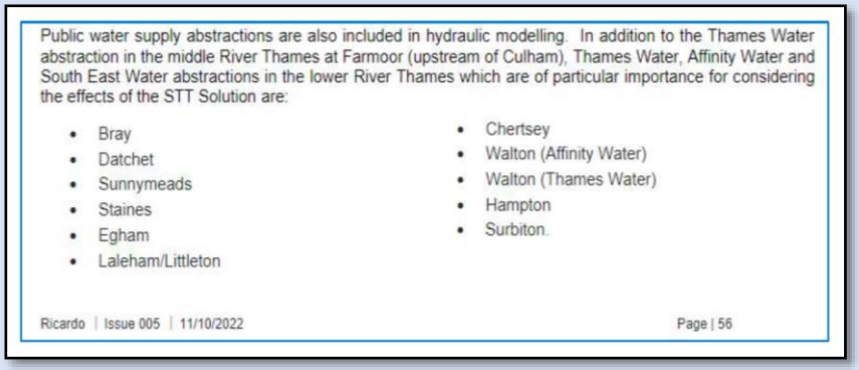
STT RAPID Queries - Gate 2 Query Process

Query ID	Date Sent	Query	Response Sent	Response
STT001	18/11/22	Section 5.2 in the STT-G2-S1-001-STT Detailed Feasibility and Concept Design did not mention South East Water (SEW). SEW have a River Thames Abstraction at Bray. Has this point been considered in both hydraulic calculations (abstraction volume in river flows) and has this treatment works been considered in the water quality risk assessments? What, if any engagement has been had with SEW Stakeholders and Water Quality Team? Where is this referenced?	21/11/22	We confirm that South East Water's River Thames abstraction at Bray has been considered in the hydraulic modelling and assessment of the River Thames. For your ease of reference an extract from the Gate 2 annex B3.2: Water Quality Assessment Report, section 3.9 (page 56) is provided below where this is recorded.  Public water supply abstractions are also included in hydraulic modelling. In addition to the Thames Water abstraction in the middle River Thames at Farmoor (upstream of Culham), Thames Water, Affinity Water and South East Water abstractions in the lower River Thames which are of particular importance for considering the effects of the STT Solution are: • Bray • Datchet • Sunnymeads • Staines • Egham • Laleham/Littleton • Chertsey • Walton (Affinity Water) • Walton (Thames Water) • Hampton • Surbiton. Ricardo | Issue 005 | 11/10/2022 Page | 56 SEW's abstraction at Bray was however omitted from the STT Gate 2 strategic water quality risk assessment (SWQRA). The Bray abstraction is in reasonable proximity to both the Thames Water and Affinity Water abstractions. We would expect that the drinking water quality risks for the Bray abstraction would be similar to those for the Thames Water and Affinity abstractions and would not materially change the Gate 2 SWQRA findings. It is however noted that SEW's relevant DWSP and other site-specific data will need to be reviewed to assess and confirm this, identifying in consultation with SEW specific risks to SEW's consumers. This will be undertaken early in Gate 3.
STT002	29/11/22	**Procurement:** **Interconnector element:** 1. Please confirm whether the scope of the interconnector project that you have assessed	01/12/22	**Interconnector element:** 1. We confirm the scope of the interconnector element assessed is the same as that described in section 3 of the Gate 2 report, as illustrated in Figure 3-3.

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		as suitable for delivery via DPC is the same as that shown in figure 3-3 on page 8 of the main submission document. If it is not, please provide further detail of the scope identified as suitable for delivery for DPC, and set out the rationale for any parts excluded. **Vyrnwy bypass** 2. On page 39 of the main document, you have concluded that based on current cost of this element of the STT system is unlikely to offer enhanced value for money. You note this is particularly the case if the PR24 Methodology limits of £200m totex were applied. However on page 43, table 8-1 reports the capex cost as £198.5m with fixed annual opex costs of £0.21m, which suggests the £200m threshold would be met. Please provide supporting analysis to demonstrate why you have concluded the Vyrnwy Bypass may not be suitable for DPC, including any value you for money analysis you have carried out. 3. Should the Vyrnwy bypass not be suitable for delivery by DPC, please provide further on the preferred procurement route for the project, including underlying rationale.		**Vyrnwy bypass:** 2. Considering the DPC eligibility criteria of size, discreetness and value for money for customers we would respond as below. Size (approximately £200m or more of whole life Totex). We concur with RAPID's observations that the preferred Vyrnwy Bypass option, as currently estimated, is at the DPC threshold of £200m (Totex). The project therefore passes this eligibility criteria. (For context of the Gate 2 report and Annex E narrative, various smaller lengths and capacities of bypass pipeline option were assessed during the Gate 2 development with the larger pipeline option selected towards the end of the Gate 2 process. The narrative in some sections of the report may reflect the design development and optionality associated with these smaller sizes). **Discreetness of the project** The project is discreet in nature and could be developed and then connected with the existing system and other water assets. Therefore, the project would pass this eligibility test. **Value for Money for customers** The bypass pipeline may meet the eligibility criteria but more work will be required at the appropriate time to validate this. The bypass is both a relatively small asset and simple in nature (gravity pipeline). Given these characteristics there is likely to be limited opportunity for additional design, construction and operational innovation over and above what may be achieved through conventional water company procurement and operational integration. We will review the Value for Money further during Gate 3. Market Engagement, at the right time, will be needed to inform a final decision. Please also refer to section 5 on Annex E, procurement, ownership and commercial operation report which expands on some of these points.

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				Conclusion In principle based on the above three eligibility tests the Vyrnwy Bypass may be suitable for DPC. However, it is proposed that Vyrnwy Bypass procurement model remains under review. At the appropriate time, in future stages of the project, further market testing and a value for money assessment would be required to determine whether DPC is an appropriate method of delivery. 3. In the event the Bypass is considered not suitable for DPC, the alternative method of procurement and delivery would be through a 'business as usual' company approach, whereby the water company taking the project forward would design, build, operate and maintain, the asset as part of their infrastructure delivery conventional procurement process. This is likely to be through a Design & Build construction contract for the detailed design and construction of the asset, with operation by the company.
STT003	29/11/22	Project plan: 1. We have identified a couple of discrepancies between the dates on table 7-1 on page 28 of the main document and the programme plan in figure 7-1 on page 30: • Construction ready: table 7-1 notes this is Q2 2028 but the programme plan on page 30 shows CAP award not occurring until Q4 2028. • Mid-point Gate 3 check-in: table 7-1 says December 2023, however the programme plan shows Q1 2024. Please confirm which are the correct dates, and where necessary identify any impacts on other dates in table 7-1 or figure 7-1. 2. Please provide an assessment of progress against the project plan that indicates whether or not it is on track. Reasons should be provided for any missed milestones and impacts on the overall programme caused by delays.	30/11/22	1. In regard to the two programme discrepancies we confirm: • Construction Ready: The date in table 7.1 is in error. The correct date for earliest construction ready is Q4 2028. • Mid Gate 3 Checkpoint: The table 7.1 date of December 2023 is correct. 2. We confirm that: a. The project remains on track, with an earliest construction ready date in AMP8 achievable if that were required, and; b. there are no missed milestones or impacts at Gate 2 that have caused delays to the overall programme. We trust that the main report and supporting annexes provides sufficient supporting evidence of this, but would be pleased to provide further information if required.

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STT004	09/12/22	Procurement: 1. Please provide an assessment of the top risks & issues associated with the preferred delivery route for example, risks around capacity in the market, procurement timelines, SIPR etc.	13/12/22	The procurement delivery risks associated with the STT Scheme depend on the delivery route chosen, as well some common risks, and are presented below. We anticipate with further work these risks can be mitigated, but have provided an indication of risk level at this stage prior to further development of the commercial approach through Gate 3. These have been developed working with the STT commercial procurement lead consultant, focusing principally on the interconnector. (Please note that our Gate 2 submission assumes delivery of the Interconnector via DPC, but recommends that the potential for procurement under SIPR be reviewed in the event that legislation around the eligibility for SIPR changes.) **Common Risks – under DPC and SIPR** 1. Construction Market Appetite – The scheme is relatively large (>£1bn) and so the depth of the market for credible construction counterparties may be focused on larger contractors. Depending on the timing of the construction programme it may coincide with a substantial increase in construction demand in the infrastructure sector as a whole and so there is a risk of not attracting sufficient market interest. (low risk). 2. Planning and delivery risks– The planning processes may be subject to delay or challenge based on environmental and other concerns. If the planning process is run concurrently with the tendering process (as our Gate 2 proposals assume), there is a risk that the planning process may also introduce additional, more onerous planning requirements than is contemplated in the tender documents, adding risk and complexity to the process. (Medium risk). 3. Novelty - There is not a lot of precedent for the development of large cross boundary infrastructure. This 'novelty' may impact on investor or construction party appetite – Discussed further in Specific Delivery Model considerations (low risk). **DPC Considerations** 1. While DPC progress is substantial on other projects they have yet to complete and conclusively demonstrate investable solutions for the delivery of water assets, at least in the eyes of investors (medium risk).

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				2. There is a risk that multiple consumers of the final asset's capacity complicates the commercial model and reduces perception off financability. (Medium risk). 3. The ability of the investors to attract effective construction counterparties (low risk– links to common risk above). 4. Risks associated to long construction programmes may require specific mitigation e.g. through the use of interest rate hedging or other compensation, and project scale mitigations as used in HARP. (Low risk). **SIPR Considerations.** 1. SIPR as currently couched in legislation does not permit designation only on the basis of value for money, and so may not apply to STT. There is a risk of keeping an alternative SIPR based solution on the table, in parallel with DPC that risks confusing the market and abortive costs. (Low risk). 2. Scale of the project – The establishment of a c£1bn Infrastructure Provider relies on the attraction of utility focused investors. The scale of the project may be on the small side for such investors to be interested. This would be subject to further market engagement and testing. (Medium risk). 3. The role of the licence in the IP and the allocation of licensed revenues to beneficiary water companies, will be more complex than for Thames Tideway Tunnel and may require some additional development of regulatory mechanisms to meet investor requirements on a high quality revenue model. (Low risk).
STT005	09/12/22	We note you reference in the exec summary that Mythe and Shrewsbury are not currently available for transfer as they are now identified as needed in region. However, Mythe and Shrewsbury are still referenced in a number of tables and shown on the figures of STT system overview, e.g. Fig 3-1. And tables 3-2 and 4-2. We note Table 3-1 'source capacity changes since Gate 1' does flag that Mythe and Shrewsbury are required to resolve WRW deficit in the draft plan. We also note that Table 4-4 shows Mythe and Shrewsbury as the last sources in your preferred order. Have you		We confirm that Mythe and Shrewsbury have been developed and considered by STT as part of our Gate 2 assessment and submitted to WRSE as part of the regional planning process. However, towards the end of the Gate 2 process and as part of the regional reconciliation, the draft WRW regional plan demonstrated a deficit with the preferred plan selecting Mythe and Shrewsbury as options to resolve the deficit within the region. We have kept the references in the Gate 2 submission to reflect their inclusion in the process and to highlight their significance should they become available following the consultation and adoption of the final WRW regional plan. It should be noted however that based on the current regional modelling output, even without Mythe and Shrewsbury, not all of the source support is fully utilised.

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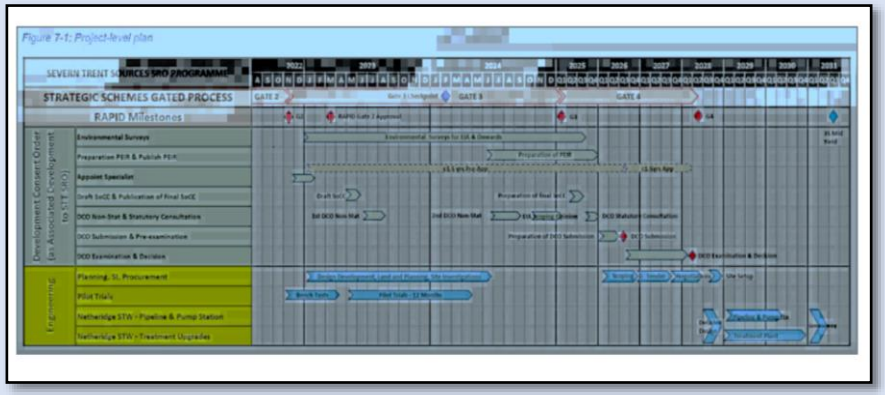
		retained them in case they become available in future/the final plan? Could you confirm/clarify the role of Mythe and Shrewsbury in your proposed solution submitted at Gate 2, including any timelines. The summary programme for earliest delivery Fig 7-1, doesn't seem to include the dates for where Netheridge, (or Mythe or Shrewsbury) come into play to support the STT SRO - Minworth and NWT SRO's are listed. Netheridge is cited as critical to STT (Fig 7-2).		With reference to the omission of the Netheridge source from STT figure 7.1, below is an extract from the corresponding Severn Trent Sources Gate 2 report which provides the programme activities for Netheridge. This shows that Netheridge source, as an integral element for sweetening flows to the interconnector, can be delivered within the overall STT programme, and ahead of the earliest STT interconnector commissioning in 2033. 
STT006	09/12/22	With reference to Section 4.9, please detail the reasoning behind why the full STT scheme utilisation of individual sources and phasing has not been provided in the Gate 2 submission. Detailing why this will be delayed until Gate 3. Outlining any obstacles and barriers to providing this information at this stage.	13/12/2022	The information relating to the STT used in the Regional Plans was provided in early 2022. The Gate 2 process since then has developed the understanding and details of the STT. It is noted in the Gate 2 report that Regional modelling is ongoing and we are proposing to provide further information / update to the Regions in 2023.The updated model output may change the utilisation of the sources in the final regional plans. There are no obstacles or barriers to this information but we need to reflect that the process will evolve in 2023/gate 3. Section 4.9 is reflecting this position. For example to illustrate the type of changes noted above, since the information provided in early 2022 there have been: • a reduction in the direct release volume and increase in the Vyrnwy Bypass capacity, • the requirement of Shrewsbury and Mythe by WRW to resolve their deficit, • and adjustments to costs. In addition looking forward we can see further changes emerging, such as the percentage of river losses in the system which may improve the overall available water volumes.

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<tr><td></td><td></td><td></td><td></td><td>The more detailed breakdown of utilisation for the individual sources at the time of the Gate 2 submission is provided below and we note that source phasing is provided in Table 4.2 of the submission.

<table><tr><td>Source</td><td>Based on stochastically generated flow data</td></tr><tr><td>Netheridge</td><td>6.20% with unsupported transfer and 22.30% with sweetening flow and options</td></tr><tr><td>Lake Vyrnwy</td><td>7.80%</td></tr><tr><td>Minworth (for larger support requests)</td><td>6.4%</td></tr></table>
• These results are based on DO modelling which maximised Thames usage for a particular scenario. Since then the need from WRSE has expanded to other companies and different updates to regional modelling have changed the context.
• The utilisation of Vyrnwy increases to 15% when accounting for a trades to STW as part of addressing the WRW deficit.</td></tr>
<tr><td>STT007</td><td>15/12/22</td><td>In section 6.1 of the STT Cost Report, could you please explain why capital maintenance assumptions are 0.71% of M&E CAPEX and 0.27% of Civil CAPEX?

Have any activities been planned post Gate 2 to inform future risk assessment?</td><td>16/12/22</td><td>Part 1 Operational maintenance
Vyrnwy Bypass
We have included operational maintenance costs for the Vyrnwy Bypass options on the following basis;
• M&E maintenance - Based on 0.71% of the M&E capital costs.
• Civil maintenance - Based on 0.27% of the civil capital costs.

These percentages are based upon analysis from UU engineering. The approach forms part of UUs costing methodology and has been used as the basis to estimate Maintenance Opex since PR09 across all WRMP projects.

Interconnector
We have included operational maintenance costs for the Interconnector options on the following basis;
• M&E maintenance - Based on 1.5% of the M&E capital costs.
• Civil maintenance - Based on 0.25% of the civil capital costs.</td></tr>
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				These allowances for operational maintenance are consistent with Thames Water's Engineering Estimating System (EES) and Asset Planning System (APS) methodology and consistent for all WRMP24 costings (non-SRO and SRO). The use of high-level percentages for operational maintenance aligns with the RAPID and OFWAT guidance document titled "Approaches for estimating and benchmarking costs for large scale water infrastructure projects" published Aug 22. **Part 2 Risk Reduction post Gate 2** The Gate 3 planned scope includes activities to address both specific identified risks and more generally to address risk through the development of the scheme. There are a range of Gate 3 activities planned across disciplines to address identified risks including those presented in table 7-5 of the Gate 2 report (risk 'RSK' references included below) and costed risk registers. Examples of this include: • formal non-statutory stakeholder consultation over the Summer 2023 on site selection methodology, route corridors and alternatives (RSK001), • ongoing development of permitting strategy working with regulators, including potentially establishing a 25Ml/d 'put and take' (RSK002). • further development of the commercial operating model (RSK003), • updated data for WRSE in early 2023 and incorporation of the Mid Gate-3. Checkpoint to align the STT system with the final approved water resource plans (RSK006), • a range of Gate 3 environmental investigations to address HRA, Vyrnwy release, water quality and other environmental issues identified and raised with regulators (RSK009,12,17), • development of the bypass, interconnector and STT system designs which will inform a planned update to costed risk and OB assessment prior to the Mid-Gate 3 Checkpoint, • assessments, design development and specific 'back-checking' for options selection in response to stakeholder representations made in Gate 2.

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				Some planned activities that address areas of risk are dependent on the outcome of the Mid Gate 3 Checkpoint and the progression of the scheme. For example, in the first year of Gate 3 further desk-based geotechnical assessment will be undertaken to better understand and characterise the geotechnical risks. However, intrusive site investigation is only planned once the scheme is confirmed to proceed following the Checkpoint. Similarly, whilst high level route corridor consultation is planned in 2023, consultation on preferred sites and a preferred route alignment is not proposed until after the Mid Gate 3 Checkpoint. We will continue to actively manage existing and emerging risks as the scheme development proceeds. Quantification and formal reporting of risks will be completed as part of cost baselines and forecast updates produced at appropriate stages during the scheme's development.
STT008	15/12/22	We notice in section 8.10-8.15 mention of the best value metrics from WRSE regional Plan and your SRO metrics. We would welcome you signposting us to where these metrics and weightings used for this SRO are detailed in the document or specific annexes. Is there a summary table that shows them all?	16/12/22	The Gate 2 report refers to WRSE and SRO metrics. These are two different datasets and each is addressed separately below. There is not a summary table that shows all of the metrics for both the WRSE and SRO. *WRSE metrics* As noted in section 8.11, in addition to cost and carbon emissions metrics assessed by WRSE there are metrics for Natural Capital (NC), Biodiversity Net Gain (BNG), SEA benefit, SEA disbenefit, resilience: reliability, evolvability and adaptability, and customer preference. This approach enables comparison between the options in a regional context, in comparison with and in combination with all other supply-side and demand-side options, to derive the regionally optimal plan. The metrics used by WRSE for their regional plan were centrally co-ordinated and aligned by WRSE. We had an input to that process for STT, but the data is ultimately held by WRSE who are currently consulting on the output of their modelling exercise as part of their draft plan. https://wrse.uk.engagementhq.com/our-draft-best-value-regional-plan We also provided cost and carbon data, for which updated Gate 2 values are contained in Chapter 6 and 8 of the Gate 2 submission. *SRO metrics for options appraisal* As noted in section 8.14 the philosophy of best value has also been applied to

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				SRO options appraisal including environmental impacts, environmental metrics, resilience metrics, societal benefits, adaptive futures and carbon. These best value metrics used for the SRO options appraisal of the interconnector are presented in Annex 1.3: Interconnector Options Appraisal Summary Report. Specific tables that highlight the analysis are tables 2.1, 3.3, 3.4, 4.2, and 4.3.
STT009	24/01/23	Please can you provide: a) A discussion on the range and impact of uncertainties and a plan to mitigate them. b) A discussion on how a focus on carbon has helped to mitigate the solution costs.	07/02/23	**a) Discussion on the range and impact of uncertainties and a plan to mitigate them.** Gate 2 of the RAPID gated process provided an opportunity to further develop the conceptual designs for the Severn to Thames Transfer (STT) and provides a mechanism for reducing risk and uncertainty. These uncertainties are discussed in the Gate 2 Annex A3.2 Carbon Strategy Report, whose purpose is to provide an analysis of the whole life carbon (WLC) emissions for the STT scheme. There is inherent uncertainty in carbon estimating due to the developing maturity of carbon accounting practices and associated data. There is also additional uncertainty driven by scope uncertainty associated with level of design information available at given stages within the project lifecycle. There is currently no standardised or established guidance to assess uncertainty in carbon estimates in a consistent way and directly applying the range of uncertainty associated with cost estimates and optimism bias would likely overstate the level of uncertainty associated with the Gate 2 carbon estimate. The STT work has been conducted in parallel with guidance from the All Company Working Group (ACWG), which ensures that water companies with SROs are using a consistent approach where possible1. It is noted however that the embedded carbon assessment will be further enhanced in Gate 3 following the updated ACWG guidance of 8th August 22 (this update came late in Gate 2 and may not have been fully implemented across all SRO's as discussed at the QLM on 1st December 2022). Further ongoing work is required at a carbon estimating and accounting discipline level and within the infrastructure sector to establish a more formalised approach to assessing carbon uncertainty. Whilst no formal uncertainty range has been presented at this stage it is estimated an uncertainty range of +/-30% would be suitable for the gate two estimate based on expert judgement.

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				This uncertainty range would account for: • Uncertainty in carbon factors related to the quality and representativeness of industry level emissions factors to the specific activities undertaken and materials used on the scheme. • Scope uncertainty associated with ensuring the carbon estimate has captured all scope requirements to fully deliver the scheme. Chapter 6 of the Gate 2 main report and Annex A3.2 highlight the carbon associated with the different options, and the efforts made to reduce associated capital and operational carbon at each stage. The reports' mitigation approach aims to prioritise efforts in the areas where there are the greatest opportunities for reductions and feasibility of successful decarbonisation interventions. It outlines what these opportunities may be while identifying sources of risk throughout the project's lifespan. This high-level analysis can be found in the Annex A3.2 Carbon Strategy Report, Section 5 Carbon Mitigation Approaches. Following review, these opportunities are summarised and ranked according to their potential impact on emissions reductions and alignment with the emissions hierarchy in order to reflect the recommendations of PAS 2080 and the Water UK Net Zero 2030 Route map (Table 2). The Gate 2 Annex A3.2 provides a guide for the next stages of embedding low carbon initiatives into the STT scheme. The project approach going forward will encourage continuous improvement with established management systems, leadership, and processes in order to minimise uncertainties and hence increase the potential for success. The uncertainties associated with carbon reporting of the Gate 2 SRO have been minimised by implementing the following measures: • Standardised methods: Using standardised and widely accepted methods, such as Inventory for Carbon and Energy (ICE), and the Civil and Engineering Standard Method of Measurement (CESMM4) Carbon and Price Book, for estimating emissions and costs has helped to reduce methodological uncertainties. • Comprehensive data collection: Gathering comprehensive and accurate data from all relevant sources, has helped to reduce data uncertainties. These sources from the design team detailed "before use" and "after use" boundaries to breakdown the materials used at each stage in the project.

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				• Expert review: Engaging internal experts in the field of carbon assessment has provided additional insight and helped to identify and address uncertainties. Our expert knowledge in large scale infrastructure projects, helped reduce errors, increase sector knowledge, and promote tailored carbon mitigation options such as renewable energy. • Regular updates: Putting the SRO through multiple gates allows increased granularity of the carbon assessment as new data becomes available and as the project progresses it has helped to reduce uncertainties and improve the accuracy of the results. • Mitigation measures: In addition to the measures detailed above, internal thorough reviewing process ensures that the options have been calculated appropriately, such as data checks, comparisons with similar projects, and using up to date methodologies and data sources. As we further develop the concept design in Gate 3 of the STT SRO, we will refine our carbon calculations and continue to seek carbon reduction opportunities. **b) Discussion on how a focus on carbon has helped to mitigate the solution costs.** The carbon assessments methodology for the STT SRO have followed PAS 2080 principles in its carbon management approach through the emission reduction hierarchy: build nothing, building less, build clever, build efficiently. The Gate 2 focus on carbon supported the mitigation of the cost of the proposed solution in several areas including infrastructure sizing, operations optimisation and options assessment. These are detailed in the Gate 2 (Chapter 6) report and Annexes (A1.3 'Interconnector Options Appraisal Summary Report' and A1.1 'Interconnector Deerhurst to Culham pipeline conceptual design report'), with the principal areas summarised below. **Infrastructure sizing** The most significant carbon hotspot on the interconnector is the pipeline due to the pipeline material (cement lined steel). The size of the pipeline was optimised in the Gate 2 design and resulted in a smaller pipe diameter and therefore lower carbon footprint and cost.

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				Opportunities have also been identified for Gate 3 to reduce carbon through material selection choices and supply chain engagement. **Operations Optimisation** The energy and chemical consumption of the treatment and transfer has been optimised particularly around the sweetening flow. The volume required for sweetening has been reduced in Gate 2 thereby reducing carbon related to energy and chemical consumption. The optimisation of operations also reduces the running costs due to the increase in efficiency and decreased need for electricity and chemicals. Opportunities have also been highlighted for Gate 3 around Nature Based Solutions for the Interconnector treatment works, hydro-power energy generation for both bypass and interconnector, and optimisation of the power supply provision. **Options assessment** Options assessment of different pipeline routes and of the pipeline options, including canal based options, were carried out in Gate 2 and Carbon was one of the factors used in the decision making process. All pipeline routes that minimised length and optimised the pumping head/ gravity flow balance provide lower carbon emissions. The minimisation of excavation, disposal, and imported materials quantities of any proposal were considered beneficial due to their associated carbon impact. Opportunities have again been highlighted for Gate 3 to minimise excavation and disposal and minimise the need for imported materials. **Other opportunities** There are other areas where opportunities exist but which also need to be balanced against broader environmental considerations. For example: • Increased direct discharges into the river Vyrnwy will reduce sizing of the bypass pipeline and therefore reduce carbon. However, direct release volumes into the River Vyrnwy were reduced in Gate 2 from 75Ml/d to 25Ml/d resulting in a larger capacity and longer bypass

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				pipeline with an associated increased capital carbon. At Gate 3 we will explore if there are opportunities to refine the direct release opportunity (i.e. somewhere between 25Ml/d and 75M/d) or whether the 25Ml/d is optimal. • Levels of treatment for Minworth and Netheridge STW's are significant with advanced 'polishing' processes that are likely worst-case scenarios. In particular, the requirement to add more advanced treatment at Minworth to allow the water to be discharged into the receiving water courses, compared to its current discharge into the River Tame, is responsible for significant construction and operational carbon. At Gate 3, with conjunction with the Severn Trent Sources SRO, we will explore further the impacts on river water quality and if this provides opportunities to refine the process requirements, reducing both capital and operation carbon on those associated SRO's. In summary, we have actively sought to mitigate carbon impacts in Gate 2 and identify opportunities for further cost and carbon reduction in future phases of the project, by changing the size and routes, operation, and by minimizing excavation, disposal, imported materials. Overall, the focus on carbon was a key factor in determining the cost-effective solution for the project.