, without Minworth WwTW discharge diversion support element

The STT canal conveyance without Minworth WwTW discharge diversion support system has been assessed as with the potential to not comply with WFD objectives. As summarised in **Table 17** this is in four specific water bodies.

**Table 17 WFD compliance assessment summary for the 300 Ml/d canal conveyance, without Minworth WwTW discharge transfer STT grouping**

| Water body   | WFD compliant against assessed WFD objectives | Potential non compliant issue   |
|--|---|---|
| Vyrnwy - Lake Vyrnwy to conf Afon Cownwy (GB109054049880)            | No (high confidence)                          | • Fish (Objective 1 status deterioration)   |
| Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy (GB109054049720)   | No (high confidence)                          | • Fish (Objective 1 status deterioration)   |
| Afon Vyrnwy - conf Afon Tanat to conf R Severn (GB109054049800)      | No (low confidence)                           | • Fish (Objective 1 status deterioration)   |
| Severn (E Channel) – Horsebere Bk to Severn Estuary (GB109054032750) | No High confidence                            | • Fish (Objective 1 status deterioration)<br>• Macroinvertebrates (Objective 1 status deterioration or Objective 2 introducing impediments) |
| Thames (Evenlode to Thame) (GB106039030334)                          | Yes (high confidence)                         | NA  |
| Thames Wallingford to Caversham (GB106039030331)                     | Yes (high confidence)                         | NA  |
| Thames (Reading to Cookham) (GB106039023233)                         | Yes (high confidence)                         | NA  |
| Thames (Cookham to Egham) (GB106039023231)                           | Yes (high confidence)                         | NA  |
| Thames (Egham to Teddington) GB106039023232                          | Yes (high confidence)                         | NA  |
| Gloucester and Sharpness Canal (GB70910509)                          | Yes (medium confidence)                       | NA  |

#### 5.5.1.1 Potential non-compliance with WFD objectives in the River Vyrnwy

In the River Vyrnwy there is potential for status deterioration of fish in three waterbodies.

<sup>14</sup> HR Wallingford and Cascade Consulting (2016) Severn Thames Transfer: Water Quality and Ecology Assessment - Phase 2. Main Project Report. Report for Thames Water

In operation there would be 75 MI/d release from Vyrnwy Reservoir direct into the River Vyrnwy at times when transfer is required below HoF conditions in the River Severn. An additional 80 MI/d would be released into the lower River Vyrnwy on most but not all of the dates of direct release from the reservoir. Operational control rules for releases are at an early stage of design. The Gate 1 assessment has used an indicative release pattern in the 2010-2019 period using information provided by TW on transfer requirements and EA river flow data in gauged in the lower River Severn in association with hands-off flow conditions and abstraction limits provided by the EA to TW. As such STT releases have been assessed irrespective of any other regulation releases or management releases from Vyrnwy Reservoir. The hydrological information to inform the assessment is considered of suitable quality.

Specific aquatic habitat surveys were undertaken in Gate 1 during trial flow releases and reference conditions in the middle River Vyrnwy in the water bodies GB109054049720 (Vyrnwy - Lake Vyrnwy to conf Afon Cownwy) and GB109054049852 (Afon Vyrnwy - conf Afon Conwy to conf Afon Banwy). Assessment of those bespoke data identified the risk of velocities and water depths exceeding the flow thresholds of critical life stages of the protected fish species at certain times. Those certain times, as agreed in discussion with NRW, are the times when 75 MI/d STT releases are made at the same time as regulation releases to support River Severn flows through the Severn Regulation. It is noted that the Severn Regulation releases are considered by NRW to be analogous to STT releases as the water is required to support flow contributions to the Severn Estuary and cannot be re-abstracted by STT at Gloucester Docks below HoF conditions. The hydro-ecological evidence to inform the assessment is considered of suitable quality.

Review of hydrological evidence alone in Gate 1 identified that in the lower River Vyrnwy, below the Vyrnwy bypass identified a moderate impact on normal flow patterns. The river in this reach, part of GB109054049800 Afon Vyrnwy - conf Afon Tanat to conf R Severn water body, has a different character to the middle Vyrnwy reach that was subject to Gate 1 bespoke survey. In the absence of specific evidence on the range of usable fish habitats in this reach and how these would change with STT releases, data confidence is low and WFD compliance for fisheries not certain. Specific aquatic habitat surveys are planned for Gate 2.

Further development of operating rules may lead to an assessment of WFD compliance for this STT grouping in the River Vyrnwy. This may include appropriate operating rules to ensure gradual reservoir release start-up and shut-down to avoid sudden changes in flow velocities. In addition operating rules to limit the use of the scheme during Severn Regulation releases. These operating rules will be developed further in Gate 2.

#### 5.5.1.2 Potential non-compliance with WFD objectives in the River Severn

In the River Severn there is potential for status deterioration or introducing impediments to target status in one waterbody.

Water body GB109054032750 Severn (E Channel) – Horsebere Bk to Severn Estuary is currently Bad status for macroinvertebrate status and Poor status for reactive phosphate. The target status for macroinvertebrate status is Poor in 2021 and for reactive phosphate remains Poor. No other biological status elements have a reported status in this heavily modified water body.

In operation there would be a transfer of 35 MI/d from Netheridge WwTW into the River Severn in GB109054032750 Severn (E Channel) – Horsebere Bk to Severn Estuary. Hydrologically there is no flow data for this former navigation cut bifurcation of the lower River Severn. However, this is not the main flow channel and with STT operation, flow would be put preferentially into Gloucester Docks. Further information would be required in Gate 2 to establish the buffering capacity of the remaining river to accommodate 35 MI/d of tertiary treated water.

The Gate 1 engineering conceptual design of the Netheridge support option states the inclusion of ferrous dosing prior to discharge, as presented in the Conceptual Design Report. At present in Gate 1 there is limited evidence on the receiving water flows or quality in the eastern channel of the River Severn. A viable SRO element would be required to achieve a discharge permit, and a discharge permit would need to demonstrate that it is WFD compliant. The nutrient quality of the receiving river is currently Poor and without a betterment target. It is unlikely that a tertiary treated discharge would deteriorate status to Bad.

The water body is currently Bad status for macroinvertebrate status, with a target status of Poor in 2021. No other biological status elements have a reported status in this heavily modified water body. The flow change in the water body, potentially a large replacement of river flow with tertiary treated water is considered, with high confidence, to impact fish and macroinvertebrate status.

This STT element has been subject to limited design to date and requires further investigation in Gate 2.

### 5.5.1.3 Compliance with WFD objectives in the River Thames

In the 100km reach of the River Thames from the transfer outfall to Windsor, where re-abstraction would commence, the flow effect of the STT transfer releases would be a moderate negative flow effect. This effect would remain a moderate negative flow effect in the 27km reach of the lower River Thames from Windsor to the tidal limit at Teddington and in the estuarine Thames Tideway flow effects would be neutral. Previous study for TW<sup>15</sup> identified that flow changes from STT of up to 300 Ml/d under low river flow conditions in the River Thames would not have significant adverse effect on water level as this is maintained for navigation, or consequently on channel width or marginal habitats. Flow velocity effects under these low flow conditions would also be not significantly adverse to the ecology of the main channel. The management of the ramping up and down of flow releases to ensure no sudden ecological effects would be subject to an operating agreement with EA. Therefore, the assessment is of compliance with WFD objectives in the River Thames with high confidence in ecological status WFD compliance following previous detailed assessment. Additional bespoke water quality data are being collected from Gate 1 and these will inform the continued suitability of the treatment unit to ensure chemical status compliance with WFD or lead to refinement of design.

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<sup>15</sup> HR Wallingford and Cascade Consulting (2016) Severn Thames Transfer: Water Quality and Ecology Assessment - Phase 2. Main Project Report. Report for Thames Water

## 6 Conclusions and recommendations

The four STT scheme groupings set out for Gate 1 have each been assessed using the ACWG guideline for WFD compliance assessments. In each case the ACWG template has been completed. That assessment identified that each of the groupings are potentially not compliant with WFD objectives, subject to further development of operating rules and treatment solutions, together with additional bespoke aquatic habitat assessment, water quality monitoring and water quality modelling planned in Gate 2. There is potential non-compliance with WFD objectives in three river water bodies in the River Vyrnwy from both direct reservoir releases and releases through the bypass outfall in the lower River Vyrnwy. Those effects may be mitigated to compliant through further development of operating rules. There is potential non-compliance with WFD objectives in three water bodies in the River Avon from the Minworth WwTW discharge diversion, where this is part of the support system. Further water quality monitoring will determine appropriate tertiary treatment prior to discharge that may provide WFD compliance, for nutrients and chemicals. However, the flow addition itself and the change in wetted usable aquatic habitat requires further assessment in Gate 2 to either confirm WFD compliance or identify mitigation actions. There is potential non-compliance with WFD objectives in one water body in the River Severn from the Netheridge WwTW discharge diversion, for canal conveyance groupings. Little is known of the buffering capacity and aquatic habitats of the receiving water course and these require further evidence and assessment in Gate 2 to either confirm WFD compliance or identify mitigation actions. For all groupings the effects on the River Thames have been assessed as WFD compliant, in part due to the treatment system included prior to discharge into the River Thames.



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