

Strategic Regional Water Resource Solutions: Annex B2.4 Macroinvertebrates / Other Freshwater Ecology Evidence Report

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

Date: November 2022



Severn to Thames Transfer

Macroinvertebrates / Other Freshwater Ecology Evidence Report

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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 SOLUTION

Macroinvertebrate & Other Freshwater Ecology Evidence Report

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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 500MI/d to the South East of England during drought, with 500MI/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 25MI/d water licensed to UU from Lake Vyrnwy directly into the River Vyrnwy;
- **Vyrnwy Reservoir:** Utilisation of 155MI/d water licensed to UU from Lake Vyrnwy and transferred via a bypass pipeline ("Vyrnwy Bypass") to the River Severn;
- **Shrewsbury:** Diversion of 25MI/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:** 15MI/d of the Severn Trent Water licensed abstraction at Mythe remaining in the River Severn for abstraction at Deerhurst;
- **Minworth:** The transfer of 115MI/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 35MI/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 1

The STT Solution was subject to a detailed assessment in Gate 1 with the objective of delivering regulatory assessments of potential environmental effects of the Solution in the context of the All Company Working Group (ACWG) guidance. This methodology is aligned to the Water Resources Planning Guideline: Working Version for Water Resource Management Plan 2024 (WRMP24) so that there is a consistent approach to evaluating potential effects on environmental aspects.

At Gate 1, using the information available, the environmental appraisals did not identify any 'material issues', i.e. any unsurmountable obstacles that mean the scheme is unfeasible due to environmental reasons, at this

stage. Both beneficial and adverse effects have been identified, which is to be expected given the scale of the scheme.

These conclusions were reached in the context of identified gaps in understanding, and the stated need for further data and evidence collection to support the Gate 2 investigations, further information on the operation of the scheme, and ongoing dialogue with regulators and other stakeholders.

1.1.2.1 Regulator feedback at Gate 1

Feedback from the regulators was sought before the submission of the Gate 1 submission and incorporated where possible. The environmental regulators also gave feedback as part of their formal Gate 1 review of the scheme. This feedback has informed the approach taken for Gate 2.

1.1.3 Gate 2

The ACWG guidelines set out that Gate 2 builds on Gate 1 activities to improve the detail and breadth of studies for a key decision point for strategic solutions. This will include concept solution designs with reduced uncertainty in costs and benefits and re-testing in revised regional and company models (to support updated decision making and filtering on outputs including those that are mutually exclusive).

At the end of Gate 2, the solution should be developed to a standard suitable for submitting into final regional plans and/or final WRMPs. In this context, this stage (Gate 2) of the programme aims to further enhance the funding portfolio, based on refined and consistent costs and benefits, with suboptimal solutions eliminated and viable solutions carried forward to the pre-planning stage.

To support the programme, the potential environmental effects associated with the STT Solution identified in Gate 1 will be considered in view of updated scheme design, changes in potential operational patterns, feedback on Gate 1 assessments from various regulators and stakeholders and further data gathering, modelling and assessment work completed since the publication of the Gate 1 assessment report¹.

RAPID issued a guidance document² 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. This includes, where relevant, Water Resource Management Plan (WRMP) guidance for 2024, All Company Working Group (ACWG) guidance³ and the Environment Agency Invasive Non-native Species risk assessment tool.

1.1.3.1 Overview of the environment assessment approach for Gate 2

Figure 1.1 shows the investigations undertaken for Gate 2 and their interactions, in order to show the full scope of work across both environmental engineering disciplines. Reporting for the environmental investigations is undertaken a phased way. The Evidence reports (pale blue box in the figure below, and this report) are produced first, that set out the data and evidence to be used in the assessment. The Assessment Reports which use the evidence to determine the potential effect of the STT scheme on the different topics, is produced later (dark blue box in the figure below). Together with other inputs, these reports feed into the production of the statutory reports and summary reports (yellow boxes).

1.1.3.2 Regulator engagement for Gate 2

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 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 the methodology documents have been issued, plus other technical

¹ [United Utilities - Water Transfers – RAPID Gate 1 Submission](#)

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

³ All Companies Working Group (2020) WRMP environmental assessment guidance and applicability with SROs

notes, to the regulators to solicit feedback on the proposed approaches. Feedback on the drafts have been used to inform the wider environmental assessment for Gate 2 and finalise the approach and reporting.

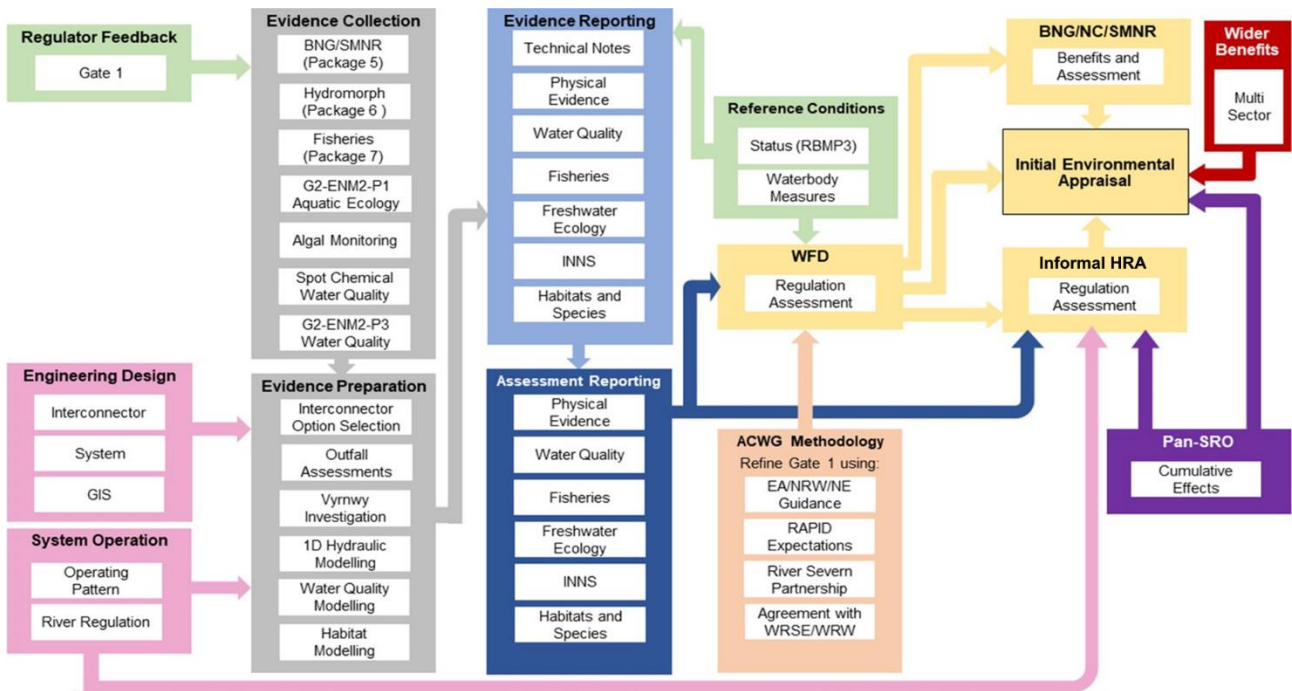


Figure 1.1 Flow chart showing the investigations undertaken for Gate 2 and their interactions

1.2 STUDY AREA

The study area for the Gate 2 assessment is limited to specific reaches, 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;
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 WwTW to the River Avon, is included in the ST Minworth Solution and therefore excluded from the STT scheme assessment.

1.3 AIM OF THIS REPORT

The assessment of potential impacts on the macroinvertebrate and other freshwater communities (diatoms and macrophytes) from the operation of the STT Solution should be considered in the context of the ecological requirements of the baseline communities and the extent to which these requirements will be altered.

This note provides the evidence/data catalogue used to inform the baseline macroinvertebrate and other freshwater communities (diatoms/phytobenthos and macrophytes) associated with the proposed STT Solution. It should be noted that the fish communities are considered in a separate report. The baseline macroinvertebrate and other freshwater communities will inform the ecological requirements that should be considered in the assessment of the magnitude and significance of any potential impacts associated with the STT Solution. Furthermore, this report identifies the remaining data/evidence gaps, provides a summary of the proposed programme of works and approach to address any data/evidence gaps as part of the RAPID's gated assessment process for the Solution.

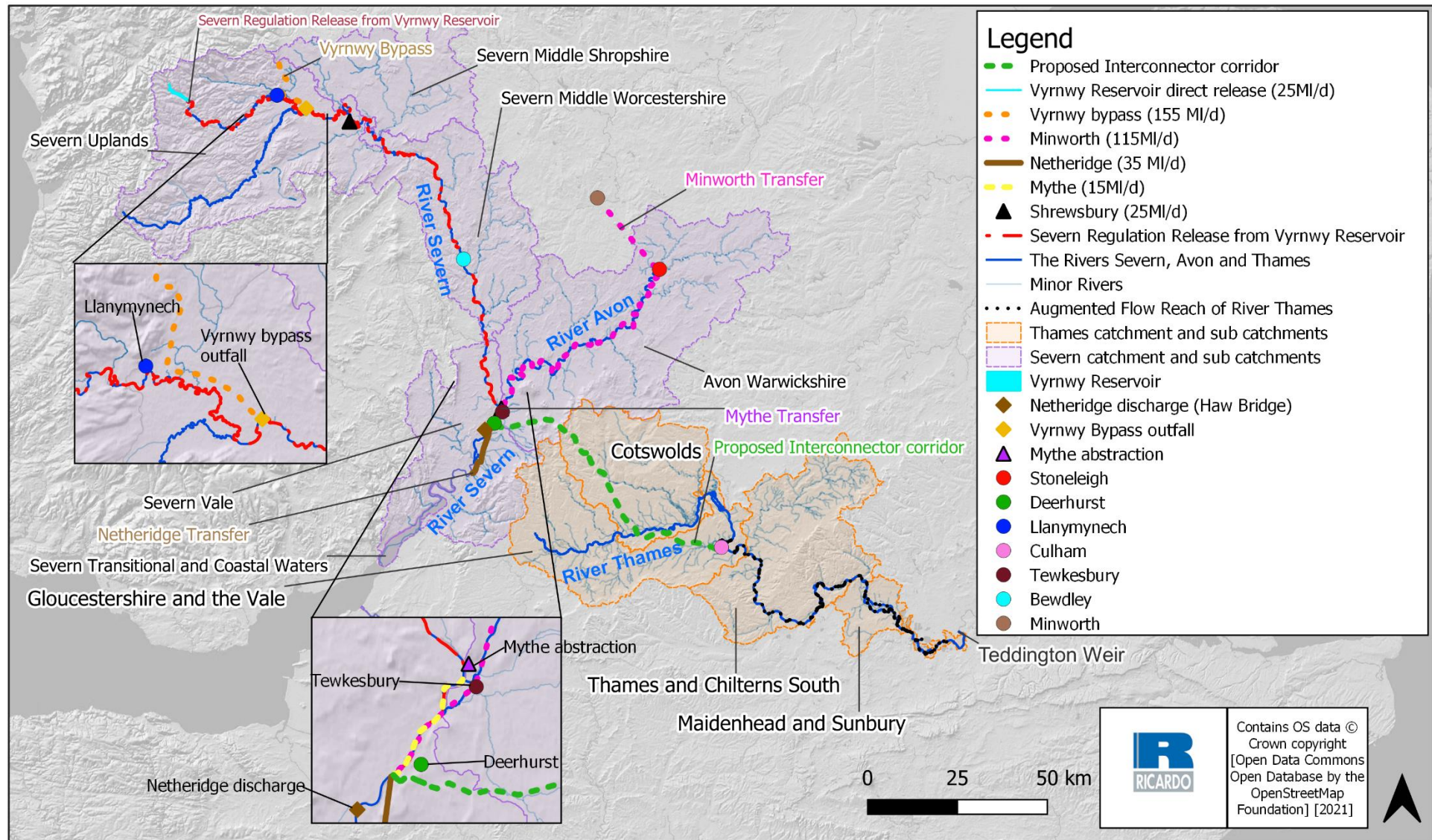


Figure 1.2 Map showing the proposed interconnector corridor

2. EVIDENCE BASE FOR, AND APPROACH TO, THE GATE 2 ASSESSMENT

Gate 1 of the STT Solution identified several datasets and studies that form the evidence base for the assessment of effects on macroinvertebrate and other freshwater communities. The Gate 1 process also identified where additional data is required to undertake the necessary assessments for Gate 2.

Stakeholder consultation with the environmental regulators for England and Wales also identified additional datasets and studies that are necessary to improve the evidence base for the Gate 2 assessments.

This section:

1. Outlines the scope and approach to the macroinvertebrate and other freshwater communities assessment tasks that will be undertaken;
2. Summarises the additional data and evidence collection tasks that were completed for Gates 1 and 2 in respect of macroinvertebrate and other freshwater communities; and
3. Confirms the evidence base that will be used in the assessment of potential impacts on macroinvertebrate and other freshwater communities in Gate 2.

2.1 SCOPE AND APPROACH TO GATE 2 ASSESSMENT AND EVIDENCE BASE

The scope of the assessment required for Gate 2 and the approach to undertaking this assessment is described in **Table 2-1** below. This table also includes a summary of the evidence base that will be used to inform the ecological/environmental elements/receptors that require assessment and the extent to which these elements/receptors] are altered as a result of the construction and/or operation of the STT Solution.

The evidence base has been summarised in separate Excel workbooks for each of the following:

- Macroinvertebrates (*STT Macroinvertebrate Evidence Workbook*)
- Macrophytes (*STT Macrophyte Evidence Workbook*)
- Diatoms (*STT Diatom Evidence Workbook*)

Note: 3D maps have been embedded in the separate, supporting Excel workbooks that give a greater visualisation of the data than 2D maps. These can be accessed by selecting “insert” on the Excel ribbon, then “3D Maps”, and then “Open 3D Maps” then click to open the “Tour” that appears in the window.

These data were also used to inform the extent of any remaining data/evidence gaps that would result in any uncertainty in the assessments of the potential impacts of the STT Solution on the macroinvertebrate, macrophyte and diatom communities of the associated waterbodies.

The accompanying Excel workbooks include the following:

- A map showing the distribution of monitoring locations providing the dataset (including Environment Agency Data survey locations, Natural Resources Wales survey locations and targeted surveys completed by the STT Group)
- A list of survey locations and data obtained from the Environment Agency Data survey locations, Natural Resources Wales survey locations and targeted surveys completed by the STT Group and a summary of the number of surveys and their date range
- A summary of the macroinvertebrate community at each survey site per Water Framework Directive (WFD) catchment, including:
 - A summary of the biological metrics results = including the WHPT (Whalley Hawkes Paisley Trigg) indices, Lotic-invertebrate Index for Flow Evaluation (LIFE) index and The Proportion of Sediment-sensitive Invertebrates (PSI) index. This sheet also includes a summary of the WFD status based on WHPT indices.

- A list showing the designation status for species based on various sources including the species listed as of principal importance for the purpose of conserving biodiversity under Section 41 of the Natural Environment and Rural Communities Act (NERC) (2006), species listed as priority in Section 7 of the Environment (Wales) Act (2016), species that are protected under Section 9 of the Wildlife and Countryside Act (1981), species listed on the IUCN Red List of threatened species that are vulnerable, near threatened or threatened, species previously listed as priorities for conservation action under the UK Biodiversity Action Plan (UK BAP) (where available).
- Graphical representation of the results for the biological metrics listed above, plotted against flow and the 3-month seasonal hydrological summary for the associated catchment (where applicable).
- A summary of the macrophyte community at each survey site per WFD catchment, including:
 - A summary of the biological metrics results including the River Macrophyte Nutrient Index (RMNI), River Macrophyte Hydrological Index (RMHI), Number of macrophyte taxa (NTAXA), Number of functional groups (NFG) and Cover of green filamentous algae (ALG).
 - A list showing the designation status for species (where available).
 - Graphical representation of the results for the biological metrics listed above, plotting the 6-month rolling average for orthophosphate concentrations as obtained from the nearest water quality monitoring location (where applicable).
- A summary of the diatom community at each survey site per WFD catchment, including:
 - A summary of the biological metrics results including the TDI 4 scores, %Motile scores, %Organic Tolerant scores and %Saline score.
 - Graphical representation of the results for the biological metrics listed above, plotting the 6-month rolling average for orthophosphate concentrations as obtained from the nearest water quality monitoring location (where applicable)

2.2 ADDITIONAL DATA COLLECTED DURING GATE 1 AND GATE 2

To provide the necessary Gate 1 data and evidence to inform the environmental assessment associated with the STT Solution, an ecological monitoring programme was implemented by the STT Group in June 2020 (*the 2020 monitoring programme*). This monitoring programme initially consisted of 37 survey at sites across the Severn and Thames catchments. The monitoring programme was subsequently updated to include sites associated with a Thames to Southern Transfer and the Oxford Canal option considered by Thames Water in WRMP19. The 2020 monitoring programme included various ecological features, including:

- Macroinvertebrate communities (spring and autumn 2020 and spring 2021 surveys);
- Macrophyte communities (summer 2020 surveys); and
- Invasive Non-native species (INNS) (spring and summer 2020 and spring 2021 surveys).

The Gate 1 environmental assessments identified that the 2020 monitoring programme should be updated to include additional surveys and features. The available data and evidence in Gate 1 indicated that there was a lack of diatom/phytobenthos data to describe the baseline communities and the risk associated with the STT Solution. Furthermore, there was also a lack of data on the baseline macroinvertebrate communities in summer (when the STT Solution is most likely to be operational).

As such, the 2020 monitoring programme was amended to include macroinvertebrate, diatom and macrophyte sampling at additional sites and frequencies. These data are also supported by eDNA surveys to inform the INNS baseline⁴. This amended scope of works includes the following features:

- Macroinvertebrate surveys at multiple locations within the River Vyrnwy, River Severn and River Thames catchments (summer 2021, autumn 2021, spring 2022, summer 2022 and autumn 2022);

⁴ Ricardo Energy & Environment (2022). Severn Thames Transfer SRO. Invasive Non-Native Species (INNS) Evidence Report. Report for: United Utilities on behalf of the STT Group. February 2022

- Diatom surveys at multiple locations within the River Vyrnwy, River Severn and River Thames catchments (summer 2021, autumn 2021 and spring 2022, summer 2022, autumn 2022); and
- Macrophyte surveys at multiple locations within the River Vyrnwy, River Severn and River Thames catchments (summer 2021 and summer 2022).

As noted in Section 2.1, the survey locations are presented in the accompanying Excel workbooks and are also present in Section 3.

Table 2-1 Evidence and approach to the Gate 2 assessment of macroinvertebrates and other freshwater communities

Task item	Scope of assessment	Approach to assessment	Evidence Base for Task
<p>Aquatic macroinvertebrates and other freshwater ecology</p>	<ul style="list-style-type: none"> Update the Gate 1 assessment using additional baseline data collected during Gate 1 and Gate 2. 	<ul style="list-style-type: none"> Update the assessment to consider additional species/community data collected during Gate 1 and Gate 2. Update assessment in consideration of the interpretation of the fluvial (flow) model, including the flow series at key locations for different scenarios to consider the risk of changes in velocities, depth and wetted margin that may result in changes in community structure, loss of preferred habitat, scouring of biofilm, etc. Include relevant Solution monitoring programme survey data such as Acoustic Doppler Current Profiler (ADCP), habitat walkovers and River MoRPh survey⁵ outputs and additional habitat modelling at key locations. Update assessment in consideration of the interpretation of the water quality assessment and model outputs to consider risk of water quality driven changes in community structure. Suggest further mitigation measures (where required) for design/engineering interface. Review additional studies on flow related impacts on diatoms/phytobenthos to understand the potential risks. 	<ul style="list-style-type: none"> Physical Environment and Water quality assessments will provide scenario outputs to consider in the assessments. Data from Environment Agency Ecology & Fish Data Explorer from 2011-2021. Data obtained through data request to NRW Targeted monitoring completed since 2020 at freshwater sites within the project area (see Section 2.2). EA, NRW and STT Group macroinvertebrate data, WHPT scores, ASPT, NTAXA, LIFE and PSI metrics and thresholds, including Ecological Quality Ratios (EQRs). EA, NRW and STT Group macrophyte data using RMNI, RMHI, NTAXA, NFG and ALG metrics and thresholds, including Ecological Quality Ratios (EQRs). EA, NRW and STT Group diatom data using TDI5, TDI4 %motile, %organic tolerant and %saline metrics and thresholds. Studies/investigations on flow related impacts on diatom communities.

⁵ [Modular River Survey](#)

3. CONCLUSIONS

3.1 DIATOMS

3.1.1 Summary of baseline data, uncertainty and data gaps

The diatom community forms the basis of a food web or provides a source of food for protected species (e.g. lamprey ammocoetes). Significant changes in the diatom/phytobenthos community could, therefore, result in changes in species composition of the wider aquatic communities. The transfer of raw water from the lower reaches of the River Severn to the upper/middle reaches of the River Thames could result in water quality changes that could affect the structure of the diatom/phytobenthos community by creating conditions that are more favourable for other species. Any potential impact will, however, be mitigated through the implementation of a water treatment system prior to discharge into the river Thames.

There remains limited information or available baseline data on the sensitivity of the diatom/phytobenthos community in summer months (when the STT Solution will be operational).

The potential for changes in community composition and distribution due to water quality as a result of water diversion, with specific focus on phytoplankton dynamics are well documented^{6,7}. Diatoms/phytobenthos reproduce and respond rapidly to environmental changes, such as water quality. However, limited information is available on the flow preference of various diatom species, and the subsequent risk of changes in community structure as a result of increased flows (in the absence of water quality pressures). Factors such as hydromorphological regimes, and flow, can influence diatom/phytobenthos abundance and composition although these factors aren't considered in existing WFD metrics.

The Gate 2 assessments will require a review of available studies/investigations of the effects of hydrological changes on diatom/phytobenthos communities. It is recommended that the baseline monitoring programme continues beyond Gate 2 in order to provide a minimum 3 year baseline. The specific survey locations, monitoring that has been completed, and recommended programme going forward is provided in Locations associated with the potential canal transfer have not been identified for further monitoring, as the canal transfer option will not be further considered in Gate 2 pending the outcome of the "potential futures' workstream and regional plan updates. It is recommended that the survey methodologies applied in the 2020 and 2021 monitoring programme should continue to be used, to ensure consistency.

Table 3-1. Diatom/phytobenthos surveys are not included at STT-6a and STT-09 as data is considered sufficient for these sites to inform the assessments.

Locations associated with the potential canal transfer have not been identified for further monitoring, as the canal transfer option will not be further considered in Gate 2 pending the outcome of the "potential futures' workstream and regional plan updates. It is recommended that the survey methodologies applied in the 2020 and 2021 monitoring programme should continue to be used, to ensure consistency.

Table 3-1 Survey locations for the STT Solution monitoring programme for diatom communities

Note: Dates highlighted in green indicate surveys completed and dates highlighted in blue indicate recommended surveys to complete a 3-year baseline

Site Nr	Gate 1 site code	Description	NGR	Monitoring Programme			
				2020	2021	2022	2023
STT-01	M3	River Vyrnwy U/S Conwy	SJ0222317235	-			
STT-01a	M2	River Vyrnwy D/S Reservoir U/S Conwy	SJ0318118954	-			
STT-01b	M4	River Vyrnwy U/S SSSI	SJ0274815326	-			
STT-03	-	River Vyrnwy at Dolanog - Mill Lane (NRW macrophyte site)	SJ0683712739	-			
STT-04	-	River Vyrnwy at Pontrobert	SJ1080012600	-			
STT-05	-	River Vyrnwy D/S Meifod	SJ1956815645	-			

⁶ Moreno-Ostos, E., J A Elliott, L.Cruz-Pizzaro, C. Escot, A Basanta and D.G George, 2007, using a numerical model (PROTECH) to examine the impact of water transfer on phytoplankton dynamics in a Mediterranean reservoir: *Limnetica* 26(1): 1-11

⁷ Bertrand, C., Franquet, E., Chomerat. N and Cazaubon. A., (2004). An approach to the intermediate disturbance hypothesis at the landscape scale: the effect of hydrodynamic on phytoplankton communities. *Archiv for hydrobiology* 161(3): 351-369

Site Nr	Gate 1 site code	Description	NGR	Monitoring Programme			
				2020	2021	2022	2023
STT-05a	-	River Vyrnwy U/S Llanymynech	SJ2533119597	-			
STT-05b	-	River Vyrnwy near Melverley Green	SJ3197617389	-			
STT-6a	M1	River Vyrnwy U/S Severn confluence	SJ3322316529	-	-	-	-
STT-06	-	River Severn D/S Vyrnwy Confluence	SJ3509017329	-			
STT-07a	W2	Discharge location on River Avon u/s Warwick for Minworth support	SP3305372491	-			
STT-08	W1	Discharge location on River Avon for Minworth support option	SP2739962452	-			
STT-08a	-	River Avon at Abbot's Salford	SP0797149927	-			
STT-08b	-	River Avon D/S Evesham	SP0315144409	-			
STT-08c	-	River Avon near Twyning	SO9055836630	-			
STT-09	D1	Abstraction location on River Severn for transfer pipeline Deerhurst	SO8594129233	-	-	-	-
STT-10	D2	Discharge location on River Severn for Netheridge support	SO8545028500	-			
STT-11*	G1	Abstraction location on River Severn for Cotswold Canal transfer (Gloucester Dock)	SO8269518594	-		-	-
STT-12*	G2	Discharge location in Gloucester and Sharpness canal	SO8267318300	-		-	-
STT-12a	-	Discharge location on River Severn for Netheridge support D/S Gloucester Docks	SO8243218278	-		-	-
STT-13*	SJ1	Abstraction location in Gloucester and Sharpness canal at Saul Junction	SO7565609338	-		-	-
STT-14*	SJ2	Discharge location on River Frome for Cotswold Canal transfer at Saul Junction	SO7574709112	-		-	-
STT-15*	ST1	Abstraction location on River Frome for Cotswold Canal transfer at Stroud	SO8547504598	-		-	-
STT-16*	L1	Discharge location on River Thames for Cotswold Canal transfer at Lechlade	SU2112799327	-		-	-

* These sites will no longer be considered as the canal transfer will not be selected for Gate 2 assessments

3.2 MACROPHYTES

3.2.1 Summary of baseline data, uncertainty and data gaps

The baseline data suggests that the macrophyte community is a primary component in terms of the productivity of the River Severn and River Thames, and change in macrophyte community diversity and abundance may have significant implications for other species, notably invertebrate and bird species which utilise macrophyte communities as refuge and feeding habitats. The study reaches of the River Vyrnwy are associated with a diverse lichen and bryophyte community.

The available macrophyte data for the zone of influence was limited in Gate 1 resulting in uncertainty in the assessments. Following completion of the Gate 1 assessment, targeted surveys were completed at key locations downstream on behalf of the STT Group.

There is low uncertainty in the Gate 2 assessments, however, the baseline monitoring programme should continue beyond Gate 2 to provide a minimum 3 year baseline. The survey locations, monitoring that has been completed and recommended future programme is outlined in Table 3-2. Locations associated with the potential canal transfer have not been identified for further monitoring, as the canal transfer option will not be further considered in Gate 2, pending the outcome of the “potential futures’ workstream and regional plan updates.

Macrophyte surveys are not required at certain sites (e.g., STT-01a, STT-01b, STT-04, STT-6a and STT-09) as surveys are either being completed as part of the EA and NRW survey programmes or sufficient data is available to represent the baseline communities in the particular reach.

It is recommended that the survey methodologies applied in the 2020 and 2021 monitoring programme should continue to be used, to ensure consistency. It should be noted that the surveys of the macrophyte communities in the River Vyrnwy adopted a bespoke approach which included surveys of lichen and bryophyte communities during standard macrophyte surveys.

Table 3-2 Survey locations for the STT Solution monitoring programme for macrophyte communities

Note: Dates highlighted in green indicates surveys completed and dates highlighted in blue indicate recommended surveys to complete a 3-year baseline

Site Nr	Gate 1 site code	Description	NGR	Monitoring programme			
				2020	2021	2022	2023
STT-01	M3	River Vyrnwy U/S Conwy	SJ0222317235				
STT-01a	M2	River Vyrnwy D/S Reservoir U/S Conwy	SJ0318118954	-	-	-	-
STT-01b	M4	River Vyrnwy U/S SSSI	SJ0274815326	-	-	-	-
STT-03	-	River Vyrnwy at Dolanog - Mill Lane (NRW macrophyte site)	SJ0683712739				
STT-04	-	River Vyrnwy at Pontrobert	SJ1080012600	-	-	-	-
STT-05	-	River Vyrnwy D/S Meifod	SJ1956815645				
STT-05a	-	River Vyrnwy U/S Llanymynech	SJ2533119597	-			
STT-05b	-	River Vyrnwy near Merverley Green	SJ3197617389	-			
STT-6a	M1	River Vyrnwy U/S Severn confluence	SJ3322316529	-	-	-	-
STT-06	-	River Severn D/S Vyrnwy Confluence	SJ3509017329				
STT-07a	W2	Discharge location on R. Avon u/s Warwick for Minworth support	SP3305372491				
STT-08	W1	Discharge location on R. Avon for Minworth support	SP2739962452				
STT-08a	-	River Avon at Abbot's Salford	SP0797149927	-			
STT-08b	-	River Avon D/S Evesham	SP0315144409	-			
STT-08c	-	River Avon near Twyning	SO9055836630	-			
STT-09	D1	Abstraction location on R. Severn for transfer pipeline Deerhurst	SO8594129233	-	-	-	-
STT-10	D2	Discharge location on R. Severn for Netheridge support	SO8545028500	-			
STT-11*	G1	Abstraction location on River Severn for Cotswold Canal transfer (Gloucester Dock)	SO8269518594			-	-
STT-12*	G2	Discharge location in Gloucester and Sharpness canal	SO8267318300	-	-	-	-
STT-12a	-	Discharge location on River Severn for Netheridge support D/S Gloucester Docks	SO8243218278	-	-	-	-
STT-13*	SJ1	Abstraction location in Gloucester and Sharpness canal at Saul Junction	SO7565609338	-		-	-
STT-14*	SJ2	Discharge location on River Frome for Cotswold Canal transfer at Saul Junction	SO7574709112	-		-	-
STT-15*	ST1	Abstraction location on River Frome for Cotswold Canal transfer at Stroud	SO8547504598	-		-	-
STT-16*	L1	Discharge location on River Thames for Cotswold Canal transfer at Lechlade	SU2112799327	-		-	-

* These sites will no longer be considered as the canal transfer will not be selected for Gate 2 assessments

3.3 MACROINVERTEBRATES

3.3.1 Summary of baseline data, uncertainty and data gaps

The available macroinvertebrate data within the zone of influence is, generally, considered sufficient to provide an indication of the baseline community. This is because a long-term data set is available for numerous sites, however, additional surveys are required at selected sites to provide a robust baseline.

Following completion of the Gate 1 assessment, targeted surveys were completed for the length of the River Vyrnwy and also at key locations downstream on behalf of the STT Group.

However, it is recommended that the baseline monitoring programme continues beyond Gate 2 to provide a minimum 3 year baseline. The specific survey locations, monitoring that has been completed and recommended future programme is outlined in Table 3-3. Locations associated with the potential canal transfer have not been identified for further monitoring, as the canal transfer option may not be further considered in Gate 2 pending the outcome of the “potential futures’ workstream and regional plan updates.

During surveys in summer 2021 using environmental DNA (eDNA) sampling approaches to inform the risk of distributing Invasive Non-Native Species (INNS), other macroinvertebrates of interest were recorded in the River Vyrnwy between the Vyrnwy Reservoir and the confluence with the River Banwy. These included the freshwater pearl mussel *Margaritifera margaritifera* and the depressed river mussel *Pseudanodonta complanata*. The freshwater pearl mussel is considered Critically Endangered by IUCN Red list and Nationally Rare whilst the depressed river mussel is considered Vulnerable by IUCN Red list and Nationally Scarce.

Follow up surveys in autumn 2021, the eDNA analysis did not return any target sequences. This was expected as freshwater pearl mussel in particular, are not very active in the colder months. As such, there remains some uncertainty with regards to the extent of the population of both freshwater pearl mussel and the depressed river mussel in the River Vyrnwy. It is, therefore, recommend that further surveys are completed for both species.

In the case of the freshwater pearl mussel populations, it is recommended that the surveys are completed adopting the Common Standards for Monitoring Guidance protocol for freshwater fauna. This will require a survey of habitat suitability, a physical search/survey to establish abundances and community structure and sampling host fish for the assessment of glochidial presence and development.

Table 3-3 Survey locations for the STT Solution monitoring programme for macroinvertebrate communities

Note: Dates highlighted in green indicates surveys completed and dates highlighted in blue indicate recommended surveys to complete a 3-year baseline

Site Nr	Gate 1 site code	Description	NGR	Monitoring programme			
				2020	2021	2022	2023
STT-01	M3	River Vyrnwy U/S Conwy	SJ0222317235				
STT-01a	M2	River Vyrnwy D/S Reservoir U/S Conwy	SJ0318118954				-
STT-01b	M4	River Vyrnwy U/S SSSI	SJ0274815326				-
STT-03	-	River Vyrnwy at Dolanog - Mill Lane (NRW macrophyte site)	SJ0683712739				
STT-04	-	River Vyrnwy at Pontrobert	SJ1080012600	-			
STT-05	-	River Vyrnwy D/S Meifod	SJ1956815645				
STT-05a	-	River Vyrnwy U/S Llanymynech	SJ2533119597	-			
STT-05b	-	River Vyrnwy near Melverley Green	SJ3197617389	-			
STT-6a	M1	River Vyrnwy U/S Severn confluence	SJ3322316529				
STT-06	-	River Severn D/S Vyrnwy Confluence	SJ3509017329				
STT-07a	W2	Discharge location on River Avon u/s Warwick for Minworth support	SP3305372491				
STT-08	W1	Discharge location on River Avon for Minworth support option	SP2739962452				
STT-08a	-	River Avon at Abbot's Salford	SP0797149927	-			
STT-08b	-	River Avon D/S Evesham	SP0315144409	-			
STT-08c	-	River Avon near Twyning	SO9055836630	-			
STT-09	D1	Abstraction location on River Severn for transfer pipeline Deerhurst	SO8594129233				-
STT-10	D2	Discharge location on River Severn for Netheridge support	SO8545028500				-
STT-11*	G1	Abstraction location on River Severn for Cotswold Canal transfer (Gloucester Dock)	SO8269518594			-	-
STT-12*	G2	Discharge location in Gloucester and Sharpness canal	SO8267318300			-	-
STT-12a	-	Discharge location on River Severn for Netheridge support D/S Gloucester Docks	SO8243218278	-		-	-
STT-13*	SJ1	Abstraction location in Gloucester and Sharpness canal at Saul Junction	SO7565609338	-		-	-
STT-14*	SJ2	Discharge location on River Frome for Cotswold Canal transfer at Saul Junction	SO7574709112	-		-	-
STT-15*	ST1	Abstraction location on River Frome for Cotswold Canal transfer at Stroud	SO8547504598	-		-	-
STT-16*	L1	Discharge location on River Thames for Cotswold Canal transfer at Lechlade	SU2112799327			-	-

*These sites will no longer be considered as the canal transfer will not be selected for Gate 2 assessments

