Strategic Regional Water Resource Solutions: Annex B4.3: Water Framework Directive (WFD) Assessment

Standard Gate Two Submission for River Severn to River Thames Transfer (STT)

Date: November 2022

Severn to Thames Transfer

Water Framework Directive assessment (WFD)

STT-G2-S3-122

November 2022

Disclaimer

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

SEVERN THAMES TRANSFER (STT) SOLUTION

Water Framework Directive (WFD) Regulations Compliance Assessment Report

Ricardo ref. ED15323 Issue: 005 11/10/2022

Ricardo Energy & Environment, Gemini Building, Fermi Avenue, Harwell, Oxfordshire, OX11 0QR, UK | +44(0)1235 75 3000 | ee.ricardo.com
Registered company no. 08229264 | VAT no. GB 212 8365 24

CONTENTS

1. Introduction 1
1.1 Background and description of the STT scheme 1
1.1.1 The River Severn to River Thames Transfer Description 1
1.1.2 Gate 2 1
1.2 Study area 2
1.3 STT Solution Summary of the Solution components and operation 4
1.4 Scope of this report 7
1.5 Structure of this report 8
2. Methodology 9
2.1 Introduction 9
2.1.1 Regulator Engagement 10
2.1.2 Level 1 WFD screening 11
2.1.3 Level 2 WFD assessment 11
3. Summary of Basic Level 1 WFD screening 16
4. Level 2 WFD Reach by reach assessment 18
4.1 Introduction 18
4.2 Early Phase STT 18
4.2.1 The River Severn from Deerhurst to the tidal limit at Gloucester 18
4.2.2 The Severn Estuary downstream of the tidal limit at Gloucester 19
4.2.3 River Thames downstream of Culham to tidal limit at Teddington. 21
4.3 Full STT 23
4.3.1 The River Vyrnwy from the Vyrnwy Reservoir to the confluence with the River Severn 23
4.3.2 The River Severn from the Vyrnwy Bypass Outfall to Bewdley 24
4.3.3 The River Severn from Bewdley to the confluence with the River Avon 26
4.3.4 The River Avon from Stoneleigh to the confluence with the River Severn 26
4.3.5 The River Severn from the confluence with the River Avon to Deerhurst 29
4.3.6 The River Severn from Deerhurst to the tidal limit at Gloucester 30
4.3.7 The Severn Estuary downstream of the tidal limit at Gloucester 32
4.3.8 River Thames downstream of Culham to tidal limit at Teddington. 34
5. Conclusions 38
5.1 Summary of POTENTIAL WFD non-compliance of Early Phase STT and Full STT 38
5.2 Uncertainty and confidence data gaps 39
5.3 Recommendations for Gate 3 39

Separate Annexes

(Excel workbooks of completed ACWG Spreadsheet template)

Filename	Content
STTGate2_WFD_ACWGspreadsheet _FullSTT _20220922	STT WFD Assessment – Full STT Grouping
STTGate2_WFDACWGSpreadsheet _EarlyPhaseSTT _20220922	Gate 2 STT WFD Assessment – Early Phase STT Grouping

Figures

Figure 1.1 Flow chart showing the scope of investigations for STT Gate 2 and their interactions 2
Figure 1.2 Map showing the study area and associated catchments 3
Figure 1.3 Schematic representing flow changes (accounting for losses) of STT Solution 5
Figure 1.4 Representation of dates full STT Solution would be on (for water resources purposes) as used in the environmental assessment 6

Tables

Table 1-1 Components of Early Phase and Full STT Operation 4
Table 1-2 River Severn at Deerhurst: HoF conditions 6
Table 2-1 Relevant WFD status elements from which to assess compliance in river waterbodies 13
Table 2-2 Relevant WFD status elements from which to assess compliance in Coastal and TRaC waterbodies 14
Table 2-3 WFD Waterbodies by Reach 15
Table 3-1 WFD Level 1 Compliance Assessment Summary – Waterbodies Subject to Flow Change and Passed Forward to Level 2 and Associated ACWG Listed Activities 16
Table 4-1 WFD compliance assessment summary - The River Severn from Deerhurst to the tidal limit at Gloucester 18
Table 4-2 WFD compliance assessment summary - The Severn Estuary downstream of the tidal limit at Gloucester 20
Table 4-3 WFD compliance assessment summary - The River Thames downstream of Culham to tidal limit at Teddington 21
Table 4-4 WFD compliance assessment summary - River Vyrnwy from the Vyrnwy Reservoir to the confluence with the River Severn 23
Table 4-5 WFD compliance assessment summary - River Severn from the confluence with the River Vyrnwy to Bewdley 24
Table 4-6 WFD compliance assessment summary - River Severn from Bewdley to the confluence with the River Avon 26
Table 4-7 WFD compliance assessment summary - River Avon from Stoneleigh to the confluence with the River Severn 27
Table 4-8 WFD compliance assessment summary - River Severn from the confluence with the River Avon to Deerhurst 29
Table 4-9 WFD compliance assessment summary - The River Severn from Deerhurst to the tidal limit at Gloucester 30
Table 4-10 WFD compliance assessment summary - The Severn Estuary downstream of the tidal limit at Gloucester 32
Table 4-11 WFD compliance assessment summary - The River Thames downstream of Culham to tidal limit at Teddington 34

Glossary and Abbreviations

Glossary and Abbreviations	
Glossary	
Cotswold Canals	Partially refurbished canal network and associated infrastructure (including pumping stations, bypass pipework, treatment plant and pipeline) with design capacity of 300Ml/d to convey river water from River Severn to River Thames.
Deerhurst Pipeline	Pipeline and associated infrastructure (including pump station, treatment plant, break pressure tank) with design capacity of 300/400/500Ml/d to convey river water from River Severn to River Thames.
Hands off Flow	This is the flow below which abstractions from the River Severn are restricted or not permitted
Interconnector	Term used to describe infrastructure required to convey river water from River Severn to River Thames. The Interconnector options are the Deerhurst Pipeline or Cotswold Canals.
Interconnector design capacity	Raw water volume abstracted from the River Severn at the start of the Interconnector. Not the volume delivered to the River Thames at the end of the Interconnector and not the Deployable Output of the STT system.
Minworth SRO	Minworth WwTW effluent transfer to the River Avon (covered under Severn Trent Water (STW) Minworth SRO developed by Severn Trent and Affinity Water). This has the capacity to release up to 115Ml/d into the River Avon.
Mythe Abstraction Licence	Mythe Water Treatment Works (WTW) source support element (covered under Severn Trent Sources SRO developed by STW). Unused abstraction licence transfer has the capacity to release 15Ml/d into the River Severn.
Netheridge Wastewater Treatment Works	Netheridge Wastewater Treatment Works (WwTW) source support element (covered under Severn Trent Sources SRO developed by STW). Effluent diversion has the capacity to release up to 35Ml/d into the River Severn.
Plan pathway	A pathway within an adaptive plan.
Preferred options	The set of water resources options included in the preferred plan.
Preferred plan	Comprises a set of options and a schedule of dates for implementing these options. These options have been selected through the planning process and evidence provided as to why they perform better against the objectives of the plan. Sometimes also referred to as the preferred programme of options.
Revised feasible options	A subset of the feasible options, post AIC cuts which are considered in more detail through the decision making process. The list of revised feasible options is generated by high level screening.
Shrewsbury Redeployment	Shrewsbury Redeployment is facilitated by a supply from the Oswestry WTW. This allows the reduction in the abstraction at Shelton WTW of 25Ml/d.
Source support elements	Elements which have the potential to make additional raw water resources available for abstraction at the start of the Interconnector.
STT partners	The three companies promoting this SRO i.e. Severn Trent Water, United Utilities and Thames Water
STT SRO	Comprises the Interconnector, the River Vyrnwy Bypass Pipeline, Shrewsbury Redeployment and conveyance of the source support elements through the river systems (Vyrnwy, Severn, Avon, and Thames).
STT system	Comprises the STT SRO plus STT source support elements that together form an operational system.
STT system operating strategy	Description of contribution/operation of source support elements and river systems to form an operational system.
Supported flow	When the flow in the River Severn is below the hands-off flow rate at which point abstraction from the River Severn may lead to unacceptable environmental impacts downstream. To mitigate these environmental impacts a permitting strategy is being developed whereby additional water put into the River Severn can be abstracted for a Severn to Thames transfer. The additional water is referred to as Supported flow
Unconstrained list of options	All the possible options that could reasonably be used in the plan. This will include all the options considered in the previous planning round, as well as any options that have been identified since.
Unsupported flow	Unsupported flow occurs when the flow in the River Severn is above the hands-off flow rate and raw water can be freely abstracted from the River Severn for transfer to the River Thames
Vyrnwy Mitigation – River Vyrnwy Bypass Pipeline	Pipeline from the Oswestry Water Treatment Works to the River Severn. The release of partially treated water via the bypass pipeline is a mitigation measure to the River Vyrnwy from the Vyrnwy Release source support element. The pipeline has the capacity to convey up to 155Ml/d.

Vyrnwy Release	Lake Vyrnwy source support element (covered under North West Transfer SRO developed by United Utilities). This source has a capacity of up to 180Ml/d. A direct release of 25Ml/d into River Vyrnwy.
Water Resource Zone	Section 4.4. of the draft WRPG defines a water resource zone as “an area within which the abstraction and distribution of water to meet demand is largely self-contained (with the exception of agreed bulk transfers)”.
Abbreviations	
1880 Act	The Liverpool Corporation Act 1880 which authorises the discharge of compensation water from the Vyrnwy Reservoir into the River Vyrnwy
ACWG	All Company Working Group
AEoI	Adverse Effect on Integrity
AMP	Asset Management Plan
BNG	Biodiversity Net Gain
CAPEX	Capital Expenditure
DCO	Development Consent Order
DO	Deployable Output
DWI	Drinking Water Inspectorate
EA	Environment Agency
EIA	Environmental Impact Assessment
HoF	Hands off Flow
HRA	Habitats Regulations Assessment
IEA	Initial Environmental Appraisal
INNS	Invasive Non-Native Species
Ml	Mega litres
Ml/d	Mega litres per day
NC	Natural Capital
NE	Natural England
NPV	Net Present Value
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Project
NWT	North West Transfer SRO
OPEX	Operational Expenditure
RAPID	Regulatory Alliance for Progressing Infrastructure Development
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SESRO	South East Strategic Reservoir Option
SMNR	Sustainable Management of Natural Resources
SRO	Strategic Resource Option
STT	River Severn to River Thames Transfer
STW	Severn Trent Water
SWQRA	Strategic Water Quality Risk Assessment
T2AT	Thames to Affinity Transfer
T2ST	Thames to Southern Transfer
TW	Thames Water
UU	United Utilities
WFD	Water Framework Directive
WRMP	Water Resource Management Plan
WRSE	Water Resources South East
WRW	Water Resources West
WTW	Water Treatment Works
WwTW	Wastewater Treatment Works

1. INTRODUCTION

1.1 BACKGROUND AND DESCRIPTION OF THE STT SCHEME

1.1.1 The River Severn to River Thames Transfer Description

The aim of the Severn Thames Transfer is to provide additional raw water resources of 300 to 500Ml/d to the South East of England during drought, with 500Ml/d preferred by the Water Resources in the South East (WRSE) group's emerging regional plan. The water would be provided from flows in the River Severn and transferred via an interconnector to the River Thames. For the completion of the Gate 2 assessment, a pipeline "Interconnector" has been selected as the preferred option to transfer water from the River Severn to the River Thames.

Due to the risk of concurrent low flow periods in both river catchments, additional sources of water, apart from those naturally occurring in the River Severn, have been identified to augment the baseline flows. These multiple diverse sources of additional water provide resilience in the provision of raw water transfer to the River Thames. A 'put and take' arrangement has been agreed in principle with the Environment Agency (EA) and Natural Resources Wales (NRW) which means that if additional source water is 'put' into the river, then the Interconnector can 'take' that volume, less catchment losses, regardless of the baseline flows in the River Severn itself.

The regional planning process will determine the volume, timing, and utilisation of water to be transferred. The diversity of sources means they can be developed in a phased manner to meet the ultimate demand profile as determined by the regional planning. These additional sources of water are being provided by United Utilities (UU) and Severn Trent Water (STW) who are working in collaboration with Thames Water (TW) to develop this solution. The additional sources are:

- Vyrnwy Reservoir: Release of 25Ml/d water licensed to UU from Lake Vyrnwy directly into the River Vyrnwy;
- Vyrnwy Reservoir: Utilisation of 155Ml/d water licensed to UU from Lake Vyrnwy and transferred via a bypass pipeline ("Vyrnwy Bypass") to the River Severn;
- Shrewsbury: Diversion of 25Ml/d treated water from UU's Oswestry Water Treatment Works (WTW) via an existing emergency transfer (the Llanforda connection), thus enabling a reduction in abstraction from the River Severn at Shelton WTW to remain in the River Severn for abstraction at Deerhurst;
- Mythe: 15Ml/d of the Severn Trent Water licensed abstraction at Mythe remaining in the River Severn for abstraction at Deerhurst;
- Minworth: The transfer of 115Ml/d of treated wastewater discharge from Severn Trent Water's Minworth Wastewater Treatment Works (WwTW) via a pipeline, to the River Severn via the River Avon at Stoneleigh; and
- Netheridge: The transfer of 35Ml/d of treated wastewater discharge at Severn Trent Water's Netheridge WwTW to the River Severn at Haw Bridge, via a pipeline, upstream of the current discharge to the River Severn.

The STT Gate 1 submission was assessed by the Regulators' Alliance for Progressing Infrastructure Development (RAPID) who concluded that it should progress to standard Gate 2. The recommendations and actions received from RAPID and feedback from stakeholders from the Gate 1 process have been reflected in the scheme development and environmental assessments.

1.1.2 Gate 2

RAPID issued a guidance document[1] in April 2022 to describe the Gate 2 process and set out the expectations for solutions at standard Gate 2. The guidance stated the environmental assessment methodologies should be consistent with any relevant legislation and guidance, and follow best practice.

[1] RAPID (2022) Strategic regional water resource solutions guidance for Gate 2

This includes, where relevant, WRMP24, All Company Working Group (ACWG) guidance[2], and the Environment Agency Invasive Non-native Species risk assessment tool.

Figure 1.1 shows the investigations undertaken for STT Gate 2 and their interactions, in order to show the full scope of work across both environmental and engineering disciplines. Reporting for the environmental investigations has been undertaken in a phased way to account for, and incorporate all previous assessments, data collection and feedback (i) the evidence reports were produced first, and set out the data and evidence to be used in the assessment; (ii) assessment reports were then produced using the evidence to determine the potential effect of the STT Solution on the physical environment, water quality and ecological receptors (dark blue box in Figure 1.1); (iii) based on the evidence and assessments, the statutory reports and assessments required to meet the RAPID and regulatory expectations for solutions at Gate 2 were produced.

This report sets out the Water Framework Directive Regulations[3] (WFD) Compliance Assessment for the STT Solution at Gate 2. It is an assessment of the WFD compliance of the STT solution. A cumulative WFD compliance assessment with other water resources schemes under consideration regionally is included in the Regional Plans of the Water Resources West (WRW) group and Water Resources South East (WRSE) group. Those cumulative effects with the STT solution, assessed elsewhere, include, but are not exclusively, other strategic resource options. This WFD compliance assessment of the STT solution is informed by other assessments, including evidence reporting and assessments.

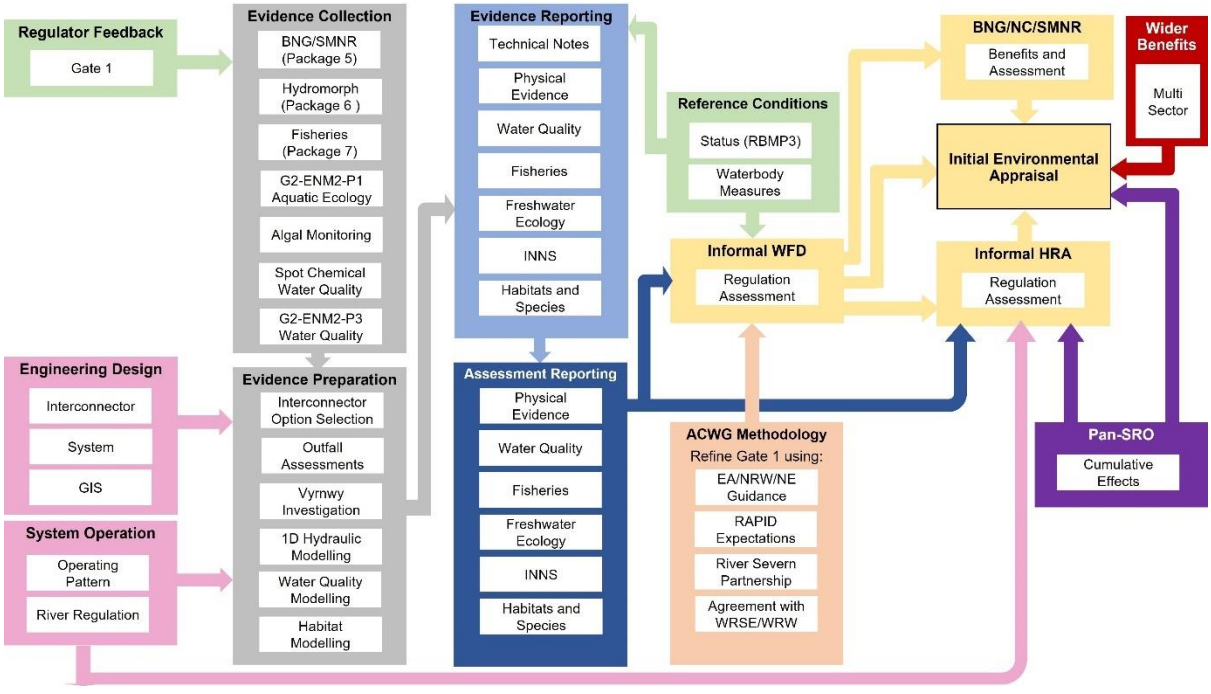

Figure 1.1 Flow chart showing the scope of investigations for STT Gate 2 and their interactions

1.2 STUDY AREA

The study area for the STT Solution for Gate 2 assessment cover the specific reaches deemed within the zone of influence, as shown in Figure 1.2:

1. The River Vyrnwy catchment (River Vyrnwy from Vyrnwy Reservoir to the confluence with the River Severn);
2. The River Severn catchment (River Severn from the confluence with the River Vyrnwy to the Severn Estuary), as well as those tributaries of the River Severn which could indirectly be affected by the operation of the STT solution;

[2] All Companies Working Group (2020) WRMP environmental assessment guidance and applicability with SROs
[3] Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. SI 2017 No. 407

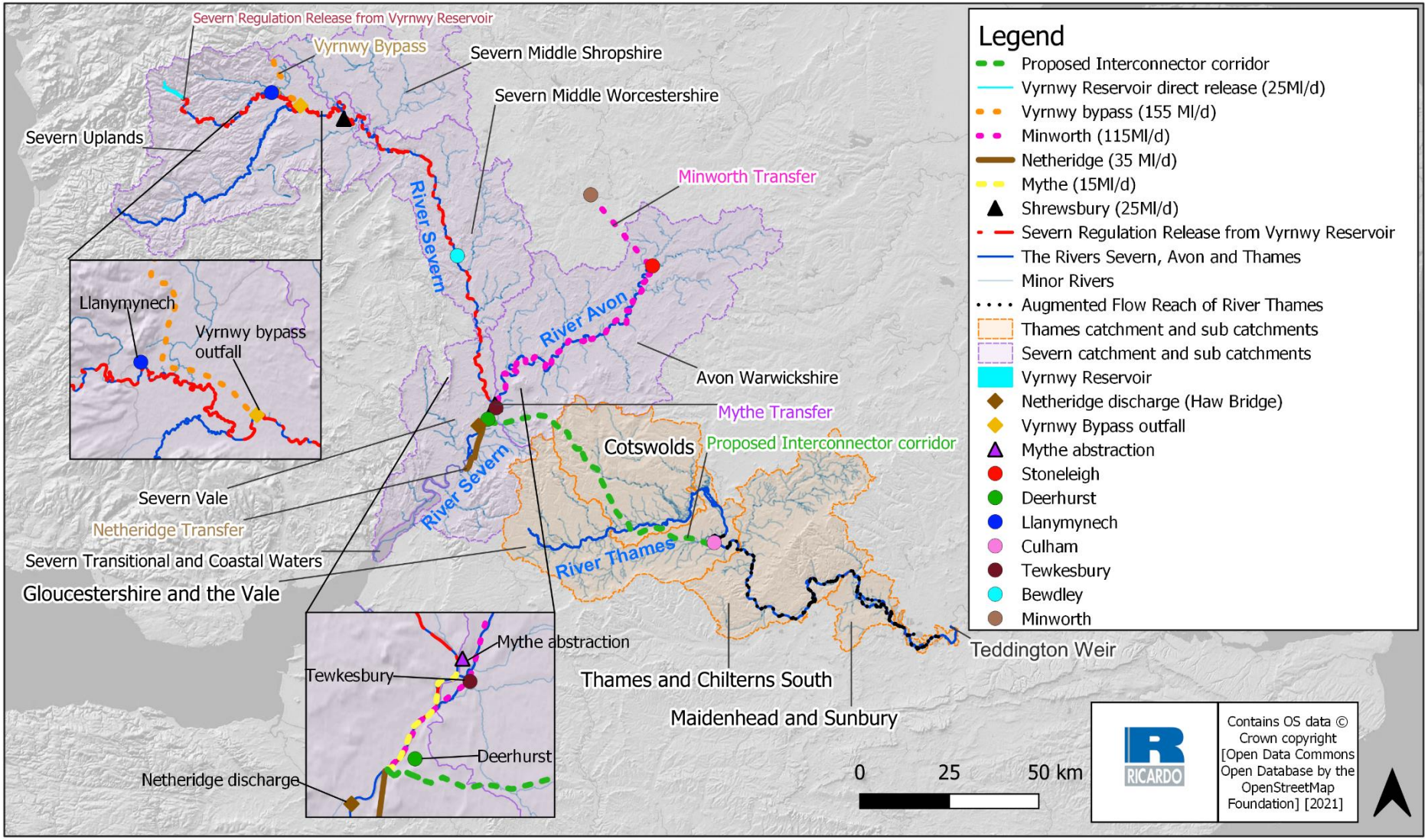

Figure 1.2 Map showing the proposed interconnector corridors

3. The Warwickshire River Avon upstream of Warwick to the River Severn confluence; and
4. The River Thames catchment (River Thames from Culham to Teddington Weir).

It should be noted that the consideration of impacts in the River Tame and Trent, from the transfer of treated discharge from Minworth Wastewater Treatment Works (WwTW) to the River Avon, is included in Severn Trent Water's Minworth Strategic Resource Option (SRO) and therefore excluded from the STT Solution assessment.

Similarly, the STT Solution assessment accounts for the effects from the relevant SROs related to the supply of water into the STT system (United Utilities and Severn Trent Water Sources). It therefore includes an assessment of the potential effects of the water arising from the outfalls from the transfers (Minworth and Netheridge). The assessment does not include analysis of the potential impact arising from the construction of the infrastructure, as this is included in Severn Trent Water's Minworth and Sources SRO assessments.

1.3 STT SOLUTION SUMMARY OF THE SOLUTION COMPONENTS AND OPERATION

The STT Solution STT Solution developed for Gate 2 is described through its engineering components in the Conceptual Design Report. For environmental assessment purposes, as these relate to in-river physical environment effects, the solution has been split into two phases, with and without support, described as (i) an *early phase* of the STT solution, which is without the inclusion of most of the support options that augment flow in the River Severn (see Section 1.1.1), and (ii) a *full STT* solution, which includes all the support options. The river flow changes that comprise these two phases are set out in Table 1-1.

Supporting options would be operational at those times when the STT is transferring water from the River Severn to the River Thames, and when flows in the River Severn are lower than hands-off flow (HoF) thresholds in the River Severn. The EA has advised that a STT abstraction licence would be imposed so flows at Deerhurst flow gauging station do not drop below 2,568 Ml/d. Above this HoF, there is a maximum abstraction limit of 172 Ml/d, up to the next HoF condition of 3,333 Ml/d, where 355 Ml/d can be abstracted, in addition to the available 172 Ml/d unsupported[4]. This is summarised in Table 1-2.

The EA has advised the STT Group of appropriate values of "in-river losses" to include in the hydraulic modelling[5] and subsequent environmental assessments. The advised values include a 20% loss in the River Vyrnwy and a 10% loss for water transferred into the River Avon, in the augmented flow reach between Stoneleigh and the River Severn confluence at Tewkesbury, with the loss occurring evenly over the distance. As such, of the total 370Ml/d augmenting flows into the River Severn catchment for full STT, the equivalent re-abstraction value at Deerhurst used for the environmental assessment is 353Ml/d as shown in Figure 1.3.

Table 1-1 Components of Early Phase and Full STT Operation

Early Phase STT	Full STT
500Ml/d interconnector pipeline.	500Ml/d interconnector pipeline
Part-time, *unsupported* abstraction up to 500Ml/d from the River Severn at Deerhurst and transferred to the River Thames at Culham, subject to HoF conditions identified by the EA.	Part-time, *unsupported* abstraction up to 500Ml/d from the River Severn at Deerhurst and transferred to the River Thames at Culham, subject to hands-off flow conditions identified by EA
Part-time, *supported* abstraction up to 35Ml/d from the River Severn at Deerhurst and transferred to the River Thames at Culham, at flows constrained by hands-off flow conditions, provided by 35Ml/d flow volume from the Netheridge Transfer.	Part-time, supported abstraction up to 353Ml/d from the River Severn at Deerhurst and transferred to the River Thames at Culham, at flows constrained by hands-off flow conditions, and accounting for assumed river transfer losses. Flow provided by UU and STW sources. The order in which these sources are utilised has been determined by optimising the engineering solution and through the regional water resilience modelling by WRSE:

[4] Email from Caroline Howells (Environment Agency Environment Planning Officer) to Peter Blair (Thames Water, Water Resources Modelling Specialist) 27 February 2020.

[5] Email from Alison Williams (Environment Agency Senior Water Resources Officer) to Helen Gavin (Ricardo) and Valerie Howden (HRW) on 10 February 2022.

Early Phase STT	Full STT
The early phase STT Solution STT Solution does not include the full range of support options and as such supported abstraction is limited to the value of the Netheridge Transfer, 35 Ml/d.	1. Vyrnwy Reservoir: Release of 25Ml/d water licensed to UU from Lake Vyrnwy directly into the River Vyrnwy; 2. Vyrnwy Reservoir: Utilisation of 155Ml/d water licensed to UU from Lake Vyrnwy and transferred via a bypass pipeline ("Vyrnwy Bypass") to the River Severn; 3. Shrewsbury: Diversion of 25Ml/d treated water from UU's Oswestry Water Treatment Works (WTW) via an existing emergency transfer (the Llanforda connection), thus enabling a reduction in abstraction from the River Severn at Shelton WTW to remain in the River Severn for abstraction at Deerhurst; 4. Mythe: 15Ml/d of the Severn Trent Water licensed abstraction at Mythe remaining in the River Severn for abstraction at Deerhurst; 5. Minworth: The transfer of 115Ml/d of treated wastewater discharge from Severn Trent Water's Minworth Wastewater Treatment Works (WwTW) via a pipeline, to the River Severn via the River Avon at Stoneleigh; and 6. Netheridge: 35Ml/d of the Severn Trent Water licensed abstraction piped to the River Severn for abstraction at Deerhurst.
Continuous abstraction from River Severn at Deerhurst of 20Ml/d to provide a pipeline maintenance flow, with continuous transfer to River Thames at Culham: • Either unsupported abstraction when not limited by hands-off flow conditions; or • Supported abstraction by flow volume matching from Netheridge Transfer	Continuous abstraction from River Severn at Deerhurst of 20Ml/d to provide a pipeline maintenance flow, with continuous transfer to River Thames at Culham: • Either unsupported abstraction when not limited by hands-off flow conditions; or • Supported abstraction by flow volume matching from Netheridge Transfer

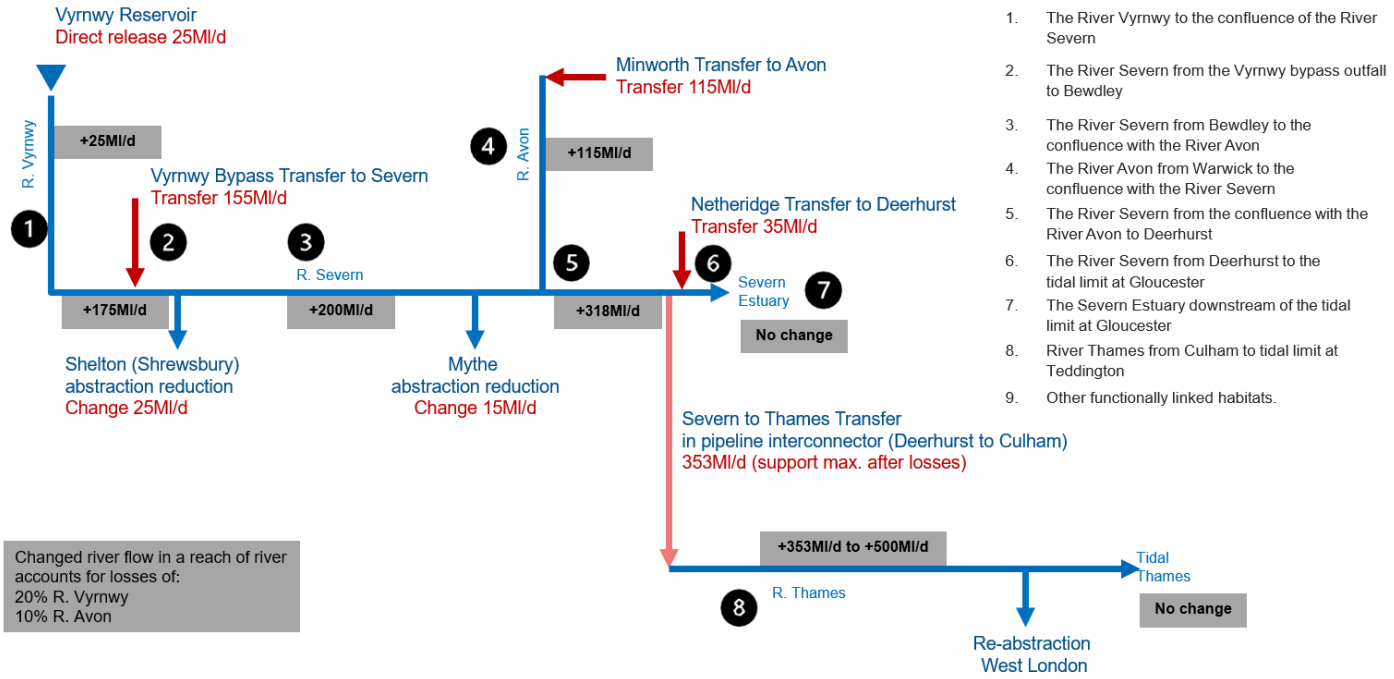

Figure 1.3 Schematic representing flow changes (accounting for losses) of STT Solution

Table 1-2 River Severn at Deerhurst: HoF conditions

HoF	Flow threshold (Ml/d)	Maximum abstraction value at flows greater than the threshold (Ml/d)
1	2,568	172
2	3,333	527

To support the environmental assessments at Gate 2, an indicative operating pattern has been developed. The approach uses the 19,200 year stochastic flow series developed separately for the River Severn catchment for the Water Resources West (WRW) group and for the River Thames catchment for the WRSE group. The stochastic flow series represents contemporary climate conditions and provides information on the return frequency, or regularity, of both the likely river flow conditions and STT operation. The stochastic years have been made available as 48-year continuous periods, and one of those has been selected as having representative flow characteristics to inform the environmental assessments. The selected 48-year series[6] includes a suitable range of regular low and moderate low flow periods. It does not include extreme low flows that are considered to be less regular than once every fifty years. This is described further in Section 2.2.3 of the Physical Environment Assessment Report, with the derived representation of dates with the full STT in operation (for water resources purposes) as used in environmental assessment shown in Figure 1.4. It should be noted that this operating pattern is for the STT Solution STT Solution used on its own for Thames Water, without conjunctive use with other Thames Water SROs (such as the South East Strategic Resource Option (SESRO). It also uses the controlling triggers developed by Thames Water for SESRO based on lower River Thames flows and Thames Water's total London reservoir storage.

Figure 1.4 Representation of dates full STT Solution would be on (for water resources purposes) as used in the environmental assessment

Where: purple indicates periods when the early phase STT would be in operation (unsupported abstraction); and the combined purple and blue periods (supported abstraction) indicate the full STT

[6] Note these are 48 calendar years. The environmental assessment period has been selected as a water resources year (1 April to 31 March) and as such the selected period includes 47 water resources years from the 48 calendar years.

The general description in Figure 1.4 identifies periods in purple when the early phase STT pattern would be in operation: the combined purple and blue periods show the periods when the full STT operation pattern is being deployed. The review of river flows and operating patterns for the environmental assessment has identified that all support options would be on at the same time, rather than any selective or preferential use of support sources. These patterns of river flow and operational need inform the range of likely environmental effects of the scheme. Having identified these patterns, selected return frequencies have been selected for the detailed assessment for Gate 2, which has included hydraulic modelling of different scenarios. The scenarios modelled are:

- a 1:5 return frequency year with moderate-low flows in the River Severn at Deerhurst with a 1:5 return frequency operating pattern in terms of duration and season (model reference A82); and
- a 1:20 return frequency year with very low flow years in the River Severn at Deerhurst with a 1:20 return frequency operating pattern in terms of duration and season (model reference M96).

Noting the scheme would only be used on a 1:2 return frequency, these scenarios capture a suitable range of circumstances and have been discussed and reviewed with the regulators during Gate 2.

It should be noted that, in addition to the above, a 1:50 return frequency year of extremely low flows in the River Severn at Deerhurst and with a 1:20 return frequency operating pattern in terms of duration and season (model reference N17), has been prepared and reviewed for the consideration of scheme resilience. Such a low return frequency is outside the regularity of occurrence included in WFD assessments and is thus not described further in this report. For further information see the EA's position statement LIT 14339 01/2021[7].

The Gate 2 assessment also incorporates climate change scenarios into 1D hydraulic models for the assessment of river flow and Severn Estuary pass-forward flows. However, WFD compliance is assessed against current River Basin Management Plan and not against future projected WFD status. As such the futures assessment is not described further in this report.

1.4 SCOPE OF THIS REPORT

This report sets out the Water Framework Directive Regulations[8] (WFD) Compliance Assessment for STT at Gate 2. Gate 2 builds on Gate 1 activities to improve the detail and breadth of feasibility studies, and to develop concept solution designs with reduced uncertainty in costs and benefits. The SRO schemes are to be developed to a standard suitable for submitting into final regional plans and / or final water resources management plans (WRMPs). A full WFD assessment will be done at a plan level for the WRMP24 and at a project level in the consenting process. Pursuant to the RAPID gated process, this WFD Compliance Assessment reports the assessment as at the current point in time and will continue to be refined and supplemented in line with the gated process. Therefore, statements of WFD compliance are for the purposes of Gate 2 only.

The Gate 1 WFD assessment was completed for four individual STT scheme groupings, which have subsequently been refined and limited to two groupings through the gated process. The 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, now completed as part of the Gate 2 works.

There are also important updates that have been made by the project team to the Gate 1 approach to incorporate the latest position of the EA and NRW on testing WFD compliance of water resources options, and to revise the baseline for testing to draft River Basin Management Plan 3 (RBMP3). It is our current understanding[9] that the draft RBMP3 status, when published, will match the 2019 interim status as currently published.

The Water Framework Directive[10] is an EU Directive which, as of 31/12/2020, is no longer applicable to the United Kingdom. Therefore, the principal 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

[7] EA (2021) Supporting implementation of river basin management plans position. LIT 14339. 01/2021.

[8] Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. SI 2017 No. 407

[9] As identified to Ricardo by Environment Agency National Advisory Unit (NAU) lead for Severn to Thames Transfer solution (Alison Williams) at WFD assessment approach meeting, 13 December 2021

[10] European Union (2000) Directive 2000/60/EC of the European Parliament and of the Council

(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 Solution 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 Solution in a manner consistent with the assessments that will be undertaken for the regional and individual water company WRMPs.

It is noted that there are differences in the review of water quality for environmental permitting and WFD compliance. WFD compliance is assessed in this report strictly according to the WFD assessment objective set out in Section 2.1. Discharge permitting requirements are as set out through Environment Agency LIT 13134 *Permitting of Hazardous Chemicals and Elements in Discharges to Surface Waters* and Environment Agency Guidance H1 Annex D2 for the *Assessment of Sanitary and Other Pollutants within Surface Waters* and are different to the tests for WFD Regulations compliance. Furthermore it is noted that environmental permitting for discharges is not a RAPID requirement for Gate 2 SRO assessments and that this will commence in RAPID Gate 3 and incorporate *Frequently Asked* Questions advice provided by Environment Agency in Gate 2[11].

1.5 STRUCTURE OF THIS REPORT

The report is divided into the following sections:

- Section 1: This introduction;
- Section 2: Provides the methodology adopted for the WFD Regulations compliance assessment;
- Section 3: Provides the results of the WFD compliance assessment Level 1 screening of STT Solution options (combined STT Source Support Elements and Interconnector elements);
- Section 4: Provides the results of the WFD compliance assessment Level 2 assessment of STT Solution options (combined STT Source Support Elements and Interconnector elements); and
- Section 5: Conclusions and Recommendations.

[11] Environment Agency. National Appraisal Unit Water Quality Permitting for Strategic Resource Options: Transferring Recycled Effluent via Water Bodies for Water Supply. July 2022

2. METHODOLOGY

2.1 INTRODUCTION

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 SROs. Following discussion with the EA and NRW during preparation of the WFD Regulations assessment methodology for the Water Resources West group of companies' 2022 Regional Plan, the WFD assessment objectives from ACWG Gate 1 are outdated. In Gate 2, the STT Solution is tested against the principal WFD Assessment Objectives as follows:

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[12] of any WFD element of any waterbody - in line with Regulation 13(2)a and 13(5)a[13];
2. To prevent the introduction of impediments to the attainment of 'Good' WFD status or potential for any waterbody in line with Regulation 13(2)b and 13(5)c[14]; and
3. To ensure that the planned programme of water body measures in RBMP2[15], to protect and enhance the status of waterbodies, are not compromised.

The WFD Assessment Objectives detailed above are the fundamental WFD Assessment Objectives that have been used for testing.

There are a number of further WFD Assessment Objectives, set out in the Water Resource Planning Guidelines (WRPG), which are outlined below. These are considered as progressive WFD Assessment Objectives rather than tests of constraint and do not lead to WFD non-compliance of STT Solution if not achieved. These are as follows:

4. To assist the attainment of the WFD Objectives for the waterbody – in line with Regulation 13(2)(b) and 13(2)(c);
5. To assist the attainment of the objectives for associated WFD protected areas – in line with Regulation 13(6); and

---

[12] European Court of Justice (ECJ) ruling
ECJ Case C-461/13: Bund für Umwelt und Naturschutz Deutschland v Bundesrepublik Deutschland *http://curia.europa.eu/juris/document/document.jsf?docid=178918&mode=req&pageIndex=1&dir=&occ=first&part=1&text=&doclang=EN&cid=175124* [accessed 11/04/2022] clarified that 'no deterioration' means a deterioration **between** a whole 'status class' (e.g. 'good', 'moderate', etc.) of one or more of the relevant 'quality elements' (e.g. biological, phyisco-chemical, etc.). This definition applies equally to Artificial Waterbodies and Heavily Modified Waterbodies in respect of the relevant quality elements that relate to the defined uses of these waterbodies. The ECJ ruling further states that if the quality element concerned is already in the lowest class, any deterioration of that element constitutes a deterioration of the status. References to 'no deterioration' in this WFD methodology align to this ECJ ruling.

[13] The no deterioration baseline for each water body and element is the status reported in the RBMP. The RBMP 3 will be used. Discussion with EA and review of EA internal guidance[#1] has identified that the EA consider *'When making management decisions, any 'interim' classification results are also relevant [in addition to the published RBMP status] to making sure any deterioration in status is taken into account and to meet the objective of aiming to achieve good status in waterbodies*.'

[#1] EA (2021) Supporting implementation of river basin management plans position. LIT 14339. 01/2021 Discussion with NRW and through review of NRW internal guidance[#2] identified that NRW consider *'You must use the most recent classification information in any assessment.'*

[#2] NRW (2020) Guidance for assessing activities and projects for compliance with the Water Framework Directive. Operation Guidance Note 72

[14] WRPG (2021) states that this a test to identify any options that 'prevent the achievement of the waterbody status objectives in the river basin management plan'. At present this is RBMP2. Discussion with EA review of EA internal guidance[#1] has identified that the EA consider 'less stringent objectives are not permanent and the assessment of any new activity or project must take into account the need to continue to aim for good status. The new activity or project must not jeopardise the achievement of good status in the future, irrespective of whether a less stringent objective was set in RBMP2'.

[#1] EA (2021) Supporting implementation of river basin management plans position. LIT 14339. 01/2021

[15] Until publication of draft RBMP3 there are no catalogued published water body measures that update from those published with RBMP2

6. To reduce the treatment needed to produce drinking water and look to work in partnership with others; promoting the requirements of Article 7 of the WFD[16].

Furthermore, with reference to components of the STT Solution located in Wales, additional WFD Assessment Objectives have been identified as appropriate from OGN72[17]. These are progressive WFD Assessment Objectives rather than tests of constraint. These are as follows:

7. To promote the sustainable use of water as a natural resource;
8. To conserve habitats and species that depend directly on water;
9. To progressively reduce or phase out the release of individual pollutants or groups of pollutants that present a significant threat to the aquatic environment;
10. To progressively reduce the pollution of groundwater and prevent or limit the entry of pollutants and
11. To contribute to mitigating the effects of floods and droughts.

A negative answer to WFD Assessment Objectives 4-11 above does not determine that the STT Solution has WFD constraints; however, they can be used in decision making.

It is noted that, although not specifically linked to WFD, The Welsh Government Guiding Principles for Developing Water Resources Management Plans (WRMPs) for 2020[18] outlines that water companies should have regard to Section 6 and Section 7 of the Environment (Wales) Act 2016 when producing their WRMPs. The obligations of this Act are covered in the SEA and Natural Capital/Environmental Resilience assessments which will be undertaken in parallel to the WFD assessment.

At Gate 1, the STT Solution was assessed using the Level 1 basic screening to identify potentially affected WFD waterbodies and possible impacts based on activities, following the ACWG guidelines. For each of the WFD waterbodies screened into the Level 2 assessment, the ACWG reporting spreadsheets were completed and assessed via a detailed screening process for impact on each status element and RBMP2 programme of water body measures.

At Gate 2, all potentially affected WFD waterbodies have been reassessed following the Level 2 methodology detailed below. For each WFD waterbody, the ACWG reporting spreadsheets (see supporting Annexes) set out the draft RBMP3 status of each WFD status element. 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 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 waterbody. 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 water body measure. Assessments have been undertaken proportionate to the assessment requirements of Gate 2, noting the level of confidence in the assessment and the level of design certainty.

A summary of the Level 1 assessment is detailed in Section 3. The Level 2 assessment is detailed in Section 4. The Gate 2 Environmental Assessment Reports provide the supporting physical environment, water quality and aquatic ecology assessments that underpin the WFD compliance assessment.

2.1.1 Regulator Engagement

The recommendations and actions received from RAPID and feedback from stakeholders from the Gate 1 process have been reflected in the scheme development and environmental assessments including this WFD assessment.

In order to engage with regulators over the approach, evidence collection, monitoring programmes, and data analysis for Gate 2, the environmental assessment team have held monthly meetings with the EA, NRW and

[16] Specifically set out in WRPG 2021 (updated 17 March 2021) at Section 9.4.5
[17] NRW. (2020). Guidance for assessing activities and projects for compliance with the Water Framework Directive. Operation Guidance Note 72
[18] Welsh Government (2016), The Welsh Government Guiding Principles for Developing Water Resources Management Plans (WRMPs) for 2020, April 2016

NE, in addition to topic-specific sessions and workshops with technical specialists. The regulators are asked to provide insights and inputs on specific aspects where needed in order to ensure the work undertaken is as robust as possible.

In the monthly meetings, the programme, progress and deliverables are reviewed; issues are raised for clarification and resolution, and the regulators are asked for their views and advice on different topics or issues.

In the sessions with technical specialists, each of the proposed approaches to the topics and statutory reports have been set out and explained. Drafts of documents have been issued, plus other technical notes, to the regulators to solicit feedback on the proposed approaches. Feedback on the drafts has been used to inform the wider environmental assessment for Gate 2 and finalise the approach and reporting.

2.1.2 Level 1 WFD screening

A Level 1 screening was completed, reported in Section 3, for all in-river construction works and the combined operating effects of the STT Solution during the WFD Gate 1 assessment, using the ACWG spreadsheet and the agreed methodology. Headwork activities scored 0 or 1 in the associated ACWG spreadsheets and are therefore considered compliant at Gate 2, and such activities were screened out of further assessment in Level 2. As with Gate 1, pipeline construction activities have been screened as compliant as per the agreed methodology.

For the purposes of this report, all applicable waterbodies subject to potential flow change have been passed forward at Gate 2 and assessed further for operating effects at the Level 2 WFD assessment stage.

2.1.3 Level 2 WFD assessment

As stated in Section 2, the STT Solution will be assessed in detail as two separate groupings. The groupings are referred to as:

1) “Early Phase STT” and;

2) “Full STT”.

In summary, early Phase STT comprises the 500Ml/d pipe with unsupported abstraction above Severn at Deerhurst HoFs, with the Netheridge Transfer providing the augmenting flow to enable pipeline maintenance flow to be taken at flows <HoF. Full STT is as above but with all support elements available to facilitate transfer to Thames catchment whenever required (see further details in Section 2.0). Under each grouping, the WFD waterbodies to be assessed have been separated into reaches to correspond with the associated evidence reports and assessments.

These reaches are as follows:

- The River Vyrnwy from the Vyrnwy Reservoir to the confluence with the River Severn
- The River Severn from the Vyrnwy bypass outfall to Bewdley
- The River Severn from Bewdley to the confluence with the River Avon
- The River Avon from Stoneleigh to the confluence with the River Severn
- The River Severn from the confluence with the River Avon to Deerhurst
- The River Severn from Deerhurst to the tidal limit at Gloucester
- The Severn Estuary downstream of the tidal limit at Gloucester
- River Thames downstream Culham to tidal limit at Teddington.

The associated evidence reports and assessments which have informed this report include:

- Physical Environment Assessment Report, June 2022
- Environmental Water Quality Assessment Report, June 2022
- Fisheries Assessment Report, June 2022
- Macroinvertebrate and Other Ecology Assessment Report, June 2022
- Gate 2 Environmental Water Quality Evidence Report, March 2022
- Gate 2 Physical Environment Evidence Report, March 2022
- Fisheries Evidence Report, March 2022
- Macroinvertebrate & Other Freshwater Ecology Evidence Report, March 2022.

Within the ACWG spreadsheet template, the following style guide indicates how the WFD assessment has been documented:

- Assessment has been undertaken against draft RBMP3 status (to be finalised following consultation and review period by September 2022[19]). The embedded data in the ACWG spreadsheet template has been updated by manually inputting the draft RBMP3 targets into the spreadsheet to ensure the assessment is up to date. Status targets from previous years are not applicable and have therefore not been assessed against. To ensure that older targets have not been assessed, these have been removed from the ACWG spreadsheet embedded data.
- Where the associated evidence and assessment reports have identified an impact to a WFD status element with no published targets in the draft RBMP3, this impact has still been considered within the Level 2 assessment. This is to ensure a holistic understanding of the potential impacts of the scheme is maintained throughout the assessment. When this is the case, a note stating 'No Classification in RBMP3' within the waterbody-specific tabs has been provided.
- The ACWG spreadsheet template includes the objective "Assists attainment of waterbody objectives". That objective is outside the ACWG guidelines and has not been used in the assessment of the STT Solution 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 draft RBMP3 reported status is High or Good, Objective 2 is not applicable and has not been assessed against.
- The relevant WFD status elements for assessment of Objective 1 and Objective 2 in river water bodies[20] are those in the Water Framework Directive (WFD) Directions[21], as listed in Table 2-1.
- The ACWG template includes data from the EA "Reasons for Not Achieving Good" status database. These are not applicable to Objectives 1 or 2 and have not been assessed against.
- For proportionality of assessment, the ACWG spreadsheet template "potential impacts of asset" have been collated for each "activity" with one consolidated assessment undertaken for each WFD status element.
- All assessments have been undertaken using the design and mitigation measures set out for the Gate 2 STT solution, 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 are indicated in the narrative summary in Section 4 below, but not included in the WFD compliance assessment as these are not currently committed to or costed into STT design.

The relevant WFD status elements as assessed in the supporting ACWG spreadsheets have been detailed in Table 2-1 and Table 2-2. The 2015 Directions note the reporting of additional substances from 2018. These substances have been given a formal status in draft RBMP3, and a target status for 2027. Relevant EQS for WFD elements can be found in the Water Framework Directive (Standards and Classification) Directions (England and Wales), 2015.

In Level 2 the WFD waterbodies have been assessed on a reach by reach basis for each grouping. Table 2-3 WFD Waterbodies provides a summary of the WFD waterbodies included in each reach.

[19] Consultation on draft River Basin & Flood Risk Management Plans opens - GOV.UK (www.gov.uk)

[20] It is noted that only river waterbodies have been passed forward to the Level 2 WFD assessment of the STT Solution.

[21] Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

Table 2-1 Relevant WFD status elements from which to assess compliance in river waterbodies

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

Table 2-2 Relevant WFD status elements from which to assess compliance in Coastal and TRaC waterbodies

Ecological status		
Biological status elements	Angiosperms (saltmarsh and seagrass) Fish Phytoplankton	Invertebrates (imposex, infaunal quality index) Macroalgae (fucoid extent, opportunistic marcoalgae, rocky shore macroalgae)
Physio-chemical	Dissolved Inorganic Nitrogen (DIN) Dissolved Oxygen	
Specific pollutants	2,4-dichlorophenol 2,4-dichlorophenoxyacetic acid Arsenic Chlorothalonil Copper Diazinon Dimethoate Iron Linuron Mecoprop	Pendimethalin Permethrin Phenol Toluene Triclosan Un-ionised ammonia Zinc 1-1-1 trichloroethane Fenitrothion Malathion
Chemical status		
Priority Substances, Priority Hazardous Substances and Other pollutants contributing to chemical status	Aclonifen Alachlor Anthracene Atrazine Benzene Benzo(a)-pyrene (BaP) Benzo(b)-fluor-anthene Benzo(k)-fluor-anthene Benzo(g,h,i)-perylene Brominated diphenylether Cadmium and its compounds Carbon tetrachloride Chlorfenvinphos C10-13 chloroalkanes Chlorpyrifos Cybutryne Cyclodiene pesticides isodrin Cybermethrin DDT total Para-para-DDT 1,2-dichloro-ethane Dichloro-methane Di(2-ethylhexyl)-phthalate (DEHP) Diuron Endosulphan Fluoranthene Heptachlor and heptachlor epoxide Hexachloro-benzene Hexachloro-butadiene Hexachloro-cyclohexane Indeno(1,2,3-cd)-pyrene Isoproturon Lead and its compounds Mercury and its compounds	Naphthalene Nickel and its compounds Nonylphenol Octylphenol Pentachloro-benzene Pentachloro-phenol Perfluorooctane sulfonic acid and its derivatives (PFOS) Quinoxyfen Simazine Terbutryn Tetrachloro-ethylene Tributyltin compounds Trichloro-benzenes Trichloro-ethylene Tricholoro-methane Trifluralin

Table 2-3 WFD Waterbodies by Reach

WFD Waterbody	Waterbody I.D
The River Vyrnwy from the Vyrnwy Reservoir to the confluence with the River Severn	
Vyrnwy - Lake Vyrnwy to conf Afon Cownwy	GB109054049880
Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy	GB109054049720
Afon Vyrnwy DS of Banwy confluence	GB109054049852
Afon Vyrnwy - conf Afon Tanat to conf R Severn	GB109054049800
The River Severn from the Vyrnwy bypass outfall to Bewdley	
Severn - conf Bele Bk to conf Sundorne Bk	GB109054049142
Severn - Sundorne Bk to conf M Wenlock-Farley Bk	GB109054049141
Severn conf M Wenlock-Farley Bk to conf R Worfe	GB109054049143
Severn - conf R Worfe to conf R Stour	GB109054049145
The River Severn from Bewdley to the confluence with the River Avon	
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
The River Avon from Stoneleigh to the confluence with the River Severn	
Severn - conf R Avon to conf Upper Parting	GB109054044404
Avon (Warks) - conf R Sowe to conf R Leam	GB109054043840
Avon (Wark) conf R Leam to Tramway Br, Stratford	GB109054044402
Avon- Tramway Br Stratford to Workman Br Evesham	GB109054044401
Avon conf Workman Br, Evesham to conf R Severn	GB109054044403
The River Severn from the confluence with the River Avon to Deerhurst	
Severn - conf R Avon to conf Upper Parting	GB109054044404
The River Severn from Deerhurst to the tidal limit at Gloucester	
Severn - conf R Avon to conf Upper Parting	GB109054044404
Severn (E Channel) - Horsebere Bk to Severn Est	GB109054032750
The Severn Estuary downstream of the tidal limit at Gloucester	
Severn Upper	GB530905415403
The River Thames downstream of Culham to tidal limit at Teddington	
Thames (Evenlode to Thame)	GB106039030334
Thames Wallingford to Caversham	GB106039030331
Thames (Reading to Cookham)	GB106039023233
Thames (Cookham to Egham)	GB106039023231
Thames (Egham to Teddington)	GB106039023232

3. SUMMARY OF BASIC LEVEL 1 WFD SCREENING

In the supporting Annexes, the ACWG spreadsheet template Level 1 assessment worksheets have completed:

"2. Level 1 activities" - These are the specific activities to be assessed per waterbody in the Level 1 screening.

"3. Level 1 summary" – A summary of the waterbodies assessed in the Level 1 screening, a summary of waterbody screening impact scores, and a list of those waterbodies carried on to Level 2 for a further, more detailed assessment.

A Level 1 screening was completed for all in-river construction works and the combined operating effects of the STT Solution for the WFD Gate 1 assessment using the ACWG spreadsheet and agreed methodology. For the purposes of this report, all applicable waterbodies subject to potential flow change have been passed forward at Gate 2 for the detailed assessment of impacts. The full list of waterbodies passed forward for a detailed assessment, along with assessed ACWG listed activities is provided in Table 3-1 below. Intake and outfall headwork construction activities were screened as compliant within the ACWG spreadsheets for each grouping, scoring a value of 0-1 in the ACWG spreadsheets in Level 1, and therefore have not been passed forward for further assessment. Pipeline construction was also screened as compliant as per the agreed methodology.

Table 3-1 WFD Level 1 Compliance Assessment Summary – Waterbodies Subject to Flow Change and Passed Forward to Level 2 and Associated ACWG Listed Activities

WFD Waterbody	Waterbody I.D	Assessed ACWG listed activity
Vyrnwy - Lake Vyrnwy to conf Afon Cownwy	GB109054049880	• Transfer of water via a river, canal or aqueduct • High volume discharge of water with a quality element of the same WFD status as the receiving waterbody (Vyrnwy Reservoir release)
Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy	GB109054049720	• Transfer of water via a river, canal or aqueduct
Afon Vyrnwy DS of Banwy confluence	GB109054049852	• Transfer of water via a river, canal or aqueduct
Afon Vyrnwy - conf Afon Tanat to conf R Severn	GB109054049800	• Transfer of water via a river, canal or aqueduct
Severn - conf Bele Bk to conf Sundorne Bk	GB109054049142	• Transfer of water via a river, canal or aqueduct • High volume discharge of water with a quality element of the same WFD status as the receiving waterbody (Vyrnwy Bypass outfall) • Use of existing surface water abstraction licences, outside existing licence conditions but inside of the recent actual rates (Shelton at Shrewsbury abstraction reduction) • Maintenance and use of river outfall • Maintenance and use of river intake
Severn - Sundorne Bk to conf M Wenlock-Farley Bk	GB109054049141	• Transfer of water via a river, canal or aqueduct
Severn conf M Wenlock-Farley Bk to conf R Worfe	GB109054049143	• Transfer of water via a river, canal or aqueduct
Severn - conf R Worfe to conf R Stour	GB109054049145	• Transfer of water via a river, canal or aqueduct
Severn - conf R Stour to conf River Teme	GB109054049144	• Transfer of water via a river, canal or aqueduct
Severn - conf R Teme to conf R Avon	GB109054039760	• Transfer of water via a river, canal or aqueduct • Use of existing surface water abstraction licences, outside existing licence conditions but inside of the recent actual rates (Mythe) • Maintenance and use of river intake

WFD Waterbody	Waterbody I.D	Assessed ACWG listed activity
Avon (Warks) - conf R Sowe to conf R Leam	GB109054043840	• Transfer of water via a river, canal or aqueduct • High volume discharge of water with a quality element of lower WFD status as the receiving waterbody (Minworth transfer) • Maintenance and use of river outfall
Avon (Wark) conf R Leam to Tramway Br, Stratford	GB109054044402	• Transfer of water via a river, canal or aqueduct
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 - conf R Avon to conf Upper Parting	GB109054044404	• Transfer of water via a river, canal or aqueduct • High volume discharge of water with a quality element of the same WFD status as the receiving waterbody (Netheridge augmentation) • New or increased surface water abstraction (Deerhurst abstraction) • Maintenance and use of river outfall • Maintenance and use of river intake
Severn (E Channel) - Horsebere Bk to Severn Est	GB109054032750	• Transfer of water via a river, canal or aqueduct
Severn Upper	GB530905415403	• Transfer of water via a river, canal or aqueduct
Thames (Evenlode to Thame)	GB106039030334	• Transfer of water via a river, canal or aqueduct • High volume discharge of water with a quality element of the same WFD status as the receiving waterbody (Culham outfall) • Maintenance and use of river outfall
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
Thames (Egham to Teddington)	GB106039023232	• Transfer of water via a river, canal or aqueduct

4. LEVEL 2 WFD REACH BY REACH ASSESSMENT

4.1 INTRODUCTION

In the supporting Annexes, the ACWG spreadsheet template Level 2 assessment worksheets have been completed:

"*4. Assign Level 2 WB Impacts*" – these are the specific activities to be assessed per waterbody. For consistency, these have been selected as those reported in worksheet "2. Level 1 activities".

"*5. Level 2 assessment template*" – a tab of the spreadsheet template has been set out for each of the waterbodies carried forward to the Level 2 assessment and these are renamed as the waterbody ID code.

A third worksheet "6. Level 2 summary" is auto-generated by the template to summarise the Level 2 assessments.

Using the information presented in the spreadsheets, a narrative description of the WFD compliance assessment is provided below on a reach by reach basis. In particular, the narrative provides information on the confidence in the assessment – the data confidence and the design certainty. As stated in Section 2, the reaches will be assessed under two separate groupings "Early Phase STT" and "Full STT".

4.2 EARLY PHASE STT

This section outlines the WFD compliance assessment for the Early Phase STT grouping. In summary, Early Phase STT comprises the 500Ml/d pipe with unsupported abstraction above Severn at Deerhurst HoFs, with the Netheridge Transfer providing the augmenting flow to enable pipeline maintenance flow to be taken at flows <HoF. The assessed reaches are as follows:

- The River Severn from Deerhurst to the tidal limit at Gloucester
- The Severn Estuary downstream of the tidal limit at Gloucester
- River Thames downstream Culham to tidal limit at Teddington.

4.2.1 The River Severn from Deerhurst to the tidal limit at Gloucester

The River Severn from Deerhurst to the tidal limit at Gloucester reach has been assessed for the potential of the STT Solution to not comply with WFD objectives. As summarised in Table 4-1 this has been completed for two specific water bodies.

In this reach, the STT operation would abstract flow for transfer in the STT interconnector. The abstraction regime is dependent on the maturity of the STT solution. In the Early Phase STT scheme, abstraction would be unsupported up to 500Ml/d at selected times, subject to HOF conditions identified by the EA, and there would be a continuous abstraction of 20 Ml/d at Deerhurst to maintain a constant minimum flow and maintain water quality in the interconnector pipeline at all other times.

Flow augmentation releases from advanced treated wastewater transfer from Netheridge WwTW of 35Ml/d to the River Severn upstream of Haw Bridge, will enable a pipeline maintenance flow to continue to be abstracted at Deerhurst, some 2km upstream, when River Severn flows are less than HoF conditions.

Table 4-1 WFD compliance assessment summary - The River Severn from Deerhurst to the tidal limit at Gloucester

WFD Waterbody	WFD I.D	WFD compliant against assessed WFD objectives	Potential non-compliant issue
Severn - conf R Avon to conf Upper Parting	GB109054044404	Yes (Medium confidence)	None
Severn (E Channel) - Horsebere Bk to Severn Est	GB109054032750	Yes (Medium confidence)	None

In line with the Water Quality Evidence and Assessment Reports, only the Netheridge Transfer release (directly) has the potential for amending water quality in this reach.

4.2.1.1.1 Physio-Chemical Quality Elements

Consistent with the Water Quality Assessment Report, in the River Severn downstream of Deerhurst (upstream of the Netheridge discharge) and at the tidal limit, the STT operation is predicted to reduce water temperature by 0.2°C (A82) and 0.3°C (M96) from a baseline of between 6 and 20°C. The Severn – conf R Avon to conf Upper Parting and Severn (E Channel) - Horsebere Bk to Severn Est are considered to be of High WFD status for temperature and the proposed scheme does not pose a risk to status deterioration.

The two watercourses is considered to be of High WFD status for dissolved oxygen concentrations. Dissolved oxygen concentrations are predicted to be reduced by about 0.1 mg/l at both sites (a reduction of less than 1%sat) from a baseline of between 8.5 and 14 mg/l, with the higher values occurring in the winter, at both locations. During the period when the scheme would be operating, the concentration is between 85%sat and 100%sat. Therefore, the proposed scheme does not pose a risk to status deterioration.

The two watercourses are considered to be of High WFD status for ammonia. Ammoniacal nitrogen concentrations are predicted to be increased by about 0.02 mg/l at both sites from a baseline of 0.04 – 0.18 mg/l. An increase of 0.02 mg/l is not predicted to result in status deterioration.

The two watercourses considered to be of Moderate WFD status for phosphate concentrations. Soluble reactive phosphate concentrations are predicted to be reduced by up to 0.02 mg/l during the operation of the scheme at both sites from a baseline of 0.1 – 0.4 mg/l, and this reduction does not change the WFD status of the corresponding element or cause an impediment to reaching target status.

4.2.1.1.2 Priority Substances and Other Chemicals

With regards the Netheridge Transfer and the planned advanced treatment processes included in the Severn Trent Sources SRO Gate 2 scheme. For those chemicals with an EQS, there would be no change in concentration from EQS pass to EQS fail; no reduction in quality where there is EQS pass; no further reduction in quality where there is currently EQS fail; and for chemicals with current EQS fail, no impediments to achieving EQS pass. For further details see the Water Quality Assessment Report.

The review has been undertaken using River Severn at Deerhurst chemical concentrations and post-removal treatment efficacy from Severn Trent Sources SRO engineers, and is without recourse to the minimum 1:37 dilution rate of the River Severn at the Netheridge Transfer outfall.

4.2.1.1.3 Biological Quality Elements

Consistent with the Macroinvertebrates and Other Ecology Assessment Report, it is evident that the change in flow is neither distinct or substantially different from reference conditions without the STT Solution, and will not impact on the overall dominant habitats within the reach which will remain present through the operation of the scheme. The potential changes in velocity and depth are not considered to be of a magnitude to result in impacts on habitat availability for the macroinvertebrate, macrophyte and phytobenthos communities in this reach with the velocity and depths that would be observed under an unsupported and fully supported STT operation remaining similar to baseline conditions and within the preferred and optimum requirements for baseline communities associated with the reach.

Consistent with the fisheries report, the change in flow is neither distinct or substantially different from reference conditions without the STT Solution and will not impact on migration for the anadromous and catadromous species associated with the Severn Estuary or the River Clun SAC. This is because hydrological cues for migration will not be impacted, and the increased flows will not impact on the passability of any barriers. Flows and velocities will also remain sufficient to support the downstream drift of post-metamorphic transformers and juvenile shad. Flows and velocities will also not result in the washout of any incubating eggs or juveniles. As there are no changes in the physic-chemical characteristics of the water, impacts on the fish community are not expected, albeit with low confidence.

4.2.2 The Severn Estuary downstream of the tidal limit at Gloucester

The Severn Estuary downstream of the tidal limit at Gloucester has been assessed for the potential of the STT Solution to not comply with WFD objectives. As summarised in Table 4-2 this has been completed for one specific waterbody.

In this reach, the STT operation would have reduced flow for transfer in the STT interconnector. The abstraction regime is dependent on the maturity of the STT solution. In the Early Phase STT scheme, this reach includes the pass forward effects of the unsupported abstraction of up to 500Ml/d at selected times, subject to HOF conditions identified by the EA, or a pipeline maintenance flow of 20 Ml/d at all other times.

A Mythe licence transfer of 15Ml/d, and flow augmentation releases from advanced treated wastewater transfer from Netheridge WwTW of 15Ml/d to the River Severn upstream of Haw Bridge will enable a pipeline

maintenance flow to continue to be abstracted at Deerhurst, some 2km upstream, when River Severn flows are less than HoF conditions.

Table 4-2 WFD compliance assessment summary - The Severn Estuary downstream of the tidal limit at Gloucester

WFD Waterbody	WFD I.D	WFD compliant against assessed WFD objectives	Potential non-compliant issue
Severn Upper	GB530905415403	Yes (Medium - low confidence)	Physio-Chemical Status (Objective 2 – Introducing Impediments)

4.2.2.1 Assessment of compliance / non-compliance with WFD objectives

At the tidal limit, the residual effects on flow and water quality of the River Severn from flow augmentation and abstraction from the STT Solution would be passed forward to the Severn Estuary. Of the flow augmentation releases, only the Netheridge Transfer (directly) has the potential for amending water quality in the pass forward flow. This assessment considers a TRaC water body and is completed in accordance with the Clearing Waters for All estuarine and coastal waters guidance[22].

4.2.2.1.1 Physio-Chemical Quality Elements

Consistent with the Water Quality Assessment Report, in the River Severn at the tidal limit the non-supported STT operation is predicted to reduce water temperature by 0.2°C (A82) and 0.3°C (M96) from a baseline of between 6 and 20°C.

The Severn Upper is considered to be of High WFD status for dissolved oxygen concentrations. Concentrations are predicted to be reduced by about 0.1 mg/l from a baseline of between 8 and 14 mg/l. Therefore, the proposed scheme does not pose a risk to status deterioration.

Ammoniacal nitrogen concentrations are predicted to be increased by about 0.02 mg/l from a baseline of between 0.04 – 0.2 mg/l. Oxidised nitrogen is increased by about 0.8 mg/l during the scheme from a baseline of between 3.0 – 7 mg/l (~10% increase on baseline).

Specific additional analysis has been undertaken in relation to DIN using the EA long term water quality monitoring point at Haw Bridge[23] for the 10 year period 2013-2022. The 117 data points identify DIN concentration as 5.65 mg-N/l with a standard deviation of 1.14 mg-N/l. Allowing for the expected removal rates of the Severn Trent Sources SRO's advanced treatment processes for the Netheridge Transfer, discharged concentration to the Severn at Haw Bridge could be 15.8 mg-N/l. Modelled assessment identifies an overall reduction in DIN input from the freshwater River Severn and Netheridge WwTW combined into the Severn Estuary as result of STT solution. The current WFD status for DIN is moderate and therefore the reduction in DIN input into the may be considered failing in Objective 2 - impediment to achieving target status. Further details on the specific DIN analysis can be found in section 4.3.7.1.1.

4.2.2.1.2 Priority Substances and Other Chemicals

With regards the Netheridge Transfer and the planned advanced treatment processes included in the Severn Trent Sources SRO Gate 2 scheme. For those chemicals with an EQS, there would be no change in concentration that changes from EQS pass to EQS fail; no reduction in quality where there is EQS pass; no further reduction in quality where there is currently EQS fail; and for chemicals with current EQS fail, no impediments to achieving EQS pass. The review has been undertaken using River Severn at Deerhurst chemical concentrations and post-removal treatment efficacy from Severn Trent Sources SRO engineers, and is without recourse to the minimum 1:37 dilution rate of the River Severn at the Netheridge Transfer outfall. For further details see the Water Quality Assessment Report.

4.2.2.1.3 Biological Quality Elements

With regards to flows and physical habitat, impacts on freshwater inputs into the Severn Estuary are neither distinct or substantially different from reference conditions without the STT Solution. As such, the changes in pass forward flow are not expected to impact on the resident fish, macroinvertebrate or phytobenthos communities of the Severn Estuary, or impact the morphology of the river. Impacts on macroinvertebrate and

[22] Water Framework Directive assessment: estuarine and coastal waters - GOV.UK (www.gov.uk)

[23] https://environment.data.gov.uk/water-quality/view/sampling-point/MD-00025085

aquatic plant communities as a result of water quality changes in this reach are not expected under the current conditions. Decreased DIN concentration would provide a potential benefit through a reduction in algal growth. The potential increase in fish olfactory inhibitor loads in the context of the Severn Estuary is considered to be neither distinct or substantially different from reference conditions without the STT Solution (medium confidence). Subsequently, impacts on aquatic ecological communities including fisheries, and associated risk of WFD non-compliance, is not expected.

4.2.3 River Thames downstream of Culham to tidal limit at Teddington.

The River Thames downstream of Culham to tidal limit at Teddington has been assessed for the potential of the STT Solution to not comply with WFD objectives. As summarised in Table 4-3 this has been completed for five specific waterbodies. In this reach, the STT Solution would augment flow via the STT interconnector. The flow augmentation regime is dependent on the maturity of the STT solution.

For the early phase STT, flow augmentation would be unsupported up to 500Ml/d at selected times, subject to hands-off flow conditions in the River Severn at Deerhurst identified by the EA. A pipeline maintenance flow of 20 Ml/d would be discharged at all other times.

Table 4-3 WFD compliance assessment summary - The River Thames downstream of Culham to tidal limit at Teddington

WFD Waterbody	WFD I.D	WFD compliant against assessed WFD objectives	Potential non-compliant issue
Thames (Evenlode to Thame)	GB106039030334	Yes (low confidence)	None
Thames Wallingford to Caversham	GB106039030331	Yes (low confidence)	None
Thames (Reading to Cookham)	GB106039023233	Yes (low confidence)	None
Thames (Cookham to Egham)	GB106039023231	Yes (low confidence)	None
Thames (Egham to Teddington)	GB106039023232	Yes (low confidence)	None

4.2.3.1 Assessment of compliance / non-compliance with WFD objectives

In this reach the STT interconnector has the potential for amending water quality and physical conditions in the River Thames.

4.2.3.1.1 Physio-Chemical Quality Elements

The River Thames is considered to be at High status for temperature. During periods of scheme operation in early summer (June and July) when River Thames water temperatures are at their highest (17°C), flow augmentation from the STT Solution could cool river temperatures by up to 1°C.

The River Thames is considered to be at High status for dissolved oxygen. The modelling identifies a potential zone of influence of the increase in saturation as far as the River Thames confluence 12km downstream of the STT interconnector outfall. Dissolved oxygen saturation in both scenarios along this reach is increased by 4%sat at times of STT Solution augmenting low flows in the River Thames at Culham, from a baseline of >95%sat. However, as modelled increases are at times of super-saturation, this may be an over-representation. At higher river flows the effect of flow augmentation is less. Based on the above the scheme is not predicted to pose a risk of status deterioration in the River Thames.

The River Thames is considered to be at Moderate status for Phosphate. Phosphorus is predicted to increase during the scheme operation by around 0.05 mg/l (from a baseline of 0.12 – 0.35 mg/l) at Culham downstream of the STT interconnector outfall with a lower rate of increase downstream. Downstream of Culham, the River Thame is modelled to increase pressure on phosphorus concentrations and the Rivers Pang and Kennet to reduce pressure. Increases are greatest at times of low flow in the River Thames. At times of up to 500Ml/d unsupported transfer (both early phase and full STT solution), baseline river flows in the River Thames are modelled as higher, and phosphorus concentrations are modelled to increase by around 0.03 mg/l. Whilst status deterioration is considered unlikely, the scheme does present a risk of introducing an impediment to achieving target status (Objective 2: introducing impediments). However, it should be noted that although this

is arithmetically-speaking an impediment to target quality for reactive phosphate in the middle River Thames, it is recognised that reactive phosphate is a WFD supporting element to plant growth.

The River Thames is considered to be at High Status for Ammoniacal nitrogen. Ammoniacal nitrogen is predicted to increase during the scheme operation by around 0.03 mg/l (from a baseline of 0.02 – 0.06 mg/l) at Culham downstream of the STT interconnector outfall. This does not present a risk of status deterioration.

pH change was calculated from pan-SRO monitoring data. Those spot monitoring data identify a pH range in the lower Severn at Deerhurst of 7.5 – 8.7 (mean 8.1). Although there is greater variability in the range of pH in the lower Severn than the middle Thames, the difference in mean value is neither distinct or substantially different from reference conditions without the STT Solution. Acid neutralising capacity in the middle Thames is very low. In the lower Severn acid neutralising capacity is better, and at times of STT Solution flow augmentation, there would be a marked improvement in acid neutralising capacity of the middle Thames.

4.2.3.1.2 Priority Substances and Other Chemicals

In line with the Water Quality Assessment report, four WFD chemicals were identified as not achieving EQS in the source water for the interconnector treatment unit: the polyaromatic hydrocarbon benzo(g,h,i)perylene; two synthetic pyrethroid insecticide (permethrin and cypermethrin); and PFOS. The WFD waterbodies assessed in the Thames reach currently fail the EQS for benzo(g,h,i)perylene, cypermethrin and PFOS.

With this in mind, the assessment identifies no substantial change from reference conditions without the STT Solution in the concentrations of permethrin or cypermethrin in the River Thames from operation of a STT solution. The assessment identifies a potential improvement in the maximum concentration of the polyaromatic hydrocarbon benzo(g,h,i)perylene and PFOS, although this betterment is unlikely to improve the River Thames to achieving EQS.

For further details pertaining to the Thames water quality modelling, refer to the Water Quality Assessment Report, Section 3.9.2.

4.2.3.1.3 Biological Quality Elements

In line with the Macroinvertebrate and Other Ecology Assessment Report, no discernible impacts from changes in water quality are anticipated on protected species as the increases in ammoniacal nitrogen, phosphorus and dissolved oxygen saturation are minor and will not impact on the WFD status of the watercourse.

In line with the Fisheries Assessment Report, the 1D hydraulic model output for water depth variability in the River Thames has not been used in the fisheries assessment. This is because water levels in the River Thames are managed for navigation, with the normal operating level varying within one metre. For example at Culham Lock 90% of gauged river levels in the last year have varied within in a 0.3 m range; at Whitchurch Lock (local to the River Pang confluence) by approximately 0.2 m; at Romney Lock (local to the Datchet intake) by 0.40 m. This is in contrast to the differences in water depth which have been greater than one metre during the scenario periods reported for the River Thames at Culham; upstream of the River Pang; and upstream of the Datchet intake.

The 1D hydraulic model output for depth-average velocity variability in the River Thames is considered more reliable. The key summary of the modelled velocity change is that the STT solution would reduce the extent of average velocity reduction within the channel during summer periods of low flow in the River Thames. With the STT solution, average velocity at Culham would not fall below 0.2 m s-1; and upstream of the River Pang and upstream of the Datchet intake average velocity would not fall below 0.25 m s-1 at times of operation of the STT solution.

In line with the fisheries assessment report, an assessment is required of the potential effects from STT solution flow augmentation effects on level, velocity and wetted habitat change at selected weir pool reaches on the River Thames. Weir pool reaches are a feature of the navigation infrastructure of the River Thames, and are that part of the river at a lock, between the weir and the reconnection with the navigable channel. Weir pool reaches represent zones of hydraulic heterogeneity within the otherwise level controlled River Thames. At Gate 1 SESRO identified the first three weir pool reaches downstream of a Culham outfall (same location as the STT Solution outfall) for review: Culham Weir, Clifton Hampden Weir and Days Weir.

A screening review has been undertaken at these weir pools prior to the collection of bathymetry and hydraulic data under suitable flow conditions for inclusion in a 2D model. Those flow conditions were not present in the River Thames during the Gate 2 survey season. The screening identified there could be velocity increases within each of the weir pools from flow augmentation, but was not able to provide context around the reference condition velocities in a A82 moderate-low flow year or a M96 very low flow year or the seasonal differences from the augmentation pattern. Therefore, change to weir pool wetted habitat or weir passability remains an uncertainty and data collection and assessment will need to occur for Gate 3.

As set out in the Fisheries Assessment Repot, the review of olfaction has been undertaken to assess risks from the Minworth Transfer only (as part of the full STT scheme) on the River Severn and Severn Estuary as these relate to requirements for HRA of the Severn Estuary SAC, SPA and Ramsar site. Therefore, no olfactory assessment has been completed for the River Thames.

4.3 FULL STT

This section outlines the WFD compliance assessment for the Full STT grouping. In summary, Full STT comprises the 500Ml/d pipeline with all support elements available to facilitate transfer to Thames catchment whenever required (see further details in Section 2.0). The assessed reaches are as follows:

- The River Vyrnwy from the Vyrnwy Reservoir to the confluence with the River Severn
- The River Severn from the Vyrnwy bypass outfall to Bewdley
- The River Severn from Bewdley to the confluence with the River Avon
- The River Avon from Stoneleigh to the confluence with the River Severn
- The River Severn from the confluence with the River Avon to Deerhurst
- The River Severn from Deerhurst to the tidal limit at Gloucester
- The Severn Estuary downstream of the tidal limit at Gloucester
- River Thames downstream of Culham to tidal limit at Teddington.

4.3.1 The River Vyrnwy from the Vyrnwy Reservoir to the confluence with the River Severn

The River Vyrnwy from the Vyrnwy Reservoir to the confluence with the River Severn reach has been assessed for the potential of the STT Solution to not comply with WFD objectives. As summarised in Table 4-4 this has been completed for four specific waterbodies.

In this reach, the STT Solution would augment flows through a 25 Ml/d direct release from Vyrnwy Reservoir at selected times. The A82 scenario would include a continuous 105 day period of flow augmentation from late June to early October. The M96 scenario would include a continuous 144 day period of flow augmentation from mid-June to early November.

Table 4-4 WFD compliance assessment summary - River Vyrnwy from the Vyrnwy Reservoir to the confluence with the River Severn

WFD Waterbody	Waterbody I.D	WFD compliant against assessed WFD objectives	Potential non-compliant issue
Vyrnwy - Lake Vyrnwy to conf Afon Cownwy	GB109054049880	Yes (medium confidence)	None
Afon Vyrnwy - conf Afon Cownwy to conf Afon Banwy	GB109054049720	Yes (medium confidence)	None
Afon Vyrnwy DS of Banwy confluence	GB109054049852	Yes (medium confidence)	None
Afon Vyrnwy - conf Afon Tanat to conf R Severn	GB109054049800	Yes (medium confidence)	None

4.3.1.1 Assessment of compliance / non-compliance with WFD objectives

In this reach of the study area, the pathways of environmental water quality change from STT solution operation are limited. STT solution engineering consultants have confirmed that the infrastructure used to make STT solution flow augmentation releases from Vyrnwy Reservoir into the River Vyrnwy directly below the reservoir would be sourced from the same part of the water column as the compensation water. It is important to note that the reservoir scour valves would not be used to support the STT solution. As such flow released from Vyrnwy Reservoir into the River Vyrnwy would remain at exactly the same quality with or without the STT solution, with only the flow rate changed. The water is also native upper River Vyrnwy water and as such the chemical composition is considered appropriate for the River Vyrnwy.

4.3.1.1.1 Physio-Chemical Quality Elements

In line with the Water Quality Assessment Report, the water temperature changes predicted for STT Solution are largely indistinct and not substantial. As there is no distinct substantial water temperature change associated with the STT Solution, there is no pathway to change in the oxygen carrying capacity, the dissolved

oxygen saturation, of the River Vyrnwy. It is also noted that colder water has higher oxygen carrying capacity and as such any effects of STT Solution are considered as positive for dissolved oxygen, not negative.

Other than the assessed general water quality parameters above, there is no pathway of general water quality change in this reach from STT SRO operation. As such no assessment is included at Gate 2 in this reach and no baseline information is described here. The potential for water quality benefits in this reach associated with the enhanced dilution, of polluting pressures, from the flow augmentation are not included in this assessment. WFD non-compliance is not expected from a physical water quality perspective in this reach.

4.3.1.1.2 Priority Substances and Other Chemicals

The Water Quality Assessment Report reviewed data from the Pan-SRO monitoring programme for all WFD chemicals for both their short-term and long-term EQS. That assessment identifies potential EQS failure in the managed release water from Vyrnwy Reservoir only for chlorine (total). Chlorine (total) monitored at all other sites in the River Vyrnwy also all identify potential EQS failure. Comparison of water from the River Vyrnwy with water in Vyrnwy Reservoir (Site 22 UU intake at Vyrnwy dam) for chlorine (total), indicates lower chlorine content in the manged release. It is not considered that a 25Ml/d direct release from Vyrnwy Reservoir would increase the concentration of chlorine (total) in the River Vyrnwy. Therefore, WFD non-compliance is not expected from a chemical water quality perspective in this reach.

4.3.1.1.3 Biological Quality Elements

Consistent with the Fisheries Assessment Report, the potential changes in velocity and depth are not considered to be of a magnitude to result in impacts on habitat availability for the fish community in this reach. The velocity and depths that would be observed under a fully supported STT remain similar to baseline conditions and within the preferred and optimum requirements for the baseline fish community associated with the reach.

Consistent with the Macroinvertebrates and Other Ecology Assessment Report, impacts on the macroinvertebrate, macrophyte and phytobenthos communities as a result of hydrological and hydraulic changes in this reach is not expected under the current conditions. Furthermore, there is no pathway for environmental water quality change, and therefore no likely impact on aquatic communities in this regard. With the above in mind, the risk of WFD non-compliance from both a fisheries, macroinvertebrate and other ecology perspective is not expected.

4.3.2 The River Severn from the Vyrnwy Bypass Outfall to Bewdley

The River Severn from the Vyrnwy bypass outfall to Bewdley reach has been assessed for the potential of the STT Solution to not comply with WFD objectives. As summarised in Table 4-5 this has been completed for four specific waterbodies.

In this reach, the pass forward flows include the 25Ml/d release licensed to UU from Lake Vyrnwy directly into the River Vyrnwy, and the 155Ml/d discharge licensed to UU from Lake Vyrnwy and transferred via a bypass pipeline to the River Severn. The A82 scenario would include a continuous 105 day period of flow augmentation from late June to early October. The M96 scenario would include a continuous 144 day period of flow augmentation from mid-June to early November. This will be supported by an abstraction reduction at Shelton intake at Shrewsbury of 25 Ml/d, at selected times.

Table 4-5 WFD compliance assessment summary - River Severn from the confluence with the River Vyrnwy to Bewdley

WFD Waterbody	Waterbody I.D	WFD compliant against assessed WFD objectives	Potential non-compliant issue
Severn - conf Bele Bk to conf Sundorne Bk	GB109054049142	Yes (medium confidence)	None
Severn - Sundorne Bk to conf M Wenlock-Farley Bk	GB109054049141	Yes (medium confidence)	None
Severn conf M Wenlock-Farley Bk to conf R Worfe	GB109054049143	Yes (medium confidence)	None
Severn - conf R Worfe to conf R Stour	GB109054049145	Yes (medium confidence)	None

4.3.2.1 Assessment of compliance / non-compliance with WFD objectives

In this reach of the study area, the pathways of environmental water quality change from STT solution operation are limited. The STT solution engineering consultants have confirmed that the infrastructure used to make the STT solution flow augmentation releases from Vyrnwy Reservoir into the middle River Severn would be sourced from the same part of the water column as the compensation water. It is important to note that the reservoir scour valves would not be used to support the STT solution. As such, flow released from the Vyrnwy bypass pipeline near Ponthen would be native upper River Vyrnwy water and as such, the chemical composition is considered appropriate for the outfall location in the River Severn, which is 3.5km downstream of the confluence with the River Vyrnwy.

The Gate 2 approach identifies that, in this reach of the study area, there are no pathways of environmental water quality change from the STT solution. The information presented in this section is therefore proportionate to that scope.

4.3.2.1.1 Physio-Chemical Quality Elements

At Gate 2 there is no bespoke information on the water temperature of a Vyrnwy Bypass release to the River Severn. Although continuous water temperature data could be collected for the end of the current Vyrnwy Aqueduct, that itself would not provide a reliable guide to the temperature discharged as it does not take into account the higher rate of transfer of water along the Aqueduct for a STT Solution, nor the effect of pipeline transmission. Surrogate data used in the Gate 2 assessment are from Vyrnwy Reservoir – the Site 22 UU intake at Vyrnwy dam (a measure of near surface water temperature in Vyrnwy Reservoir) and Site 23 River Vyrnwy downstream of Vyrnwy dam (a measure of water temperature lower in the water column which corresponds with managed releases from the reservoir). The Water Quality Assessment Report identified no distinct substantial water temperature change. As there is no distinct substantial water temperature change associated with the Vyrnwy Bypass, there is no pathway to change in the oxygen carrying capacity, the dissolved oxygen saturation, of the River Vyrnwy. It is also noted that colder water has higher oxygen carrying capacity and as such any effects created by the STT Solution are considered as positive for dissolved oxygen, not negative.

Other than the assessed general water quality parameters above, there is no pathway of general water quality change in this reach from STT SRO operation. The potential for water quality benefits in this reach associated with the enhanced dilution of wastewater discharges (e.g. Shrewsbury (Monkmoor) WwTW), and other pollution pressures, from the flow augmentation are not included in this assessment.

Therefore, WFD non-compliance is not expected from a physical water quality perspective in this reach.

4.3.2.1.2 Priority Substances and Other Chemicals

In line with the Water Quality Assessment Report, at Gate 2 there is no bespoke information on the water quality for a Vyrnwy Bypass release to the River Severn. Surrogate data used in the Gate 2 assessment are from Vyrnwy Reservoir itself. The Water Quality Assessment Report reviewed data from the Pan-SRO monitoring programme for all WFD chemicals for both their short-term and long-term EQS. That assessment identifies potential EQS failure in the managed release water from Vyrnwy Reservoir only for chlorine (total). Chlorine (total) monitored at all other sites in the River Vyrnwy also all identify potential EQS failure. Comparison of water from the River Vyrnwy with water in Vyrnwy Reservoir (Site 22 UU intake at Vyrnwy dam) chlorine (total), indicates lower chlorine content in the manged release. As such Vyrnwy Bypass would not lead to deterioration in quality of the River Severn at the outfall point. Therefore, WFD non-compliance is not expected from a chemical water quality perspective in this reach.

4.3.2.1.3 Biological Elements

As above, the potential changes in velocity and depth are not considered to be of a magnitude to result in impacts on habitat availability for the fish community in this reach. The velocity and depths that would be observed under a fully supported STT remain similar to baseline conditions and within the preferred and optimum requirements for the baseline fish community associated with the reach.

Consistent with the Macroinvertebrates and Other Ecology Assessment Report, impacts on the macroinvertebrate, macrophyte and phytobenthos communities as a result of hydrological and hydraulic changes in this reach is not expected under the current conditions. Communities in the reach are likely to retain the preferred habitats of a generally uniform, slow and deep nature. With the above in mind, the risk of WFD non-compliance from both a fisheries, macroinvertebrate and other ecology perspective is not expected in this reach.

4.3.3 The River Severn from Bewdley to the confluence with the River Avon

The River Severn from Bewdley to the confluence with the River Avon reach has been assessed for the potential of the STT Solution to not comply with WFD objectives. As summarised in Table 4-6 this has been completed for three specific waterbodies.

In this reach, the STT operation would augment flows through a Release of 25Ml/d water licensed to UU from Lake Vyrnwy directly into the River Vyrnwy, and utilisation of 155Ml/d water licensed to UU from Lake Vyrnwy and transferred via a bypass pipeline ("Vyrnwy Bypass") to the River Severn. The A82 scenario would include a continuous 105 day period of flow augmentation from late June to early October. The M96 scenario would include a continuous 144 day period of flow augmentation from mid-June to early November. This will be supported by an abstraction reduction at Shelton intake at Shrewsbury of 25 Ml/d, at selected times.

Table 4-6 WFD compliance assessment summary - River Severn from Bewdley to the confluence with the River Avon

WFD Waterbody	WFD I.D	WFD compliant against assessed WFD objectives	Potential non-compliant issue
Severn - conf R Worfe to conf R Stour	GB109054049145	Yes (medium confidence)	None
Severn - conf R Stour to conf River Teme	GB109054049144	Yes (medium confidence)	None
Severn - conf R Teme to conf R Avon	GB109054039760	Yes (medium confidence)	None

4.3.3.1 Assessment of compliance / non-compliance with WFD objectives

The Gate 2 approach identifies that, in this reach of the study area, there are no pathways of environmental water quality change from the STT solution. The information presented in this section is therefore proportionate to that scope.

4.3.3.1.1 Physio-Chemical Quality Elements

There is no pathway of general water quality change in this reach from STT solution operation. As such no assessment is included at Gate 2 in this reach and no baseline information is described here. At the one STT solution monitoring site in the reach, physico-chemical water quality data are not part of the analysis suite.

4.3.3.1.2 Priority Substances and Other Chemicals

There is no pathway of chemical change in this reach from STT solution operation. As such, no assessment is included at Gate 2 in this reach and no baseline information is described here. At the one STT solution monitoring site in the reach, chemical water quality data are not part of the analysis suite.

4.3.3.1.3 Biological Elements

As above, the potential changes in velocity and depth are not considered to be of a magnitude to result in impacts on habitat availability for the fish community in this reach. The velocity and depths that would be observed under a fully supported STT remain similar to baseline conditions and within the preferred and optimum requirements for the baseline fish community associated with the reach.

Consistent with the Macroinvertebrates and Other Ecology Assessment Report, impacts on the macroinvertebrate, macrophyte and phytobenthos communities as a result of hydrological and hydraulic changes in this reach is not expected under the current conditions. Communities in the reach are likely to retain the preferred habitats of a generally uniform, slow and deep nature. With the above in mind, the risk of WFD non-compliance from both a fisheries, macroinvertebrate and other ecology perspective is not expected in this reach.

4.3.4 The River Avon from Stoneleigh to the confluence with the River Severn

The River Avon from Stoneleigh to the confluence with the River Severn reach has been assessed for the potential of the STT Solution to not comply with WFD objectives. As summarised in Table 4-7 his has been completed for four specific waterbodies.

In this reach STT operation would augment flows through a 115Ml/d advanced treated effluent transfer from Minworth WwTW at selected times. Overall, the pattern of STT releases will only occur in 24 of the 47

representative years, and on 15% of days overall. Flow changes in this reach would typically be in the months July to October, peaking in September at 46% of days in September.

Table 4-7 WFD compliance assessment summary - River Avon from Stoneleigh to the confluence with the River Severn

WFD Waterbody	WFD I.D	WFD compliant against assessed WFD objectives	Potential non-compliant issue
Avon (Warks) - conf R Sowe to conf R Leam	GB109054043840	No (medium confidence)	Specific pollutants/ chemical status (Objective 2 Introducing Impediments) Physio-Chemical Status (Objective 1 Status Deterioration)
Avon (Wark) conf R Leam to Tramway Br, Stratford	GB109054044402	No (medium confidence)	Specific pollutants/ chemical status (Objective 2 Introducing Impediments) Physio-Chemical Status (Objective 1 Status Deterioration)
Avon- Tramway Br Stratford to Workman Br Evesham	GB109054044401	No (medium confidence)	Specific pollutants/ chemical status (Objective 2 Introducing Impediments)
Avon conf Workman Br, Evesham to conf R Severn	GB109054044403	No (medium confidence)	Specific pollutants/ chemical status (Objective 2 Introducing Impediments)

4.3.4.1 Assessment of compliance / non-compliance with WFD objectives

In this reach, there is potential for non-compliance with WFD objective 1 introducing impediments to target status in four waterbodies. The impediments are associated with the 115Ml/d advanced treated effluent transfer from Minworth WwTW. A risk non-compliance with WFD objective 2 status deterioration has been identified in two waterbodies associated with DO concentration.

4.3.4.1.1 Physio-Chemical Quality Elements

Gate 2 STT Solution modelling presented in the Water Quality Assessment Report identified the river water temperature would be higher during discharges. This increase is similar for both A82 and M96 scenarios: up to 0.8°C upstream of Warwick, and up to 0.5°C at Evesham and at the confluence with River Severn. Modelled data indicates that in summer, temperatures will remain below 17.5^{0}C and therefore consistent with WFD High status.

Gate 2 STT Solution modelling presented in the Water Quality Assessment Report identified the discharge will reduce dissolved oxygen immediately downstream of the outfall up to the confluence with the River Leam by ~1.5mg/l. This means that the saturated concentrations during the operation of the scheme become 75-80%sat for A82, and 72-78%sat for M96 scenarios respectively upstream of Warwick. This is a potential change from a baseline of 90%sat upstream of Warwick and may therefore result in a risk to WFD non-compliance (objective 1 status deterioration). Downstream of Warwick STW, the reduction in DO is 0.2 mg/l (2%sat reduction). This is a change from a baseline of 94%sat downstream of Warwick and therefore not a risk to WFD non-compliance. There is a potential <0.1 mg/l (<1%sat reduction) at Evesham with no change due to the scheme predicted at the confluence.

Gate 2 STT Solution modelling presented in the Water Quality Assessment Report identified ammoniacal nitrogen is expected to increase by 0.1-0.15mg/l downstream of Warwick with the increase of 0.05mg/l at Evesham and 0.02mg/l at the confluence with the River Severn.

Gate 2 STT Solution modelling presented in the Water Quality Assessment Report identified soluble reactive phosphate concentrations are reduced by the scheme throughout the River Avon by up to 0.1mg/l, and therefore improve the existing conditions in this regard.

4.3.4.1.2 Priority Substances and Other Chemicals

With regards to the treated effluent transfer, water quality modelling has considered all chemicals included in the WFD Directions[24], for short-term (maximum allowable concentration or 95-percentile standards as

[24] Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

appropriate) and long term (average) where these are stated in the Directions. From the available evidence at Gate 2, and through review with Minworth SRO of advanced treatment processes efficacy three WFD chemicals have been identified as presenting a risk to the water bodies in the reach post treatment. Details of the advanced treatment processes set out in Section 2.3 of the Water Quality Assessment Report. The magnitude and frequency of the risk has been modelled using the conservative tracer dilution rates in the Severn catchment 1D water quality model.

Consistent with the Water Quality Assessment Report, the results are summarised below.

- **Cypermethrin:** ~34% increase in mean value of river. Risk of worsening non-achievement of long term EQS of 0.00008µg/l. The outputs illustrate the Minworth Transfer would increase the concentration of cypermethrin in the River Avon, a deterioration of the current quality. Mean values calculated from the reported concentrations of cypermethrin indicate EQS failure in much of the River Avon and that the Minworth Transfer could impede the reduction in concentration to EQS pass. This could be considered as introducing an impediment to target status (objective 2). It is noted that the Minworth Transfer would operate for around 15% of days overall and that for cypermethrin that could be sufficient regularity to influence long term average concentrations in the river.
- **Perfluorooctane sulfonic acid (PFOS) and its derivatives:** ~34% increase in mean value of river. Risk of worsening non-achievement of long term EQS of 0.000065µg/l. The model outputs illustrate the Minworth Transfer would increase the concentration of PFOS in the River Avon, a deterioration of the current quality. Throughout the River Avon in the study reach, the Minworth Transfer could impede the reduction in concentration to EQS pass and therefore lead to WFD non-compliance (objective 2).
- **Permethrin:** ~34% increase in mean value of river. Risk of worsening non-achievement of long term EQS. The model outputs illustrate the Minworth Transfer would increase the concentration of permethrin in the River Avon, a deterioration of the current quality. This risk is limited to the reaches above and below Warwick. This could be considered as introducing an impediment to target status (objective 2). It is noted that the Minworth Transfer would operate for around 15% of days overall and that for cypermethrin that could be sufficient regularity to influence long term average concentrations in the river in these reaches. At downstream assessment points in the River Avon, the reported data indicate EQS pass (with no reported detection of permethrin) and maintenance of EQS pass with Minworth Transfer, albeit with medium confidence.

4.3.4.1.3 Biological Quality Elements

Consistent with the Fisheries Assessment Report, the introduction of additional Permethrin into the Avon reach may act as an olfactory inhibitor to migratory European eel. However, at this stage the significance/magnitude of the impact on olfaction cannot be assessed and it is only possible to note an increased risk to olfactory inhibition. The fisheries report notes that the concentration at which individual or groups of chemicals may be disruptive to individual relevant migratory fish species is poorly understood, as is the potential role of bioaccumulation. Laboratory limits of detection are not a guide to absence of influence of a chemical, and nor is detected presence of chemical a reliable guide to presence of influence.

With regards to the physical environment, the fisheries assessment notes the abundance of available habitat for migratory European eel, and that the potential changes in velocity and depth are not considered to be of a magnitude to result in impacts on habitat availability for the fish community in this reach, with the velocity and depths that would be observed under a supported STT remaining similar to baseline conditions and within the preferred and optimum requirements for the baseline fish community associated with the reach. With the above in mind, it is highly unlikely that the scheme will result in WFD non-compliance.

Consistent with the Macroinvertebrates and Other Ecology Assessment Report, there is a risk to macroinvertebrate and macrophyte communities in the reaches upstream of Alveston when considering the potential changes in flow, as it is evident that there will be an increase in wetted widths. The increase in wetted widths could result in a loss of some marginal habitat that will be preferred by macroinvertebrates groups with a preference for slow flowing water (e.g., dragonflies and damselflies). The increase in wetted width could also reduce habitat availability for marginal macrophyte species, although this will provide additional habitat for macrophytes and macroinvertebrates with a preference for moderate to fast flowing water, and also promote the flushing of macrophytes, a key process supporting the growing season the following year.

Therefore, for those waterbodies upstream of Alveston, comprising Avon (Warks) - conf R Sowe to conf R Leam and Avon (Wark) conf R Leam to Tramway Br, Stratford, it is deemed that there may be potential for minor shifts in species composition as a result of flow preferences, but this is not deemed to result in WFD non-compliance.

Similarly, the water quality changes in this reach as a result of the effluent transfer were not considered to be of a magnitude to result in impacts on the macroinvertebrate, macrophyte and phytobenthos communities. Macrophyte and phytobenthos communities are at high status above Alveston, despite an existing Poor phosphate status and therefore changes in concentrations are unlikely to be a driving factor in a status deterioration for these elements.

4.3.5 The River Severn from the confluence with the River Avon to Deerhurst

The River Severn from the confluence with the River Avon to Deerhurst reach has been assessed for the potential of the STT Solution to not comply with WFD objectives. As summarised in Table 4-8 his has been completed for one specific waterbody.

In this reach, the STT operation would augment flows through a release of 25Ml/d water licensed to UU from Lake Vyrnwy directly into the River Vyrnwy, and utilisation of 155Ml/d water licensed to UU from Lake Vyrnwy and transferred via a bypass pipeline to the River Severn. This will be supported by an abstraction reduction at Shelton intake at Shrewsbury of 25 Ml/d, at selected times, and a 115Ml/d advanced treated effluent transfer from Minworth WwTW at selected times. The STT flow augmentation in this reach would be up to 287Ml/d. The A82 scenario would include a continuous 105 day period of flow augmentation from late June to early October. The M96 scenario would include a continuous 144 day period of flow augmentation from mid-June to early November.

Table 4-8 WFD compliance assessment summary - River Severn from the confluence with the River Avon to Deerhurst

WFD Waterbody	WFD I.D	WFD compliant against assessed WFD objectives	Potential non-compliant issue
Severn - conf R Avon to conf Upper Parting	GB109054044404	No (Medium - low confidence)	Specific pollutants/ chemical status (Objective 2 introducing impediments)

4.3.5.1 Assessment of compliance / non-compliance with WFD objectives

Of the flow augmentation releases, only the Minworth Transfer (indirectly) has the potential for amending water quality in this reach. As a result of the Minworth transfer, there is potential for status deterioration or introducing impediments to target status in one waterbody with regards to chemical water quality.

4.3.5.1.1 Physio-Chemical Quality Elements

Gate 2 STT Solution modelling presented in the Water Quality Assessment Report identified the Severn – conf R Avon to conf Upper Parting as consistent with High WFD status for temperature, High status for dissolved oxygen, High status for ammonia and Moderate status for phosphate.

With regards to physical water quality, the Gate 2 modelled effects on ammoniacal nitrogen, dissolved oxygen saturation and water temperature identified in the River Avon are not passed forward into the River Severn due to the large flow increase from the River Severn, including additionally augmented flows from the STT solution at times coincident with the Minworth Transfer.

Soluble reactive phosphate concentrations are predicted to be reduced by up to 0.05 mg/l during the operation of the scheme. Baseline levels are in the range of 0.1 – 0.4 mg/l. This amendment does not change the WFD status (Moderate) of the WFD element and does not introduce an impediment to achieving target status.

4.3.5.1.2 Priority Substances and Other Chemicals

With regards to chemical water quality, the Water Quality Assessment Report identifies three WFD chemicals at risk of quality deterioration at point of discharge and downstream in the River Avon. The carry-forward of that risk from the River Avon into the River Severn, as detailed in the Water Quality Assessment Report, has been summarised in this section.

- **Cypermethrin:** Mean values calculated from the reported concentrations indicate EQS fail at the *Severn_Deerhurst* monitoring site, with four of the 15 reported values greater than the limit of detection which mirrors the EQS. A concentration increase could be associated with the Minworth Transfer during the 15% of time that transfer would be in operation, but this is considered with medium confidence to not lead to long-term deterioration in quality or impeding achievement of targets as the main pressures to the reach lie with the upstream River Severn, not the River Avon. This therefore does not lead to WFD non-compliance.

- **Perfluorooctane sulfonic acid and its derivatives:** Mean values calculated from the reported concentrations indicate routine EQS fail at the *Severn_Deerhurst* monitoring site. A concentration increase could be associated with the Minworth Transfer and it is considered with medium confidence to potentially impede achievement of targets in the lower River Severn (objective 2) where the River Avon is a significant pressure to PFOS concentration in the downstream River Severn. Draft RBMP3 status for the Severn - conf R Avon to conf Upper Parting water body corroborates WFD water body failure for PFOS.
- **Permethrin:** Mean values calculated from the reported concentrations indicate EQS fail at the *Severn_Deerhurst* monitoring site, with one of the 15 reported values greater than the limit of detection which mirrors the EQS. A concentration increase could be associated with the Minworth Transfer but during the 15% of time that transfer would be in operation, this is considered with medium confidence to not lead to long-term deterioration in quality or impeding achievement of targets, noting the very low detection rate at the assessment point. This therefore does not lead to WFD non-compliance.

4.3.5.1.3 Biological Quality Elements

Consistent with the Fisheries Assessment Report, it is noted that this reach is of particular importance as a migratory route for anadromous and catadromous fish of the Severn Estuary and the River Clun SAC, and will also provide supporting habitat for lamprey ammocetes. Significant changes in the concentrations of olfactory inhibitors due to pass forward effects from the Avon reaches could therefore impact on the migration up the River Severn. However, as above, it is noted that the concentration at which individual or groups of chemicals may be disruptive to individual relevant migratory fish species are poorly understood, as is the potential role of bioaccumulation. At this stage, the significance/magnitude of the impact on olfaction cannot be assessed and it is only possible to note an increased risk to olfactory inhibition. In line with the Fisheries Assessment Report, the risk is not considered to be distinct or substantially different from reference conditions without the STT Solution (low confidence), given that the assessment has not considered the minimum 1:37 dilution rate of the River Severn downstream of Deerhurst, or the change in total load as a result of any abstraction at Deerhurst. As with the Avon reach, the impact on olfaction is not deemed to pose a risk to WFD non-compliance. Furthermore, impacts on the fish community as a result of hydrological and hydraulic changes in this reach is not expected under the current conditions. Furthermore, the operation of the STT will not impact on barrier passability or hydrological migration cues, or impact on the structure and function of the habitats that support the fish community of the Severn Estuary European Marine Site.

Consistent with the Macroinvertebrates and Other Ecology Assessment Report, the potential changes in velocity and depth are not considered to be of a magnitude to result in impacts on habitat availability for the macroinvertebrate, macrophyte and phytobenthos communities in this reach, with the velocity and depths that would be observed under a fully supported STT remaining similar to baseline conditions and within the preferred and optimum requirements for the baseline communities associated with the reach.

4.3.6 The River Severn from Deerhurst to the tidal limit at Gloucester

The River Severn from Deerhurst to the tidal limit at Gloucester reach has been assessed for the potential of the STT Solution to not comply with WFD objectives. As summarised in Table 4-9 his has been completed for two specific waterbodies.

In this reach, the STT operation would abstract flow for transfer in the STT interconnector. The abstraction regime is dependent on the maturity of the STT solution. For Full STT, abstraction would be unsupported up to 500Ml/d at selected times, subject to HOF conditions identified by the EA, and there would be a continuous abstraction of 20 Ml/d at Deerhurst to maintain a constant minimum flow and maintain water quality in the interconnector pipeline at all other times.

At Mythe, a licence transfer of 15Ml/d, and flow augmentation releases from advanced treated wastewater transfer from Netheridge WwTW of 15Ml/d to the River Severn upstream of Haw Bridge will enable a pipeline maintenance flow to continue to be abstracted at Deerhurst, some 2km upstream, when River Severn flows are less than HoF conditions.

Table 4-9 WFD compliance assessment summary - The River Severn from Deerhurst to the tidal limit at Gloucester

WFD Waterbody	WFD I.D	WFD compliant against assessed WFD objectives	Potential non-compliant issue
Severn - conf R Avon to conf Upper Parting	GB109054044404	Yes (Medium - Low confidence)	None

WFD Waterbody	WFD I.D	WFD compliant against assessed WFD objectives	Potential non-compliant issue
Severn (E Channel) - Horsebere Bk to Severn Est	GB109054032750	Yes (Medium confidence)	None

4.3.6.1 Assessment of compliance / non-compliance with WFD objectives

Of the flow augmentation releases, only the Minworth Transfer (indirectly) and the Netheridge Transfer (directly) have the potential for amending water quality in this reach.

4.3.6.1.1 Physio-Chemical Quality Elements

Consistent with the Water Quality Assessment Report, in the River Severn downstream of Deerhurst (upstream of the Netheridge discharge) and at the tidal limit, the STT operation is predicted to reduce water temperature by 0.2°C (A82) and 0.3°C (M96) from a baseline of between 6 and 20°C. The Severn – conf R Avon to conf Upper Parting and Severn (E Channel) - Horsebere Bk to Severn Est are considered to be of High WFD status for temperature and the proposed scheme does not pose a risk to status deterioration.

The two watercourses is considered to be of High WFD status for Dissolved oxygen concentrations. Dissolved oxygen concentrations are predicted to be reduced by about 0.1 mg/l at both sites (a reduction of less than 1%sat) from a baseline of between 8 and 14 mg/l, with the higher values occurring in the winter, at both locations. During the period when the scheme would be operating, the concentration is between 85%sat and 100%sat. Therefore, the proposed scheme does not pose a risk to status deterioration.

The two watercourses are considered to be of High WFD status for ammonia. Ammoniacal nitrogen concentrations are predicted to be increased by about 0.02 mg/l at both sites from a baseline of 0.04 – 0.18 mg/l. An increase of 0.02 mg/l is not predicted to result in status deterioration.

The two watercourses considered to be of Moderate WFD status for phosphate concentrations. Soluble reactive phosphate concentrations are predicted to be reduced by up to 0.02 mg/l during the operation of the scheme at both sites from a baseline of 0.1 – 0.4 mg/l, and this reduction does not change the WFD status of the corresponding element or cause an impediment to reaching target status.

4.3.6.1.2 Priority Substances and Other Chemicals

With regards to the Minworth Transfer, Section 4.3.5.1 reviews four WFD chemicals which are at risk of causing water quality deterioration in the River Severn downstream of the River Avon. The carry-forward of that risk downstream of the STT Solution intake at Deerhurst remains as described in Section 4.3.5.1 as abstraction itself does not change in-river concentrations.

With regards the Netheridge Transfer and the planned advanced treatment processes included in the Severn Trent Sources SRO Gate 2 scheme. For those chemicals with an EQS, there would be no change in concentration from EQS pass to EQS fail; no reduction in quality where there is EQS pass; no further reduction in quality where there is currently EQS fail; and for chemicals with current EQS fail, no impediments to achieving EQS pass.

The review has been undertaken using River Severn at Deerhurst chemical concentrations and post-removal treatment efficacy from Severn Trent Sources SRO engineers, and is without recourse to the minimum 1:37 dilution rate of the River Severn at the Netheridge Transfer outfall.

4.3.6.1.3 Biological Quality Elements

Consistent with the Macroinvertebrates and Other Ecology Assessment Report, it is evident that the change in flow is neither distinct or substantially different from reference conditions without the STT Solution, and will not impact on the overall dominant habitats within the reach which will remain present through the operation of the scheme. The potential changes in velocity and depth are not considered to be of a magnitude to result in impacts on habitat availability for the macroinvertebrate, macrophyte and phytobenthos communities in this reach with the velocity and depths that would be observed under an unsupported and fully supported STT operation remaining similar to baseline conditions and within the preferred and optimum requirements for baseline communities associated with the reach.

Consistent with the fisheries report, the change in flow is neither distinct or substantially different from reference conditions without the STT Solution and will not impact on migration for the anadromous and catadromous species associated with the Severn Estuary or the River Clun SAC. This is because hydrological cues for migration will not be impacted, and the increased flows will not impact on the passability of any barriers. Flows and velocities will also remain sufficient to support the downstream drift of post-metamorphic transformers and juvenile shad. Flows and velocities will also not result in the washout of any incubating eggs

or juveniles. As there are no changes in the physic-chemical characteristics of the water, impacts on the fish community are not expected, albeit with low confidence.

4.3.7 The Severn Estuary downstream of the tidal limit at Gloucester

The Severn Estuary downstream of the tidal limit at Gloucester has been assessed for the potential of the STT Solution to not comply with WFD objectives. As summarised in Table 4-10 his has been completed for one specific waterbody.

This reach includes the pass forward effects of the unsupported abstraction at Deerhurst of up to 500Ml/d at selected times, subject to HOF conditions identified by the EA. There would also be a continuous abstraction of 20 Ml/d at Deerhurst to maintain a constant minimum flow and maintain water quality in the interconnector pipeline at all other times.

A Mythe licence transfer of 15Ml/d, and flow augmentation releases from advanced treated wastewater transfer from Netheridge WwTW of 15Ml/d to the River Severn upstream of Haw Bridge will enable a pipeline maintenance flow to continue to be abstracted at Deerhurst, some 2km upstream, when River Severn flows are less than HoF conditions.

Table 4-10 WFD compliance assessment summary - The Severn Estuary downstream of the tidal limit at Gloucester

WFD Waterbody	WFD I.D	WFD compliant against assessed WFD objectives	Potential non-compliant issue
Severn Upper (TRaC)	GB530905415403	Yes (Medium - low confidence)	Physio-Chemical Status (Objective 2 – Introducing Impediments)

4.3.7.1 Assessment of compliance / non-compliance with WFD objectives

At the tidal limit, the residual effects on flow and water quality of the River Severn from flow augmentation and abstraction from the STT Solution would be passed forward to the Severn Estuary. Of the flow augmentation releases, only the Minworth Transfer (indirectly) and the Netheridge Transfer (directly) have the potential for amending water quality in the pass forward flow. This assessment considers a TRaC water body and is completed in accordance with the Clearing Waters for All estuarine and coastal waters guidance[25].

4.3.7.1.1 Physio-Chemical Quality Elements

Consistent with the Water Quality Assessment Report, in the River Severn at the tidal limit the fully supported STT operation is predicted to reduce water temperature by 0.2°C (A82) and 0.3°C (M96) from a baseline of between 6 and 20°C.

The Severn Upper is considered to be of High WFD status for dissolved oxygen concentrations. Concentrations are predicted to be reduced by about 0.1 mg/l from a baseline of between 8.5 and 14 mg/l. Therefore, the proposed scheme does not pose a risk to status deterioration.

Ammoniacal nitrogen concentrations are predicted to be increased by about 0.02 mg/l from a baseline of between 0.04 – 0.2 mg/l. Oxidised nitrogen is increased by about 0.8 mg/l during the scheme from a baseline of between 3.0 – 7 mg/l (~10% increase on baseline).

Specific additional analysis has been undertaken in relation to DIN using the EA long term water quality monitoring point at Haw Bridge[26] for the 10 year period 2013-2022. The 117 data points identify DIN concentration as 5.65 mg-N/l with a standard deviation of 1.14 mg-N/l. Allowing for the expected removal rates of the Minworth SRO's advanced treatment processes for the Minworth Transfer, discharged concentration to the Avon could be 16.9mg-N/l. Allowing for the expected removal rates of the Severn Trent Sources SRO's advanced treatment processes for the Netheridge Transfer, discharged concentration to the Severn at Haw Bridge could be 15.8 mg-N/l. Modelled assessment identifies:

- For the full year of the A82 moderate-low flow year scenario, and including abstraction rates for full STT, this could lead to a decrease in annual DIN contribution from the freshwater River Severn to the Severn Estuary of 96 tonnes from a baseline of 15,369 tonnes – a reduction of approximately 0.6%.

[25] Water Framework Directive assessment: estuarine and coastal waters - GOV.UK (www.gov.uk)

[26] https://environment.data.gov.uk/water-quality/view/sampling-point/MD-00025085

This includes 192 tonnes/year load addition from Minworth Transfer and 67 tonnes/year addition from Netheridge Transfer; together with a 356 tonnes/year load reduction from STT abstraction. It is noted that under these circumstances at least a further 67 tonnes/year less DIN would be input into the Severn Estuary from Netheridge WwTW at the current outfall.

- For the full year of the M96 very low flow year scenario, and including abstraction rates for full STT, this could lead to a decrease in annual DIN contribution from the freshwater River Severn to the Severn Estuary of 112 tonnes from a baseline of 14,804 tonnes – a reduction of approximately 0.8%. This includes 268 tonnes/year load addition from Minworth Transfer and 90 tonnes/year addition from Netheridge Transfer; together with a 470 tonnes/year load reduction from STT abstraction. It is noted that under these circumstances at least a further 90 tonnes/year less DIN would be input into the Severn Estuary from Netheridge WwTW at the current outfall.

As such there would be an overall reduction in DIN input from the freshwater River Severn and Netheridge WwTW combined into the Severn Estuary as result of STT solution. The current WFD status for DIN is moderate and therefore the reduction in DIN input into the may be considered failing in objective 2 - impediment to achieving target status.

4.3.7.1.2 Priority Substances and Other Chemicals

With regards to pass forward flows from the Minworth Transfer, the Water Quality Assessment Report identifies the three WFD chemicals at risk of quality deterioration at the point of discharge and downstream in the River Avon. The carry-forward of that risk into the TRaC reach has been assessed in the Water Quality Assessment Report for the Severn at Deerhurst monitoring point, and summarised below:

- **Cypermethrin:** At 0.000008 µg/l, long term average, EQS for transitional waters are 1/10th that for freshwaters[27]. Mean values calculated from the reported concentrations indicate EQS fail at the *Severn_Deerhurst* monitoring site, with four of the 15 reported values greater than the limit of detection which mirrors the freshwater long term average EQS. A concentration increase could be associated with the Minworth Transfer but during the 15% of time that transfer would be in operation, this is considered at Gate 2 with medium confidence to not lead to long-term deterioration in quality or impeding achievement of targets as the main pressures to the reach lie with the upstream River Severn, not the River Avon. This does not lead to WFD non-compliance but further confidence is required from incorporation of lower limits of detection.

- **Perfluorooctane sulfonic acid and its derivatives**: EQS for transitional waters are at 0.00014 µg/l (long term average), tighter than for freshwaters. A mean value of 0.00221 µg/l s calculated from the reported concentrations indicate routine EQS fail at the *Severn_Deerhurst* monitoring site. A concentration increase could be associated with the Minworth Transfer and it is considered with medium confidence and to potentially impede achievement of targets in the lower River Severn. However, an initial review of load change passed forward to the Severn Estuary, based on the mean reported concentrations and accounting for partial re-abstraction at Deerhurst for the STT solution, indicates an additional 0.21 – 0.29 kg/y for the moderate low flow and very low flow years respectively. Based on the mean reported concentrations for the *Severn_Deerhurst* monitoring site this represents a 3-5% increase during years when the STT Solution would be in operation. Taking into account modelling error for transitional waters, at Gate 2 it is deemed the case that PFOS is WFD compliant in this instance.

- **Permethrin:** At 0.0002µg/l, long term average, EQS for transitional waters are 1/5th that for freshwaters[28]. Mean values calculated from the reported concentrations indicate EQS fail at the *Severn_Deerhurst* monitoring site, with one of the 15 reported values greater than the limit of detection which mirrors the freshwater long term average EQS. A concentration increase could be associated with the Minworth Transfer but during the 15% of time that transfer would be in operation, this is considered with medium confidence to not lead to long-term deterioration in quality or impeding achievement of targets, noting the very low detection rate at the assessment point. At Gate 2 this is assessed to not lead to WFD non-compliance.

With regards the Netheridge Transfer and the planned advanced treatment processes included in the Severn Trent Sources SRO Gate 2 scheme. For those chemicals with an EQS, there would be no change in concentration that changes from EQS pass to EQS fail; no reduction in quality where there is EQS pass; no

[27] The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015

further reduction in quality where there is currently EQS fail; and for chemicals with current EQS fail, no impediments to achieving EQS pass. The review has been undertaken using River Severn at Deerhurst chemical concentrations and post-removal treatment efficacy from Severn Trent Sources SRO engineers, and is without recourse to the minimum 1:37 dilution rate of the River Severn at the Netheridge Transfer outfall.

4.3.7.1.3 Biological Quality Elements

Based on hydraulic modelling, the effect on pass-forward flows to the Severn Estuary from the STT solution on the flow duration curve for the full 47-year representative period (see the Physical Environment Assessment Report) is neither distinct or substantially different from reference conditions without the STT Solution. In terms of the overall pattern of changes to pass-forward flow of freshwater from the River Severn to the Severn Estuary, the effects of the STT solution are not distinct from the reference conditions pattern without the STT solution. For example, at Q95, full STT flows passed forward to the Severn Estuary would be 0.05% lower than reference conditions.

As such, the changes in pass forward flow are not expected to affect the resident benthic macroinvertebrate, phytoplankton or angiosperm communities or saltmarsh habitat of the Severn Estuary. This is because the changes in the freshwater inflows will not be of a magnitude to impact the habitats communities and supporting habitats, and the main habitat process will remain unchanged (considering the tidal regime of the Severn Estuary). A decreased DIN concentration would provide a potential benefit through a reduction in algal growth. It is also noted that flows will remain well above the residual flow requirements. Particularly in summer, flow will generally be higher when compared to naturalised flow conditions and the changes will be within the natural annual variations that would be observed under baseline conditions. In July the naturalised flows are around 20% lower than the A82 scenario reference condition.

Overall, no impacts on the invertebrate, fish, phytoplankton, macroalgae and angiosperm communities (including saltmarsh habitat) are expected as a result of hydrological and hydraulic changes in this reach under the current conditions.

With regards to flows and physical habitat, changes to freshwater inputs into the Severn Estuary are neither distinct nor substantially different from reference conditions without the STT Solution. As such, the changes in pass forward flow are not expected to impact on the resident fish communities of the Severn Estuary, or impact the morphology of the river. The potential increase in fish olfactory inhibitor loads in the context of the Severn Estuary is considered to be neither distinct or substantially different from reference conditions without the STT Solution neither distinct nor substantially different from reference conditions without the STT Solution (medium confidence).

4.3.8 River Thames downstream of Culham to tidal limit at Teddington.

The study area for STT Solution WFD compliance in the River Thames extends downstream of the STT Solution interconnector outfall at Culham to tidal limit at Teddington. The River Thames downstream of Culham to tidal limit at Teddington has been assessed for the potential of the STT Solution to not comply with WFD objectives. As summarised in Table 4-11 this has been completed for five specific waterbodies. In this reach, the STT Solution would augment flow via the STT interconnector. The flow augmentation regime is dependent on the maturity of the STT solution.

For the full STT, flow augmentation would be unsupported up to 500 Ml/d at selected times, subject to hands-off flow conditions in the River Severn at Deerhurst identified by the EA, and supplemented by flow augmentation of the River Severn at additional times.

Table 4-11 WFD compliance assessment summary - The River Thames downstream of Culham to tidal limit at Teddington

WFD Waterbody	WFD I.D	WFD compliant against assessed WFD objectives	Potential non-compliant issue
Thames (Evenlode to Thame)	GB106039030334	Yes (low confidence)	Physio-Chemical Status (Objective 2 Introducing Impediments)
Thames Wallingford to Caversham	GB106039030331	Yes (low confidence)	Physio-Chemical Status (Objective 2 Introducing Impediments)
Thames (Reading to Cookham)	GB106039023233	Yes (low confidence)	Physio-Chemical Status (Objective 2 Introducing Impediments)
Thames (Cookham to Egham)	GB106039023231	Yes (low confidence)	Physio-Chemical Status (Objective 2 Introducing Impediments)

WFD Waterbody	WFD I.D	WFD compliant against assessed WFD objectives	Potential non-compliant issue
Thames (Egham to Teddington)	GB106039023232	Yes (low confidence)	Physio-Chemical Status (Objective 2 Introducing Impediments)

4.3.8.1 Assessment of compliance / non-compliance with WFD objectives

In this reach the STT interconnector has the potential for amending water quality and physical conditions in the River Thames.

4.3.8.1.1 Physio-Chemical Quality Elements

Gate 2 STT Solution modelling presented in the Water Quality Assessment Report identified the River Thames as consistent with High status for temperature. During periods of scheme operation in early summer (June and July) when River Thames water temperatures are at their highest (17°C), flow augmentation from the STT Solution could cool river temperatures by up to 1°C.

Gate 2 STT Solution modelling presented in the Water Quality Assessment Report identified the River Thames is consistent with High status for dissolved oxygen. The modelling identifies a potential zone of influence of the increase in saturation as far as the River Thames confluence 12km downstream of the STT interconnector outfall. Dissolved oxygen saturation in both scenarios along this reach is increased by 4%sat at times of STT Solution augmenting low flows in the River Thames at Culham, from a baseline of >95%sat. However, as modelled increases are at times of super-saturation, this may be an over-representation. At higher river flows the effect of flow augmentation is less. Based on the above the scheme is not predicted to pose a risk of status deterioration in the River Thames.

Gate 2 STT Solution modelling presented in the Water Quality Assessment Report identified the River Thames is consistent with Moderate status for Phosphate. Phosphorus is predicted to increase during the scheme operation by around 0.05 mg/l (from a baseline of 0.12 – 0.35 mg/l) at Culham downstream of the STT interconnector outfall with a lower rate of increase downstream. Downstream of Culham, the River Thame is modelled to increase pressure on phosphorus concentrations and the Rivers Pang and Kennet to reduce pressure. Increases are greatest at times of low flow in the River Thames, which, in the modelled scenarios, coincide with 353 Ml/d supported transfer from the River Severn (Full STT solution). At times of up to 500Ml/d unsupported transfer (both early phase and full STT solution), baseline river flows in the River Thames are modelled as higher, and as such phosphorus concentrations are modelled to increase by around 0.03 mg/l. Whilst status deterioration is considered unlikely, the scheme does present a risk of introducing an impediment to achieving target status (Objective 2 introducing impediments). Although this is arithmetically-speaking assessed as introducing an impediment to target quality for reactive phosphate in the middle River Thames, it is recognised that reactive phosphate is a WFD supporting element to plant growth.

Gate 2 STT Solution modelling presented in the Water Quality Assessment Report identified the River Thames is consistent with High Status for Ammoniacal nitrogen. Ammoniacal nitrogen is predicted to increase during the scheme operation by around 0.03 mg/l (from a baseline of 0.02 – 0.06 mg/l) at Culham downstream of the STT interconnector outfall. This is not considered to present a risk of status deterioration.

pH change was calculated from pan-SRO monitoring data as presented in the Water Quality Assessment Report. Those spot monitoring data identify a pH range in the lower Severn at Deerhurst of 7.5 – 8.7 (mean 8.1). Although there is greater variability in the range of pH in the lower Severn than the middle Thames, the difference in mean value is neither distinct in pattern nor substantial in magnitude. Acid neutralising capacity in the middle River Thames is very low. In the lower River Severn acid neutralising capacity is better, and at times of STT Solution flow augmentation, there would be a marked improvement in acid neutralising capacity of the middle River Thames.

4.3.8.1.2 Priority Substances and Other Chemicals

With regards to the treated effluent transfer, water quality modelling has considered all chemicals included in the WFD Directions[29], for short-term (maximum allowable concentration or 95-percentile standards as appropriate) and long term (average) where these are stated in the Directions. From the available evidence at Gate 2, in line with the Water Quality Assessment report, four WFD chemicals were identified as not achieving EQS in the source water in the lower River Severn prior to the interconnector treatment unit. These are: the polyaromatic hydrocarbon benzo(g,h,i)perylene; two synthetic pyrethroid insecticide (permethrin and

[29] Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

cypermethrin); and PFOS. These chemicals include those flagged in the assessment as with potential for increasing in concentration in the River Severn at Deerhurst as consequence of operation of the Minworth Transfer (as designed at Gate 2). From this available evidence data at Gate 2, only these chemicals associate with the potential for either WFD deterioration in the River Thames (Objective 1) or introducing impediments in the River Thames (Objective 2). All other WFD chemicals are identified from Gate 2 monitoring at Deerhurst as WFD compliant and the Gate 2 assessment is that they cannot present risk of either WFD deterioration in the River Thames (Objective 1) or introducing impediments in the River Thames (Objective 2).

The WFD waterbodies assessed in the Thames reach currently fail the EQS for benzo(g,h,i)perylene, cypermethrin and PFOS.

With this in mind, the Gate 2 assessment identifies neither distinct or substantially different change from reference conditions without the STT Solution in the concentrations of permethrin or cypermethrin in the River Thames from operation of a STT Solution. Any change in the concentration of permethrin or cypermethrin in the abstracted water at Deerhurst from Minworth Transfer, at times of supported transfer only, would be low. It is noted that as supported transfer would be in use 12% of time overall, these changes are not considered significant from the perspective of long-term change. As such, for these chemicals measured as failing EQS in the River Thames at Culham, the STT Solution is considered to neither cause (further) deterioration or impede betterment to achieving EQS. The Gate 2 assessment identifies a potential improvement in the maximum concentration of the polyaromatic hydrocarbon benzo(g,h,i)perylene and PFOS, although this betterment is unlikely to improve the River Thames to achieving EQS.

For further details pertaining to the Thames water quality modelling, refer to the Water Quality Assessment Report, Section 3.9.2.

4.3.8.1.3 Biological Quality Elements

In line with the Macroinvertebrate and Other Ecology Assessment Report, no discernible impacts from changes in water quality are anticipated on protected species as the increases in ammoniacal nitrogen, phosphorus and dissolved oxygen saturation are minor and will not impact on the WFD status of the watercourse.

In line with the Fisheries Assessment Report, the 1D hydraulic model output for water depth variability in the River Thames has not been used in the fisheries assessment. This is because water levels in the River Thames are managed for navigation, with the normal operating level varying within one metre. For example at Culham Lock 90% of gauged river levels in the last year have varied within a 0.26 m range; at Whitchurch Lock (local to the River Pang confluence) by 0.22 m; at Romney Lock (local to the Datchet intake) by 0.40 m. This is in contrast to the differences in water depth which have been greater than one metre during the scenario periods reported for the River Thames at Culham; upstream of the River Pang; and upstream of the Datchet intake.

The 1D hydraulic model output for depth-average velocity variability in the River Thames is considered more reliable. The key summary of the modelled velocity change is that the STT solution would reduce the extent of average velocity reduction within the channel during summer periods of low flow in the River Thames. With the STT solution, average velocity at Culham would not fall below 0.2 m s-1; and upstream of the River Pang and upstream of the Datchet intake average velocity would not fall below 0.25 m s-1 at times of operation of the STT solution.

In line with the fisheries assessment report, an assessment is required of the potential effects from STT solution flow augmentation effects on level, velocity and wetted habitat change at selected weir pool reaches on the River Thames. Weir pool reaches are a feature of the navigation infrastructure of the River Thames, and are that part of the river at a lock, between the weir and the reconnection with the navigable channel. Weir pool reaches represent zones of hydraulic heterogeneity within the otherwise level controlled River Thames. At Gate 1 SESRO identified the first three weir pool reaches downstream of a Culham outfall (same location as the STT Solution outfall) for review: Culham Weir, Clifton Hampden Weir and Days Weir.

A screening review has been undertaken at these weir pools prior to the collection of bathymetry and hydraulic data under suitable flow conditions for inclusion in a 2D model. Those flow conditions were not present in the River Thames during the Gate 2 survey season. The screening identified there could be velocity increases within each of the weir pools from flow augmentation, but was not able to provide context around the reference condition velocities in a A82 moderate-low flow year or a M96 very low flow year or the seasonal differences from the augmentation pattern. Therefore, change to weir pool wetted habitat or weir passability remains an uncertainty and data collection and assessment will need to occur for Gate 3.

As set out in the Fisheries Assessment Repot, the review of olfaction has been undertaken to assess risks from the Minworth Transfer only on the River Severn and Severn Estuary as these relate to requirements for HRA of the Severn Estuary SAC, SPA and Ramsar site. Therefore, no olfactory assessment has been completed for the River Thames.

5. CONCLUSIONS

This assessment is of the STT Solution at Gate 2 using the scheme design information appropriate for Gate 2 and the environmental evidence and assessment undertaken at Gate 2. The assessment will be refined during Gate 3 and statements made here on WFD compliance should be considered as appropriate to assessing feasibility, a requirement of Gate 2, and not as definitive or final statements on WFD compliance.

The two STT scheme groupings set out for the Gate 2 WFD assessment i.e. “Early Phase STT” and “Full STT”, have each been assessed using the ACWG guideline for compliance assessments. In both cases, the ACWG spreadsheet template has been completed in the supporting Annexes. The assessment has identified that only the Full STT is 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 3.

5.1 SUMMARY OF POTENTIAL WFD NON-COMPLIANCE OF EARLY PHASE STT AND FULL STT

There is potential for introducing impediments to target status in four waterbodies, and deterioration of status in two waterbodies, in the River Avon from Stoneleigh to the confluence with the River Severn reach. The risk of non-compliance is associated with the 115Ml/d advanced treated effluent transfer from Minworth WwTW during the Full STT scenario where the Minworth Transfer is part of the support system. The waterbodies in this reach at risk of status deterioration and impediments are:

- Avon (Warks) - conf R Sowe to conf R Leam - GB109054043840
- Avon (Wark) conf R Leam to Tramway Br, Stratford - GB109054044402
- Avon- Tramway Br Stratford to Workman Br Evesham - GB109054044401
- Avon conf Workman Br, Evesham to conf R Severn - GB109054044403.

There is potential for introducing impediments to target status in the one waterbody in the River Severn from the confluence with the River Avon to Deerhurst reach. The risk of non-compliance is associated with pass-forward effects of the Minworth Transfer during the Full STT scenario.

- Severn - conf R Avon to conf Upper Parting - GB109054044404

The effects associated with the 115Ml/d advanced treated effluent transfer may be mitigated to compliant through further development of operating rules.

. There is potential for introducing impediments to target status in the one waterbody in the Severn Estuary downstream of the tidal limit at Gloucester. The risk of non-compliance is associated with an overall reduction in DIN input from the freshwater River Severn and Netheridge WwTW combined into the Severn Estuary as result of early phase and full STT solution.

- Severn Upper (TRaC) - GB530905415403

There is potential for introducing impediments to target status in five waterbodies in the Thames downstream of Culham to tidal limit reach. The risk of non-compliance is associated with a potential increase in phosphate concentrations during the early phase and full STT solution.

- Thames (Evenlode to Thame) - GB106039030334
- Thames Wallingford to Caversham - GB106039030331
- Thames (Reading to Cookham) - GB106039023233
- Thames (Cookham to Egham) - GB106039023231
- Thames (Egham to Teddington) - GB106039023232

The effects on the River Severn reaches upstream of the River Avon confluence (River Severn from the Vyrnwy Bypass Outfall to Bewdley, and the River Severn from Bewdley to the confluence with the River Avon), along with the Vyrnwy itself, are deemed to be WFD compliant. In these reaches, there is no pathway of environmental water quality change, and potential changes in velocity and depth are not considered to be of a magnitude to result in impacts on aquatic ecology or morphology.

In the c.140 km of the River Thames from Culham to the tidal limit at Teddington, modelled water quality predicts a benefit to a small benefit to dissolved oxygen saturation, and a small benefit to PFOS and the

polyaromatic hydrocarbon benzo(g,h,i)perylene. Although, any betterment from STT Solution would not lead to EQS being achieved in the River Thames for these chemicals.

The progressive WFD Assessment Objectives outlined in Section 2.1 have also been reviewed. Whilst some improvements to physio-chemical water quality and chemical water quality have been established, any betterment from the STT Solution is unlikely to lead to overall improvement in status class and assist the attainment of the WFD Objectives of a waterbody. Whilst it is not clear that the progressive objectives have been assisted at this time, it should be noted that the progressive objectives are not tests of constraint and do not lead to WFD non-compliance of STT Solution if not achieved.

5.2 UNCERTAINTY AND CONFIDENCE DATA GAPS

Sufficient environmental water quality evidence is available for the Gate 2 assessment, and environmental water quality evidence is generally assessed with medium confidence for the River Vyrnwy, River Avon and River Severn reaches. The hydraulic modelling of the River Thames at Gate 2 is of limited reliability, and outcomes have been assessed with low confidence. This may have repercussions for the reliability of water quality modelling in the River Thames. The hydraulic model itself requires further work for use in Gate 3 and further flow scenarios will be required to progress the assessment made at Gate 2. Further scenario modelling using the 1D hydraulic and water quality models can be assessed as the gated process progresses.

For some WFD chemicals, there are difficulties with commercially available limits of detection not being sufficiently low compared to EQS values. For potential olfactory inhibitors in fish, it is recognised that the commercially available limit of detection may be altogether too high to draw conclusions. With the above in mind, olfactory effects are generally presented with low-medium confidence.

The available evidence and data are generally considered sufficient to inform the ecological requirements of macroinvertebrate, macrophyte, and phytobenthos communities of the waterbodies associated with the STT Solution for Gate 2. Minor uncertainties exist with regards to a lack of measured data to inform the risk to weir pool habitats in the River Avon associated with the physical changes upstream of Alveston, and recommendations for further analysis have been proposed. As above, ecological effects are generally presented with medium confidence in the Vyrnwy, Avon and Severn reaches. As hydraulic modelling of the Middle Thames need further development, and further assessment of weir pool habitats is required, ecological analysis and assessment is generally presented with low confidence at this stage.

5.3 RECOMMENDATIONS FOR GATE 3

As the STT Solution moves away from strategic assessment towards planning, the WFD compliance assessment will move away from the ACWG approach towards that suitable for accompanying a planning application, incorporating guidance provided by the Planning Inspectorate[30].

Further recommendations for monitoring and assessment in Gate 3 are outlined in the relevant evidence and assessment reports which will be used to inform Gate 3 regulatory assessments. A summary of recommendations has been provided below.

With regards to the 74 km of the River Vyrnwy from Vyrnwy Reservoir to the confluence with the River Severn, flow changes would be minor in the context of the range of normal flows in the River Vyrnwy and therefore subsequent impacts on WFD ecological elements are not expected in this regard. However, further consideration in the context of Severn Regulation releases which also exert a managed flow regime on the River Vyrnwy is required from a WFD perspective.

There is a lack of measured data to inform the risk to weir pool habitats in the River Avon associated with the physical changes upstream of Alveston. Undertaking ADCP measurements upstream, downstream and within weir pool habitats and bifurcations at representative weirs/locks in the River Avon will improve the uncertainty in the current WFD assessment.

As noted in the Physical Environment Assessment report, the hydraulic modelling of the River Thames at Gate 2 is of limited reliability. This may have repercussions for the reliability of water quality modelling in the River Thames, and this is reflected in the WFD confidence scores. The hydraulic model itself requires further work for use in Gate 3 and further flow scenarios will be required to progress the assessment made at Gate 2.

[30] Advice Note Eighteen: The Water Framework Directive | National Infrastructure Planning (planninginspectorate.gov.uk)