ANNEX A1.1

Alternative Options Addendum

This document has been written in line with the requirements of the RAPID gate two guidance and to comply with the regulatory process pursuant to Severn Trent Water's 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, Severn Trent Water will be subject to the statutory duties pursuant to the necessary consenting process, including environmental assessment and consultation as required. This document should be read with those duties in mind.

STSources SRO
Severn Trent Water

Severn Trent Water

SEVERN TRENT SOURCES (NETHERIDGE) SRO

CDR Addendum - Alternative (No Treatment) Options

70088464-WSP-NETHSRO-RP-GT-2009
OCTOBER 2022

CONFIDENTIAL

Severn Trent Water

SEVERN TRENT SOURCES (NETHERIDGE) SRO

CDR Addendum - Alternative (No Treatment) Options

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 70088464

OUR REF. NO. 70088464-WSP-NETHSRO-RP-GT-2009

DATE: OCTOBER 2022

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QUALITY CONTROL

Issue/revision	Revision 2	Revision 3	Revision 4	Revision 5
Remarks	For STW review	For STW Review	For STW Review	Issue Copy
Date	26 August 2022	09 Sept 2022	13 Sept 2022	21 Oct 2022
Prepared by	[redacted]			
Signature				
Checked by				
Signature				
Authorised by				
Signature				
Project number	70088464			
Report number	70088464-WSP-NETHSRO-RP-GT-2009			
File reference				

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1. INTRODUCTION

1.1. CONTEXT AND SCOPE

This report is an addendum to the Severn Trent Sources Strategic Resource Option (Netheridge) Concept Design Report (Annex A1), and Pipeline route appraisal report (Annex A2). It provides preliminary assessment of two alternative options for the Netheridge SRO for consideration in the STSources RAPID Gate 2 submission.

This report includes:

- Identification of pipeline routes to and from Maisemore Weir;
- Identification of potential discharge and abstraction locations at Maisemore Weir;
- Identification of a location for an intermediate pumpstation;
- Preliminary assessment of power requirements and the provision thereof;
- Preliminary hydraulic calculations;
- Consideration of any operational constraints or issues;
- Cost estimates to include capital costs, operational costs and net present value; and
- Calculation of the carbon footprint estimation.

All calculations, methodologies and assumptions are the same as those adopted in the Netheridge Strategic Resource Option (Netheridge SRO) Concept Design.

1.2. BACKGROUND

The Netheridge SRO is one of a number SRO projects that form part of a wider scheme to transfer water resources from the River Severn in the northwest of England to the River Thames in the southeast of England. The scheme will see resources transferred from the River Severn augmented from several sources:

- Severn Trent Sources: Mythe abstraction licence (15 Ml/d) and Netheridge WwTW (35 Ml/d) – up to 50 Ml/d;
- Vyrnwy Aqueduct and United Utilities sources (these facilitate the release from Lake Vyrnwy) – up to 180 Ml/d; and
- Minworth Reuse – up to 115 Ml/d.

In establishing the feasibility of the overall scheme, it was assumed that the use of treated effluent from Netheridge WwTW would provide an efficient and reliable way of capturing flows from the Gloucester catchment and moving those northwards. In the early feasibility stages it was anticipated that final effluent from the Netheridge WwTW would require minimal further treatment before being transferred to a location close to the STT SRO abstraction point at Deerhurst.

As the SRO studies have progressed it has become apparent that the quality of the Netheridge final effluent will need to be significantly improved before it can be discharged in the River Severn at Deerhurst. The effluent from Netheridge WwTW currently discharges to the tidal zone of the River Severn and the discharge quality standards at this location are set to maintain the quality of the brackish waters in the tidal zone. Deerhurst is some 18km upstream of Netheridge at a point where the river is no longer under tidal influence. As such any water quality standard for effluent discharge will be set for a freshwater environment and which is more onerous than anticipated at the onset of the project.

Given the basic premise of minimal treatment requirements of the original project have changed, it is prudent to reconsider the options and the way in which water resources from the Gloucester catchment area are transferred north to augment the STT SRO scheme to ensure that STW continue to promote the most efficient options in terms of carbon, capital and operational cost, whilst ensuring that environmental standards are upheld.

1.3. ALTERNATIVE 'NO ADDITIONAL TREATMENT' OPTIONS

The River Severn is considered to change from tidal to non-tidal at Maisemore Weir which is located approximately 6km north of Netheridge WwTW and just downstream divergence of the branch of the River Severn East Channel.

The weir forms a physical barrier in the river and effectively could allow abstraction upstream and discharge downstream with minimal risk of mixing of different quality water. The premise of the alternative options identified is that any discharge downstream of the weir would be into a tidal zone and discharge standards would be the same as those at the existing Netheridge outfall.

Any abstraction upstream of the weir would then not be influenced by conditions downstream of the weir and hence the water quality at this point would be similar to that at the STT SRO Deerhurst abstraction point. Thus allowing re-discharge of water abstracted upstream Maisemore Wier to be returned downstream of the Deerhurst STT abstraction to compensate for this loss of flow without the need for any further treatment.

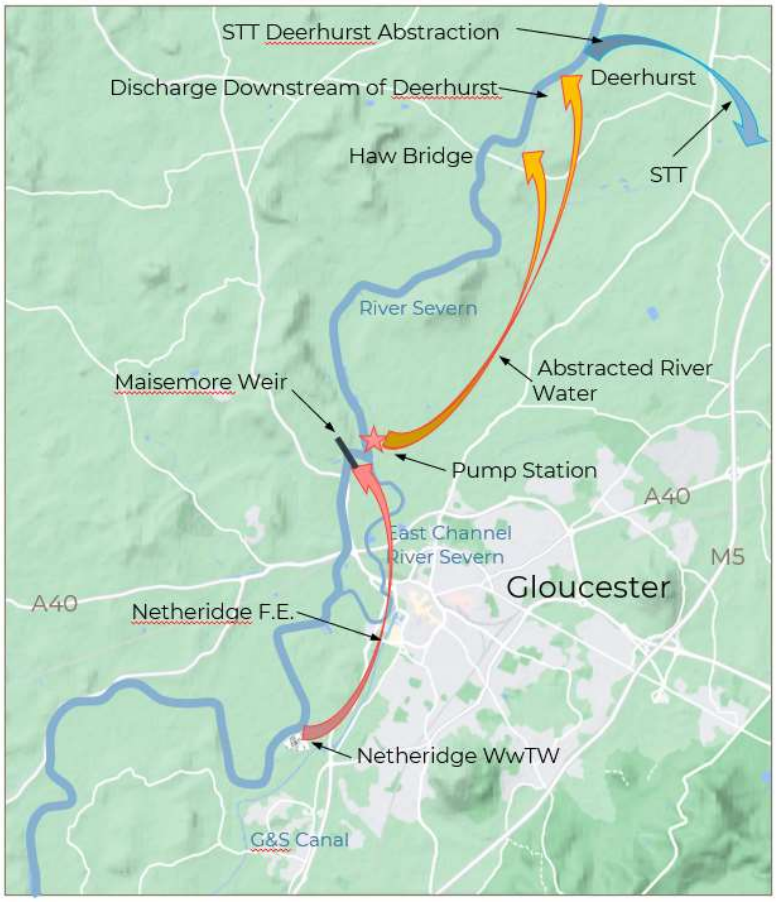


Figure 1-1 - Non-Treatment Options Overview

The basic principals of the option would be to:

- Divert flows from Netheridge WwTW final effluent outfall;
- Pump and discharge to downstream of Maisemore Weir;
- Abstract from upstream of Maisemore Weir; and
- Pump to and discharge downstream of Deerhurst[1] abstraction point

This option would require no additional treatment of the Netheridge WwTW final effluent but would require two stage pumping with additional discharge, abstraction and pumping infrastructure required in the vicinity of Maisemore Weir.

There are a number of variations on this basic option that could include:

- Abstraction from the River Severn at Netheridge rather than diverting final effluent from the WwTW;
- Discharge to the River Severn at Haw Bridge rather than immediately downstream of the STT Deerhurst abstraction;
- Discharge directly to the new STT SRO Water Treatment Works at Deerhurst rather than the River Severn;
- Transferring flow in only part of the river i.e., Netheridge to Maisemore or Maisemore to Deerhurst, on the basis that the impact on total flow in the other part of the River Severn would be minimal; and
- Transferring flows to the East Channel of the River Severn rather than Deerhurst to accommodate flow transfer to the Southwest Region (Bristol Water at Purton) rather than the STT SRO scheme

1.4. OPTIONS TO BE DEVELOPED FOR GATE 2 SUBMISSION

For the purpose of this addendum to the Concept Design Report, two potential options that require no additional treatment at Netheridge WwTW have been identified for further analysis. Of the suite of options being considered, these options are considered to represent the most expensive and least expensive of the alternative options identified and therefore will provide a good basis for assessment and decisions for the future development of the Netheridge SRO project.

These options are:

1.4.1. OPTION 6: NETHERIDGE TO DEERHURST VIA MAISEMORE WEIR

Diversion of final effluent from Netheridge WwTW. No additional treatment. Pump via 7.3km pipeline to discharge point just downstream of the Maisemore Weir. Coupled with abstraction just upstream of Maisemore Weir and Pump via a 11.6km Pipeline to discharge downstream of the STT SRO abstraction point at Deerhurst.

This option is essentially the same pipeline route as Option 1 with a break midway to discharge downstream and then abstract upstream of Maisemore Weir. No additional treatment is provided at

[1] Based on work carried out by environmental consultants Ricardo and ongoing discussions with Environment Agency regarding discharge requirements at Deerhurst.

Netheridge WwTW but additional infrastructure for river discharge, river abstraction and a second pumpstation are required.

This is the most comprehensive of all the possible options where additional treatment is not provided at Netheridge WwTW. There are no sections of the River Severn where the flows in the river are reduced due to abstraction for the STT SRO scheme.

1.4.2. OPTION 7: MAISEMORE TO HAW BRIDGE

Abstraction of flows upstream of Maisemore Weir. Pump via 9.3km pipeline to discharge at Haw Bridge.

This option is the least comprehensive option and assumes that transfers of flows from upstream of Maisemore Weir, a distance of 6.6km north to Haw Bridge will satisfy the Environment Agency definitions of 'put' and 'take' within the River Severn. The option would see reduced flows in the 6.5km section of the River Severn from Maisemore Weir to Netheridge and the 2.6km section from Deerhurst to Haw Bridge.

2. PIPELINE DESIGN

2.1. PIPELINE ROUTE

2.1.1. OPTION 6: NETHERIDGE TO DEERHURST VIA MAISEMORE WEIR

This pipeline route largely follows the same line and level as the Option 1 pipeline route with additional sections to and from Maisemore Weir. It will require the construction of ~19km of new [redacted] mm dia. rising main in two sections comprising 7.3km from Netheridge WwTW to the discharge point downstream of Maisemore Weir, and 11.6km between the proposed abstraction point upstream of Maisemore Weir and the discharge point at Deerhurst. The pipeline is shown in two sections in **Figure 2-1**- Option 6 – Route overview and **Figure 2-2**- Option 6 vs Option 1 Routes Divergence and Convergence.

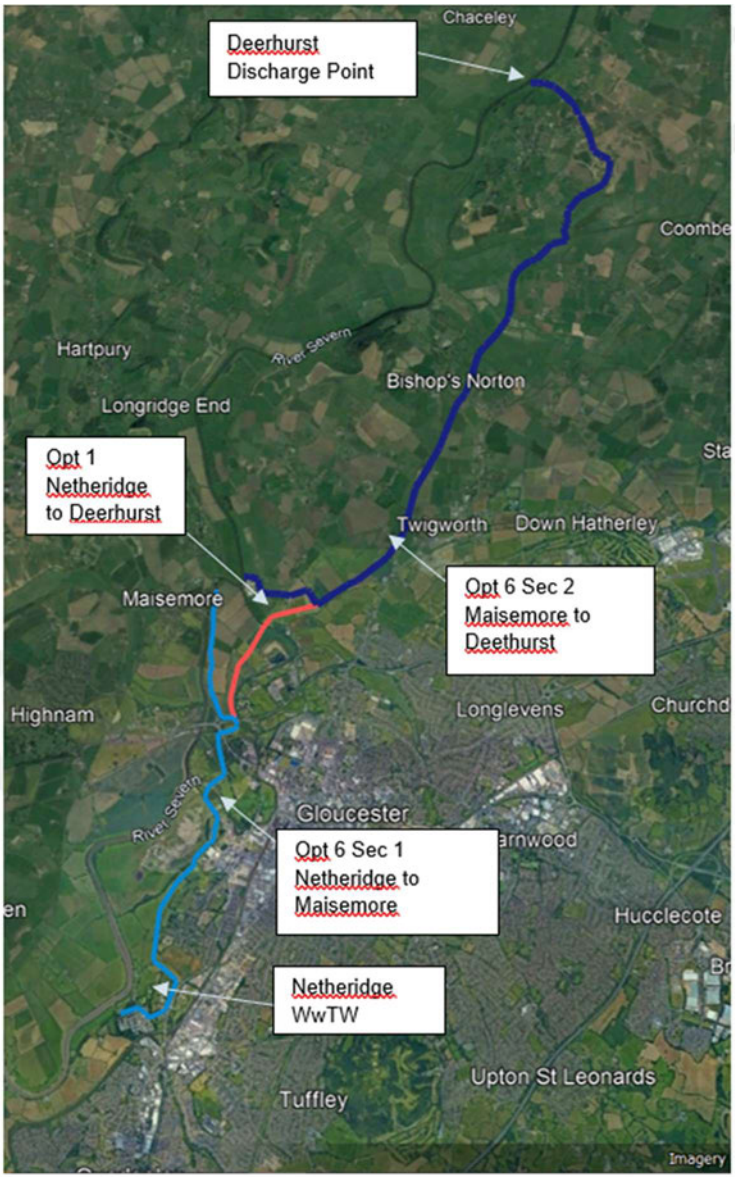


Figure 2-1 - Option 6 – Route overview

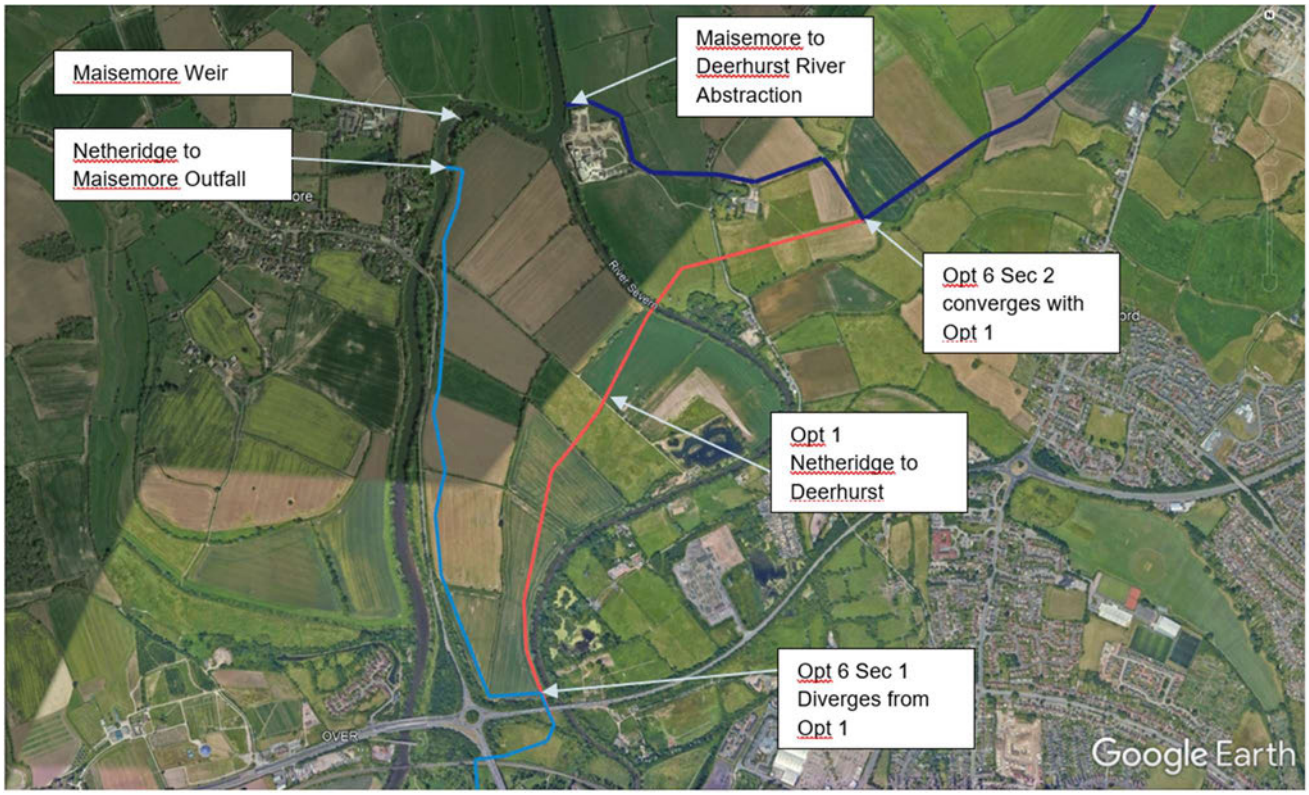


Figure 2-2 - Option 6 vs Option 1 Routes Divergence and Convergence

Section 1 - Netheridge to Maisemore Weir

Section 1 of this option requires the construction of 7.3km of [redacted]mm dia pipeline between Netheridge and the proposed discharge point just downstream of the Maisemore Wier.

CH0 TO 5336

The pipeline route for section 1 follows the same route as Options 1 and 2, between the new transfer pumping station at Netheridge WwTW and the proposed drain point DP4 at CH 5284.

For full details of the upstream sections of the pipeline refer to Severn Trent Source SRO - Netheridge Pipeline Route Appraisal Report (Ref: Annex A2).

CH5336 TO 7366

At CH5336, just downstream of the drain point DP4 (CH5284) and the A40 over bridge, this pipeline route diverges to the northwest as shown in **Figure 2-2** - Option 6 vs Option 1 Routes Divergence and Convergence. The pipeline traverses gently undulating, generally flat lying open agricultural land for approximately 2km to the proposed discharge point, approximately 170m downstream of Maisemore Wier.

The proposed discharge point has been chosen because it is as close to the weir as possible without requiring construction in a private garden. The discharge is also to be located on the inside of a slight bend in the river channel and therefore is unlikely to be susceptible to bank scour.

The pipeline rises slightly from DP4 to the proposed outfall; therefore it is proposed that it may be drained at DP4 to the River Severn East channel when not in use, however this will require Netheridge effluent with no additional treatment being discharged into a non-tidal section of the east channel.

Section 2 - Maisemore Weir to Deerhurst.

Section 2 of this option requires the construction of 11.6km of [redacted]mm dia pipeline between the abstraction point upstream of the Maisemore Wier and discharge point at Deerhurst.

CH0 TO CH1331

The initial 1.3km of pipeline for this option is routed through open agricultural fields between the proposed intake pumping station and the point where it converges with the Option 1 pipeline route.

In this section the pipeline is required to cross two small water courses and Sandhurst Lane. It is anticipated that these crossings will be possible using open cut techniques. Based on the available ground level information the pipeline is expected to fall gradually from the intake pumping station to the convergence point with the Option 2 route.

When not in use the pipeline will drain at the drain point DP6 (Cox's Brook Crossing) at CH1837m. This is unlikely to be problematic given that Cox's Brook drains to the River Severn East channel.

CHAINAGE CH 1331 TO 11665

Downstream of CH1560 the pipeline route follows and shares the same characteristics and features (tunnels, drain points and hydraulic break chamber locations) as the Option 1 route. For full details of the upstream sections of the pipeline refer to Severn Trent Source SRO - Netheridge Pipeline Route Appraisal Report (Annex A2).

2.1.2. OPTION 7: MAISEMORE TO HAW BRIDGE

This option follows the same line and level as the latter part of the Option 2 pipeline route. It will require the construction of 9.3km of new [redacted]mm dia. rising main between the proposed abstraction point at Maisemore Weir and the discharge point at Haw Bridge, as shown in Figure 2-3 - Option 7 - Maisemore Weir to Haw Bridge.

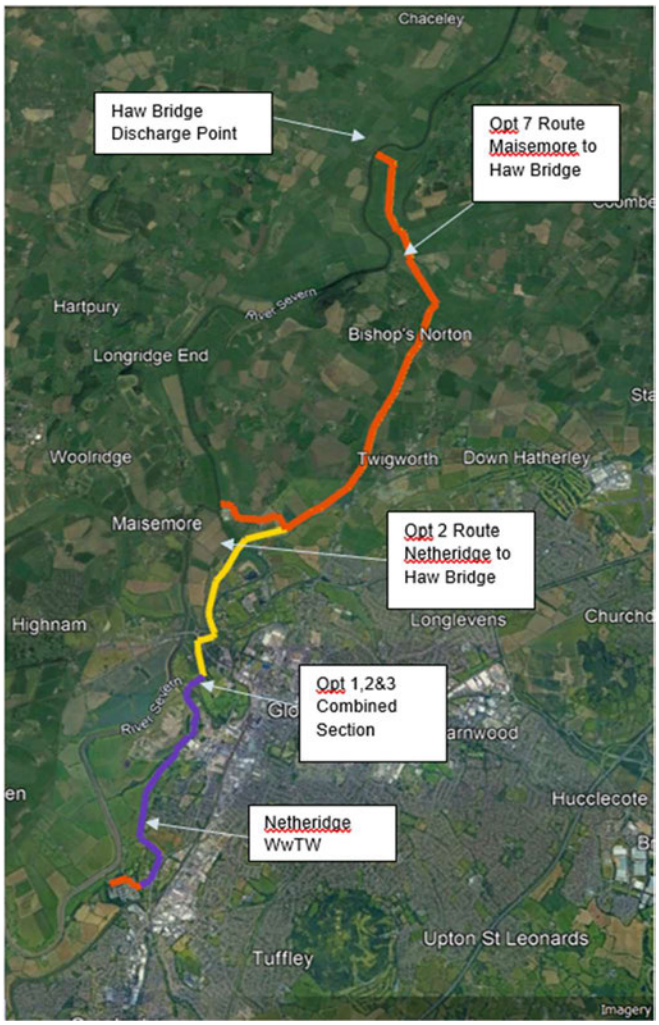


Figure 2-3 - Option 7 - Maisemore Weir to Haw Bridge

CH0 TO CH1331

The initial 1.3km of pipeline for this option is routed through open agricultural fields between the proposed intake pumping station and the point where it converges with the Option 2 pipeline route.

In this section the pipeline is required to cross two small water courses and Sandhurst Lane. It is anticipated that these crossings will be possible using open cut techniques. Based on the available ground level information the pipeline is expected to fall gradually from the intake pumping station to the convergence point with the Option 2 route.

When not in used the pipeline will drain at the drain point DP6 (Cox's Brook Crossing) at CH1837m.

CHAINAGE CH 1331 TO CH 9032

Downstream of CH1331 the pipeline route follows and shares the same characteristics and features, (tunnels, drain points and hydraulic break chamber locations) as the Option 2 route. For full details of the upstream sections of the pipeline refer to Severn Trent Source SRO - Netheridge Pipeline Route Appraisal Report (Annex A2).

2.2. HYDRAULIC DESIGN

A hydraulic analysis was carried out for each of the pipelines required for the two additional options in the same manner as for options 1 to 4.

With rising main lengths and head-losses of the same order of magnitude as options 1-4, and the flowrate unchanged, a pipeline diameter of [redacted] is still expected to provide the best balance between initial capital investment and ongoing operational costs (pump power costs).

Option 6 section 1 is a final effluent transfer from Netheridge WwTW to Maisemore Weir. As additional treatment is not included in this option, the analysis has used sewer roughness figures for the pipeline. The pipeline profile overall is downhill. This is likely to be due to Netheridge WwTW being built on higher ground relative to the River Severn locally to avoid flooding. The hydraulic grade line of the existing Netheridge WwTW process is not known and it is expected that the final effluent would need to be lifted to reach the pipeline profile start elevation of approx. 15mAOD. With these unknowns and the need to produce the required flow rate with a feasible pipeline size, pumping is considered to be required. However, there is an opportunity to consider a full gravity pipeline in subsequent design stages once further information on elevations is available. The pump size is comparable to the treatment interstage pumps for options 1-4. For option 6 section 1, a wet-well pumping station would be proposed which would have a similar footprint and cost to the interstage pumping stations, with the addition of surge mitigation measures.

Option 6 section 2 and Option 7 are raw water pumping mains, originating at a new river abstraction pumping station. For option 6 section 2, the pipeline profile shows two crests, one near the pipeline discharge - it is proposed to include a hydraulic break chamber at this point. The gravity section of this main from the hydraulic break chamber to the discharge outfall has the steepest average gradient of the options (1 in 42 fall). At this gradient, a [redacted] pipe would have a capacity of around 1800 l/s, much larger than the required 550 l/s. Therefore, for this gravity section, a diameter of [redacted] is proposed.

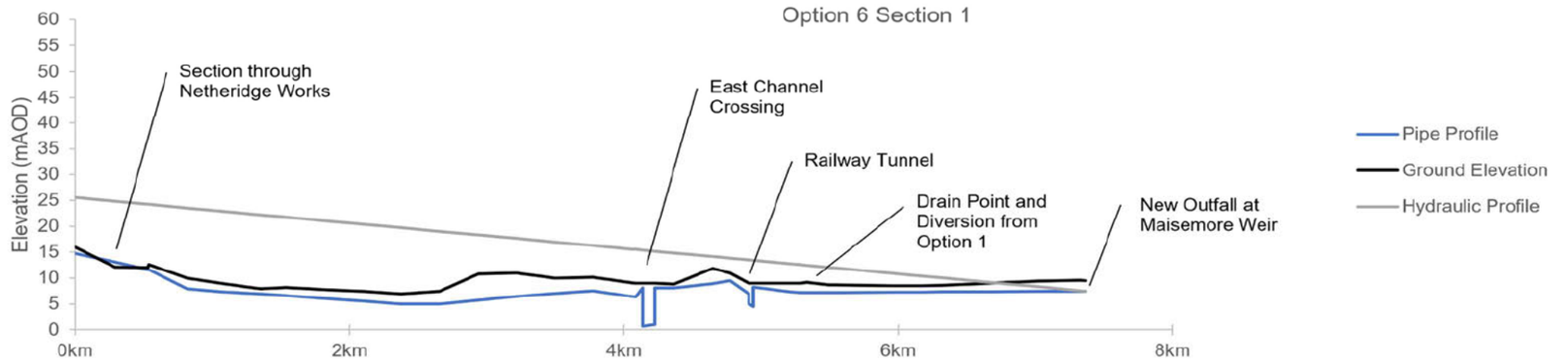
For Option 7, the pipeline profile shows a crest around the mid-point. At the outline design stage, it is considered necessary (to avoid negative pressures) and feasible (given the elevation drop) to gravitate from this crest to the discharge point, a distance of 3.5km. However, the profile of this gravity section is initially steep and then shallow for much of the distance. The impact of this is that the gravity main will mostly operate at full-bore. More detailed assessment of this condition will be required should this option be taken forward, to assess any operational issues that may occur because of the long shallow part of the gravity main. There is a risk that a second stage pumping station may be required subject to the outcome of more detailed analyses.

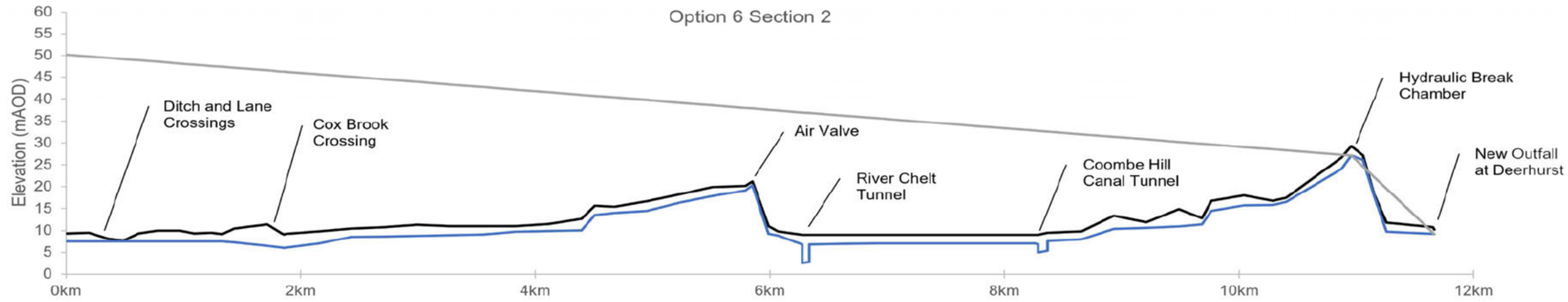
The total pump heads for Option 6 section 1, Option 6 section 2, and Option 7 are within the range of the total pump heads considered for options 1 to 4. Details are shown next to options 1 and 2 within Table 2-1– Hydraulic Calculations Summary.

Table 2-1 – Hydraulic Calculations Summary

Option	1	2	6 – 1	6 – 2	7
Design Flowrate Basis (l/s)	550	550	550	550	550
Total Pipeline Length (m)	17943	15587	7324	11388	9032
Rising Main Length (m)	17236	12129	7324	10681	5574
Rising Main Diameter (mm)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Velocity at Design Flowrate (m/s)	1.44	1.44	1.44	1.44	1.44
Roughness (mm)	0.06	0.06	0.15	0.06	0.06
Pipe Friction Losses (m)	35.5	24.95	16.04	21.05	10.99
Fittings Losses (m)	2	2	2	2	2
Suction Level (m)	12	12	12.77	5	5
Discharge Level (m)	28.2	20.3	7.5	27.13	20.3
Geodetic Head (m)	16.2	8.3	-5.27	22.13	15.3
Total Pump Head (m)	53.7	35.25	12.77	45.18	28.29
Outline Design Sizing Basis THD (m)	55	36	13	46	29

It should be noted that the total transfer pumping power for Option 6 (considering both sections) is greater than the transfer pumping power required for the other options. The power consumption is approximately double that required for Option 7.





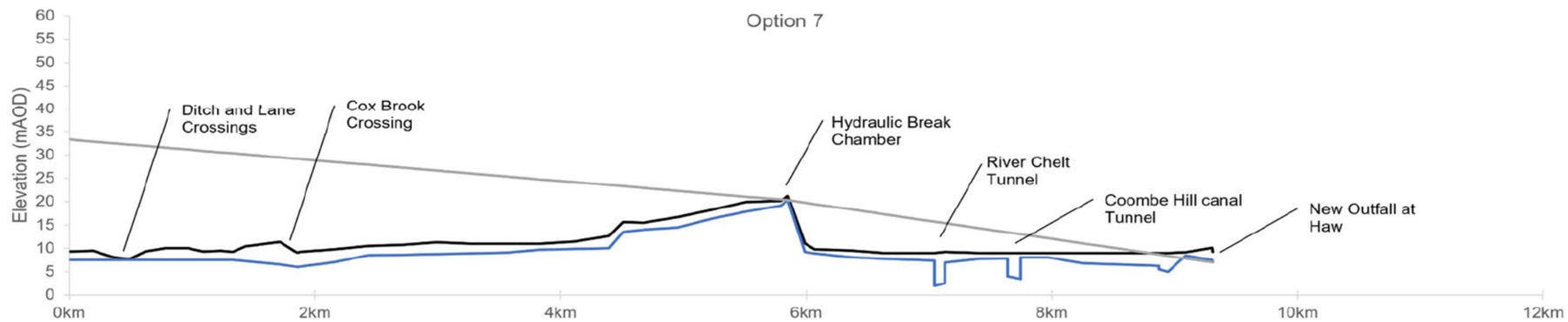


Figure 2-4 - Hydraulic Profiles for Options 6 and 7

2.3. CIVILS STRUCTURES

2.3.1. TRANSFER PUMP STATION 1 (NETHERIDGE WWTW)

This option assumes that final effluent will be diverted to a transfer pump station just prior to discharge to the River Severn at Netheridge WwTW in a similar manner to Options 1, 2 and 3, with the pumpstation being of a similar size and location within Netheridge WwTW boundary.

Discharge Downstream of Maisemore Weir

A discharge location has been identified approximately 170m downstream of Maisemore Weir. The discharge structure will comprise a similar structure to that proposed for Options 1 and 2 with a submerged outfall discharging to the centre of the riverbed. The submerged discharge arrangement allows for the greatest degree of effluent mixing in the channel and has the lowest visual impact on the bank, post construction. A submerged outfall is also considered beneficial from a health and safety point of view.

2.3.2. TRANSFER PUMP STATION 2 (MAISEMORE)

Abstraction Upstream of Maisemore Weir

Option 6 will require the construction of a new river intake structure and pump station. A review of the stretch of river upstream of Maisemore Wier has allowed identification of a possible site to the immediate north of an existing industrial site, 120m upstream of the River Severn and East Channel flow divergence point. This section of river is relatively straight reducing the risk of bank scour or sediment deposition at the site of the intake structure usually associated with locations on the outside or inside of bends respectively. This section of the river is not tidal but is affected by the River Seven Bore.

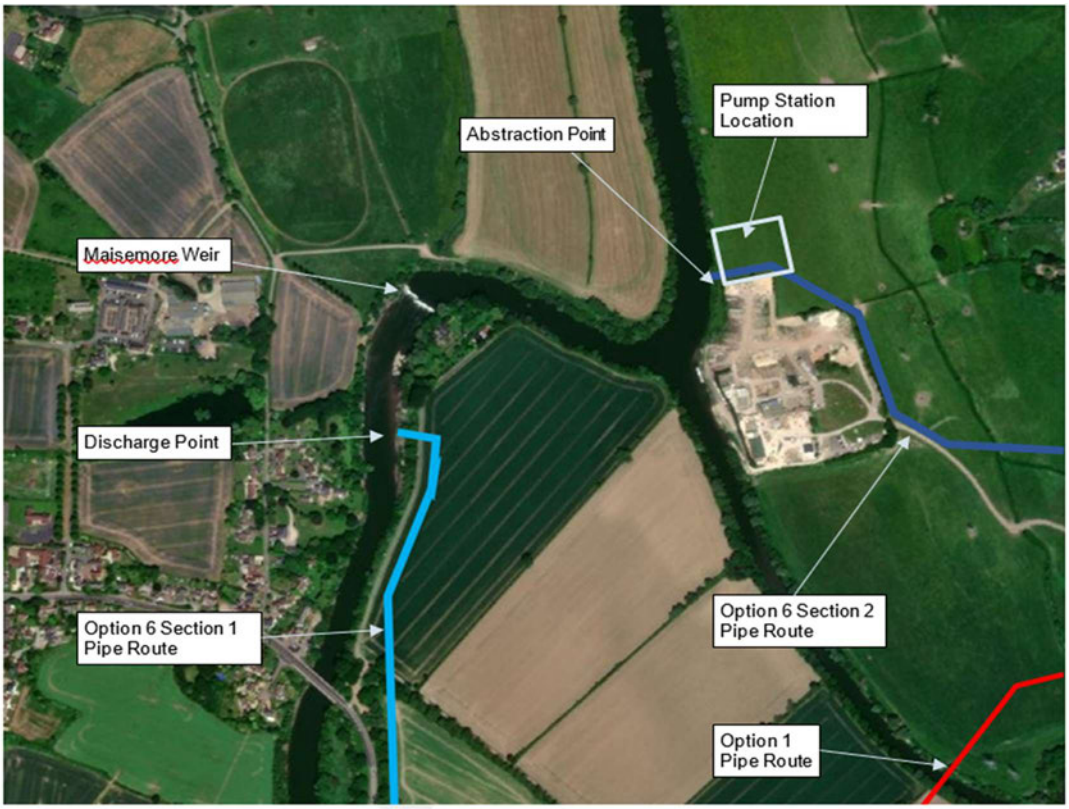


Figure 2-5 - Maisemore Abstraction Point and Pump Station Location

The River Severn is a known habitat for European eels which are legally protected, as such any intake will require a substantial screen structure to prevent the passage of eels and more particularly elvers into the intake pumps.

Fine spaced screening mesh of 1-2mm is required to prevent the passage of elvers into the intake. This significantly reduces the hydraulic capacity of the screen, therefore a much larger surface area is required to allow the passage of water through the screens to prevent starvation of the pump suction.

Fine mesh screens such as this are particularly susceptible to blockage by floating debris and aquatic life, (plants and animal). Initial investigations suggest that eel screens will likely be a large powered rotating screen system which self-cleans and returns removed trash back to the river via a trash pipe on the downstream side. A typical intake pumping station with eel screens is shown in

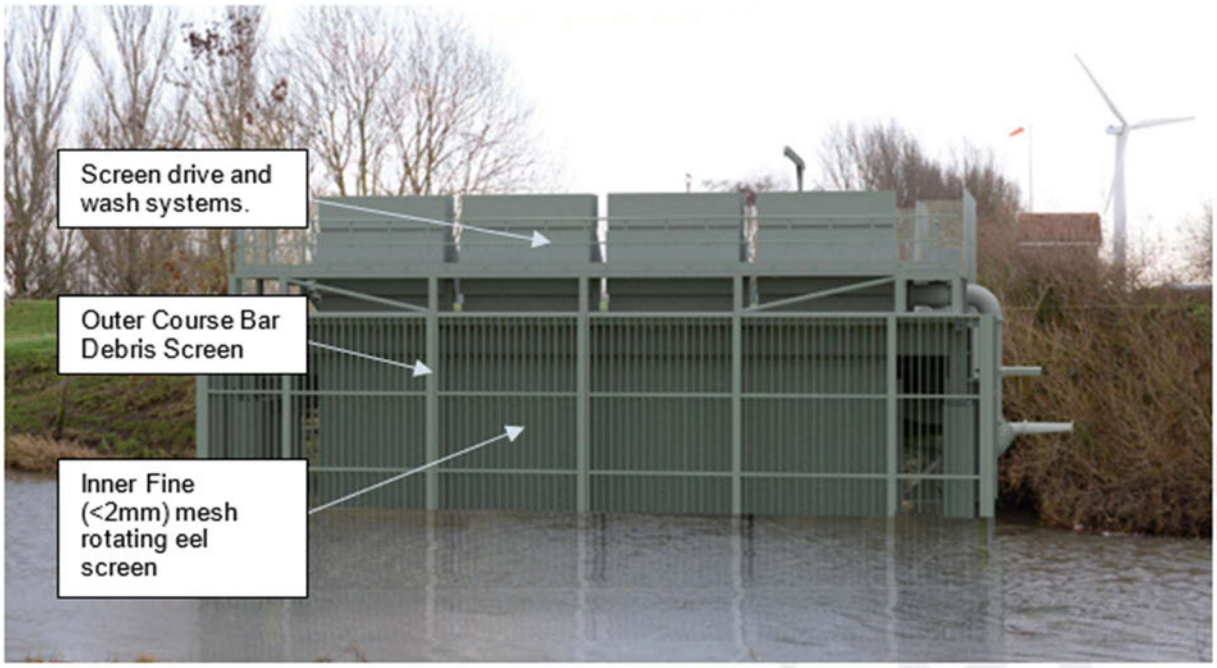


Figure 2-6 - Typical Eel Screen Arrangement for River Intake Structure

However, alternative methods of screening are being developed which will reduce the size and hence visual impact of the intake structure required. This technology being developed by Hydrok involves adding static peak wedgewire screens to the intake pipes. These screens can be supplied to 2mm aperture size. These screens are backwashed with a mix of compressed air and water from within the intake pipe to remove accumulated debris. An example of this technology is shown in Figure 2-7- Pump Suction Manifold with Wedgewire Screens (Eliquo Hydrok ltd).

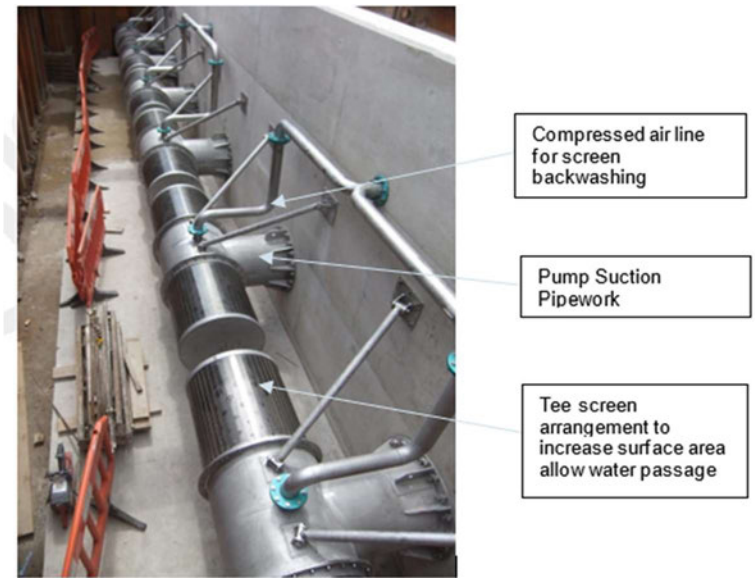


Figure 2-7 - Pump Suction Manifold with Wedgewire Screens (Eliquo Hydrok ltd)

The proposal for the Maisemore pump station arrangement is for a dry-well pumping station to be provided, abstracting water from a wet well behind the eel and debris screens. Either submersible-type pumps in a dry installation or end-suction pumps may be suitable for this application. Factors such as solids size and biological activity will be different for this application compared to untreated or treated Netheridge output.

A high-level hydraulic analysis of the pipeline routes indicates that the required transfer flowrate is readily achievable and informs the power supply requirements for the pumping station.

A secure compound area will be required around the abstraction point and the pump station structure. This will contain the pump station structure, electric transformers, control room, maintenance vehicle parking and turning areas. A permanent dedicated crane pad will be required to facilitate the safe lifting of pumps and screens for maintenance. Detailed site layouts have not been developed at this stage of the concept design.

Discharge at Deerhurst

The discharge structure and location will be the same as that proposed for Option 1 and will comprise a submerged outfall discharging to the centre of the riverbed.

2.4. MAISEMORE DISCHARGE AND PUMPING STATION GEOTECHNICAL REVIEW

Geological information available on the British Geological Surveys (BGS) Geo-index has been reviewed for the sites of both the proposed discharge and pump station. Extracts from the Geo-index are included in Appendix A.

Both sites are shown to be underlain by variable alluvial deposits comprising a mix of clay, silt sand and gravel, (river deposits) of the Quaternary Period.

However, it should be noted that no superficial deposits are recorded on the western bank of the River Severn at both locations indicating that superficial deposits are likely to be thin with rockhead encountered at shallow depth.

The superficial deposits are shown to be underlain by bedrock geology comprising interbedded Mudstone and Limestone, of the Rugby Limestone Member formed approximately 191 to 201 million years ago in the Jurassic Period.

There are no published BGS borehole logs in the immediate vicinity of either site, with the closest SO82SW83 being located approximately 700m to the south of the proposed outfall location. This borehole encountered mixed alluvial deposits to a depth of 8.3m bgl (0.60m AOD), stiff and very stiff clay underlies the alluvium to 10.23m bgl (-1.3mAOD). Weak thickly bedded mudstone was then encountered to the termination of the borehole at 15.20m bgl (-6.30m AOD). Groundwater ingress was recorded at 3.0m bgl (5.90m AOD).

Borehole log SO82SW49 is located approximately 900m to the southeast of the pumping station location. This borehole encountered an initial 0.9m thick layer of made ground, overlying mixed alluvial deposits comprising silt sand and clays to a depth of 6.2m bgl, overlying stiff clay to a depth of 8.7m bgl where the borehole was terminated. Rockhead was not encountered in this borehole. Running groundwater was encountered in this borehole at 4.8m bgl.

Preliminary interpretation of the geological conditions at the site indicates that there are unlikely to be any significant issues associated with completing the necessary excavations required for the construction of the outfall or pumping station. However, the presence of groundwater and the need for groundwater control should be anticipated. The available borehole information indicates that shallow rockhead and the need for excavations in rock are unlikely to be an issue. However, these boreholes are located a significant distance from the proposed construction sites and may not truly represent the ground and groundwater conditions at the proposed outfall and pump station construction locations.

2.4.1. MAISEMORE PUMPING STATION POWER REQUIREMENTS

The proposed river intake pumping station is expected to require a power supply in the order of 500kW. Loads comprise mainly the pumps and powered eel screens, with an allowance for other ancillaries.

A review of DNO network mapping for the area shows that there is an existing 11kv underground cable feeding the architectural salvage yard to the south of the proposed intake pumping station site.

This supply is noted to have been a supply to a former tar works that occupied the site. In its current use as an architectural salvage yard, it is expected that the power demand is much lower than the original supply to the tar works. Therefore, it is anticipated that it will be possible to supply the new

pump station from this feed with a relatively short length of new cabling and a new transformer being required.

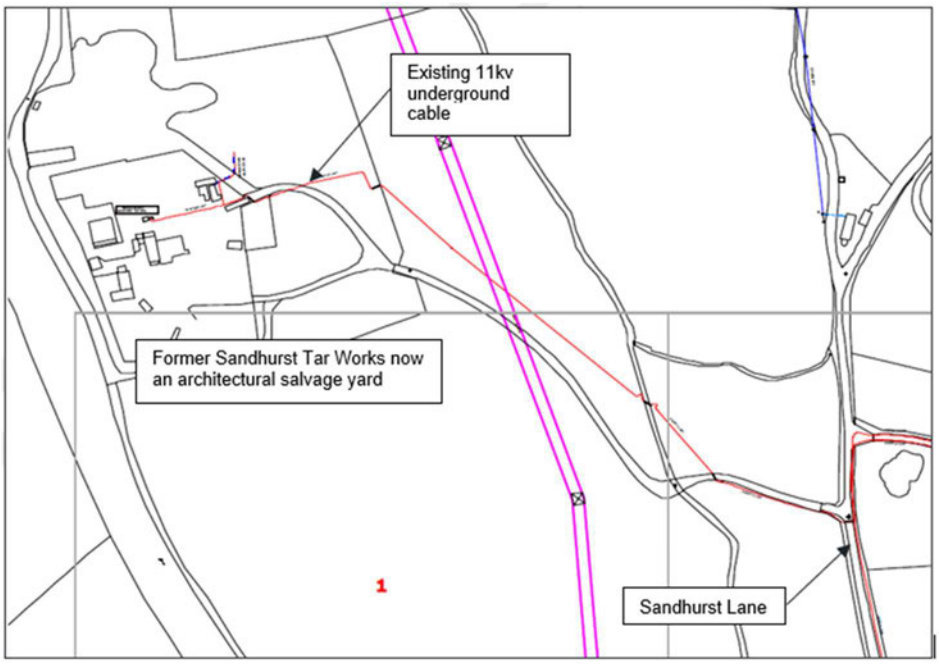


Figure 2-8 - Extract from DNO (Western Power) Mapping

2.5. OPERATIONAL CONSIDERATIONS

For the purpose of assessing the two alternative options it has been assumed that the Netheridge SRO will operate on the same basis as described in the Concept Deign Report with the pipeline system being drained when flows are not required by the STT SRO.

For Options 1 to 3 the effluent in the pipeline will have undergone additional treatment to reduce the level of nutrients and other pollutants in the final effluent. On the basis that the final effluent would be suitable for discharge to a freshwater section of the River Severn, it was considered likely that a slow release of the effluent from the pipeline to the local river and stream system would also be acceptable to the EA. This is to be pursued with the EA during G3.

The alternative options being considered do not allow for any additional treatment, and so whilst the final effluent is of relatively good quality it may not be suitable for drainage release into smaller streams. Further investigation is required to determine if the proposed drain points are practical and feasible with a lower quality of effluent.

Overall control of the pipeline system will be straightforward with flow monitoring at the pump stations and at the discharge locations to allow for leak detection and monitoring of volumes supplied to the STT SRO and for EA compliance requirements.

3. SCHEME DELIVERY

3.1. CONSTRUCTION CONSIDERATIONS

The proposed Maisemore pump station is in a greenfield location to the north of an existing industrial site which is currently used as an architectural salvage yard. There is an existing macadam topped road to the salvage yard from Sandhurst Lane. It is likely that agreement could be made with the salvage yard owner to allow STW access along this track, meaning that an additional 375m of new access track would be required to create a permanent access to the new pump station compound.

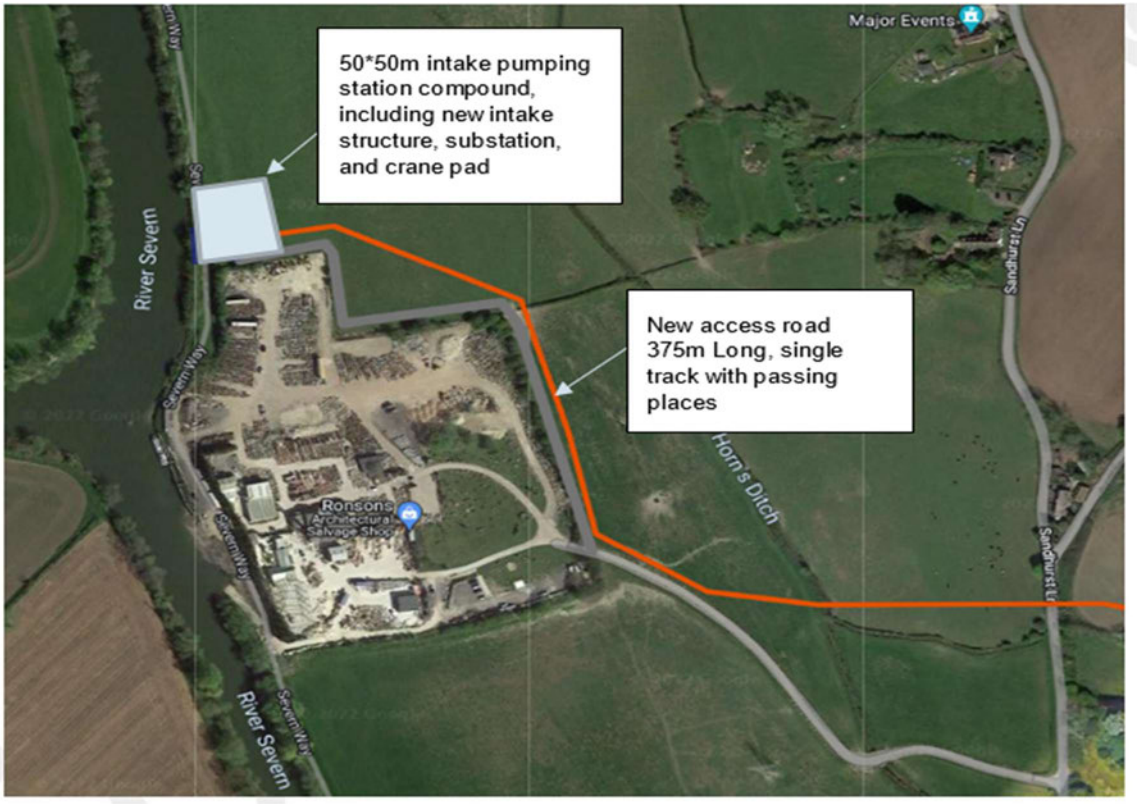


Figure 3-1 - Maisemore Abstraction and Pump Station Location

3.2. DELIVERY PROGRAMME

Delivery of Option 6 would follow a similar programme to that of Option 1 with a construction programme of 18 months assuming concurrent delivery of the discharge and abstraction infrastructure at Maisemore Weir. Option 7 would take less time to construct and could be completed within a 12-month period.

4. COST ESTIMATES

The cost estimates for the two options were developed as outlined in the Severn Trent Source SRO - Netheridge Cost Report (Annex A5). The same approach, methodology, and cost tools have been used throughout.

The following sections highlight the key outputs for the two options considered in this addendum report alongside the original five options considered for concept design.

4.1. CAPITAL COST ESTIMATES

Table 4-1 – Capital Cost Summary

Option No.	Option Name	Treatment Capex Cost	Pipeline Capex Cost	Overall Capex Cost
Option 1	Deerhurst	£69,797,800	£32,625,300	£102,423,100
Option 2	Haw Bridge	£69,797,800	£28,595,700	£98,393,500
Option 3	East Channel	£78,240,000	£9,921,500	£88,161,500
Option 4	Canal	£79,535,400	£2,421,400	£81,956,800
Option 5	Haw Bridge & East Channel	£8,442,200	£848,600	£9,290,800
Option 6	**Netheridge to Deerhurst**	**£0**	**£36,213,400**	**£36,213,400**
Option 7	**Maisemore to Haw Bridge**	**£0**	**£18,609,800**	**£18,609,800**

4.2. OPERATIONAL COST ESTIMATES

Table 4-2 – Operational Cost Summary

Option No.	Option Name	Treatment Opex	Pipeline Opex	Annual Opex
Option 1	Deerhurst	£1,447,915	£217,745	£1,665,660
Option 2	Haw Bridge	£1,447,915	£171,422	£1,619,337
Option 3	East Channel	£1,485,967	£90,203	£1,576,170
Option 4	Canal	£1,504,087	£92,374	£1,596,462
Option 5	SW Branch	£38,052	£180,786	£218,838
Option 6	**Netheridge to Deerhurst**	**£0**	**£115,110**	**£115,110**
Option 7	**Maisemore to Haw Bridge**	**£0**	**£90,290**	**£90,290**

The operational cost estimates are based on transfer of 35Ml/d for 35 days of the year and transfer of a 20Ml/d sweetening flow for 120 days of the year.

4.3. NET PRESENT VALUE AND AVERAGE INCREMENTAL COST

The NPV and AIC template provided includes the OB value in the calculation, therefore, to ensure that the results for the alternative options are comparable to Option 1-5 the OB value of 27.00% has been applied – this is the OB value for the pipeline only sub-projects for Option 1 and 2.

No formal costed risk assessment was undertaken therefore an assumption of 15% of base capex costs has been included in the NPV for Options 6 and 7.

The NPV calculation has been set to match those for Options 1-5, with 6 years for design/development and 3 years for construction, with operational costs commencing in year 10.

Both NPV and AIC values shown before are for 'max utilisation'.

Table 4-3 – NPV and AIC Template Output

Option No.	Option Name	NPV Finance (£)	NPV Opex (£)	AIC (p/m^3)
Option 1	Deerhurst	£168,185,540	£76,874,965	93.08
Option 2	Haw Bridge	£163,915,721	£73,460,388	90.17
Option 3	East Channel	£154,520,009	£70,083,464	85.31
Option 4	Canal	£146,993,167	£71,329,031	82.93
Option 5	SW Branch	£15,092,002	£15,016,144	11.44
Option 6	**Netheridge to Deerhurst**	**£38,105,825**	**£7,250,533**	**17.23**
Option 7	**Maisemore to Haw Bridge**	**£19,734,269**	**£6,001,254**	**9.78**

4.4. SUMMARY OF COSTS

Option No	Option Name	Total Project Capex Cost	Annual Opex	NPV Finance	NPV Opex	AIC (p/m3)
Option 1	Deerhurst	£153,664,600	£1,665,660	£168,185,540	£76,874,965	93.08
Option 2	Haw Bridge	£147,644,600	£1,619,337	£163,915,721	£73,460,388	90.17
Option 3	East Channel	£128,500,700	£1,576,170	£154,520,009	£70,083,464	85.31
Option 4	Canal	£116,190,800	£1,596,462	£146,993,167	£71,329,031	82.93
Option 5	SW Branch	£13,478,400	£218,838	£15,092,002	£15,016,144	11.44
Option 6	**Netheridge to Deerhurst**	**£51,423,010**	**£115,110**	**£38,105,825**	**£7,250,533**	**17.23**
Option 7	**Maisemore to Haw Bridge**	**£26,425,870**	**£90,290**	**£19,734,269**	**£6,001,254**	**9.78**

5. CARBON ESTIMATES

The carbon estimates for the two options were developed as outlined in the Severn Trent Source SRO - Netheridge Carbon Report (Annex A4). The same approach, methodology, and carbon tools have been used throughout.

The following tables highlight the key outputs for the two options considered in this addendum report alongside the original five options considered for concept design. The carbon for option 5 represents the additional carbon to option 1 or 2 for the branched pipework into the East Channel.

Table 5-1 – Construction Embodied Carbon Summary

Option No.	Option Name	Construction Embodied Carbon Pipeline (tCO_2e)	Construction Embodied Carbon Treatment (tCO_2e)	Construction Embodied Carbon Total (tCO_2e)
Option 1	Deerhurst	11,931	4,439	16,370
Option 2	Haw Bridge	11,713	4,439	16,152
Option 3	East Channel	3,674	5,014	8,688
Option 4	Canal	903	6,562	7,466
Option 5	SW Branch	841	575	1,416
Option 6	**Netheridge to Deerhurst**	**13,960**	**0**	**13,960**
Option 7	**Maisemore to Haw Bridge**	**7,349**	**0**	**7,349**

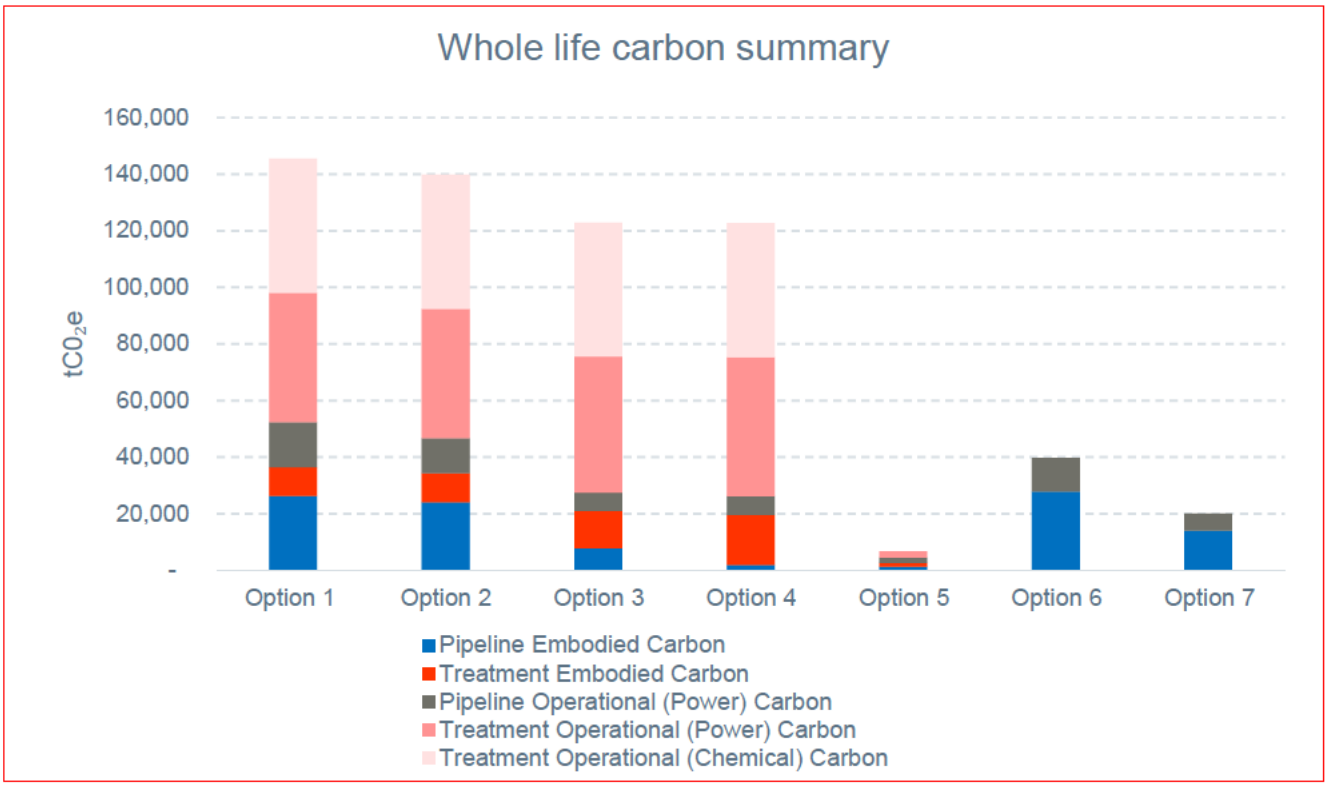
Table 5-2 – Annual Operational Carbon Summary

Option No.	Option Name	Annual Operational Carbon Pipeline (tCO_2e/year)	Annual Operational Carbon Treatment (tCO_2e/year)	Annual Operational Carbon Total (tCO_2e/year)
Option 1	Deerhurst	223	1,313	1,536
Option 2	Haw Bridge	174	1,313	1,487
Option 3	East Channel	91	1,345	1,436
Option 4	Canal	93	1,360	1,453
Option 5	SW Branch	25	32	57
Option 6	**Netheridge to Deerhurst**	**168**	**0**	**168**
Option 7	**Maisemore to Haw Bridge**	**85**	**0**	**85**

Table 5-3 – Whole Life Carbon Summary (80 year assessment period)

Option No.	Option Name	Total Whole Life Carbon (tCO_2e)	Total Whole Life Carbon (£)
Option 1	Deerhurst	145,473	£18,521,648
Option 2	Haw Bridge	139,819	£17,824,490
Option 3	East Channel	122,856	£15,525,718
Option 4	Canal	122,669	£15,170,716
Option 5	SW Branch	6,599	£909,887
Option 6	**Netheridge to Deerhurst**	**39,716**	**£5,668,354**
Option 7	**Maisemore to Haw Bridge**	**19,924**	**£2,907,206**

Figure 5-1 - Whole Life Carbon Summary



The total carbon for Options 6 and 7 is significantly lower than for the options that require treatment.

For Options 1 to 4 much of the total carbon is from the operation of the treatment plant. Removal of the treatment elements from Options 6 and 7 has significantly reduced the total carbon.

Whilst Option 6 has additional infrastructure and two stage pumping, the total carbon is 73% less than Option 1. The pipe route is marginally longer but this is easily offset by the reduced carbon from the removal of treatment plant operation.

The total Carbon for Option 7 is 85% less than Option 2 as the pipeline is 6.2 km shorter and there is no associated treatment. This option removes the treatment elements without any additional infrastructure and so it is the lowest carbon option overall.

Appendix A

GEOLOGICAL MAPPING EXTRACTS

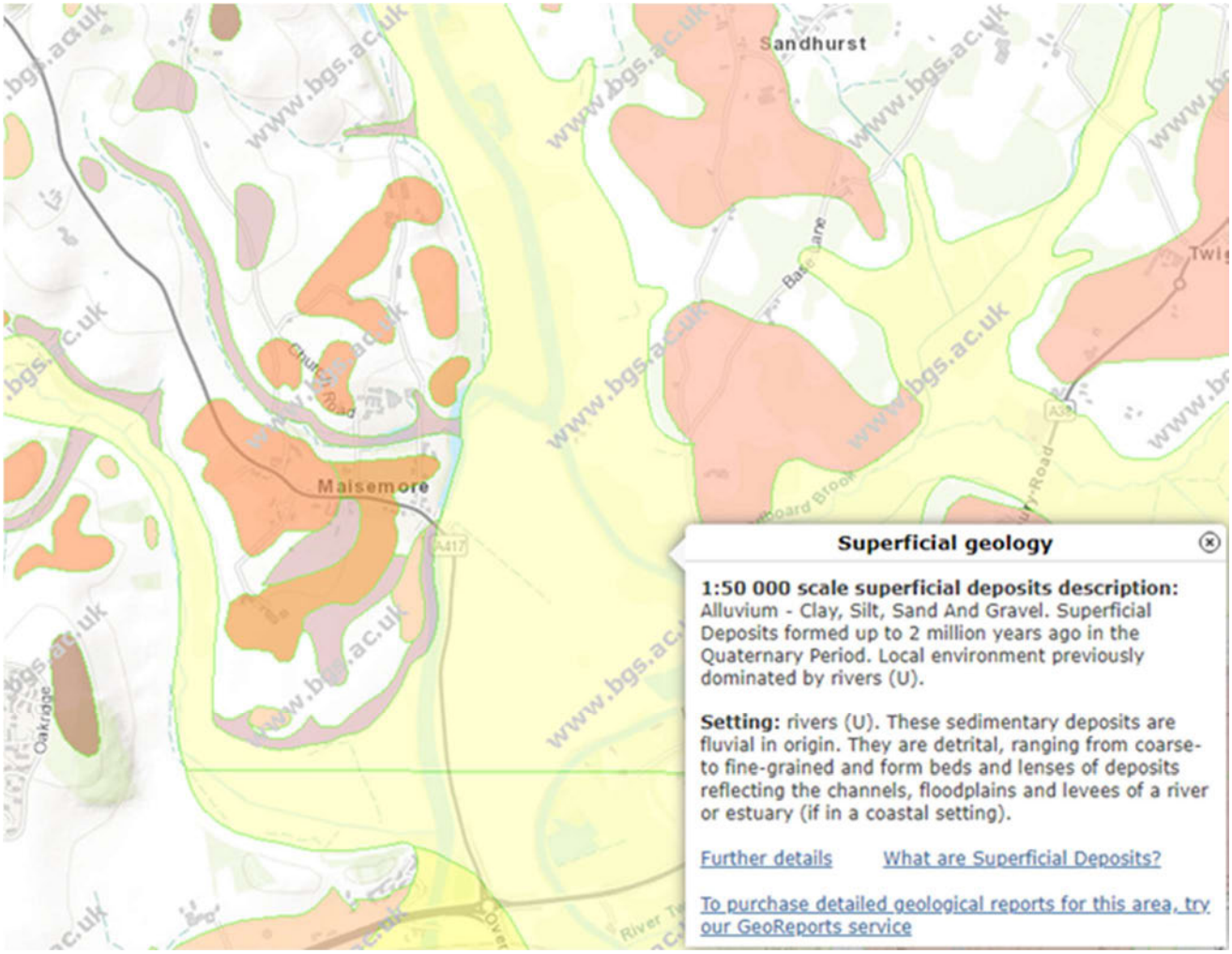


Figure A1: Superficial Deposit Geological Mapping, (BGS Geo-index)

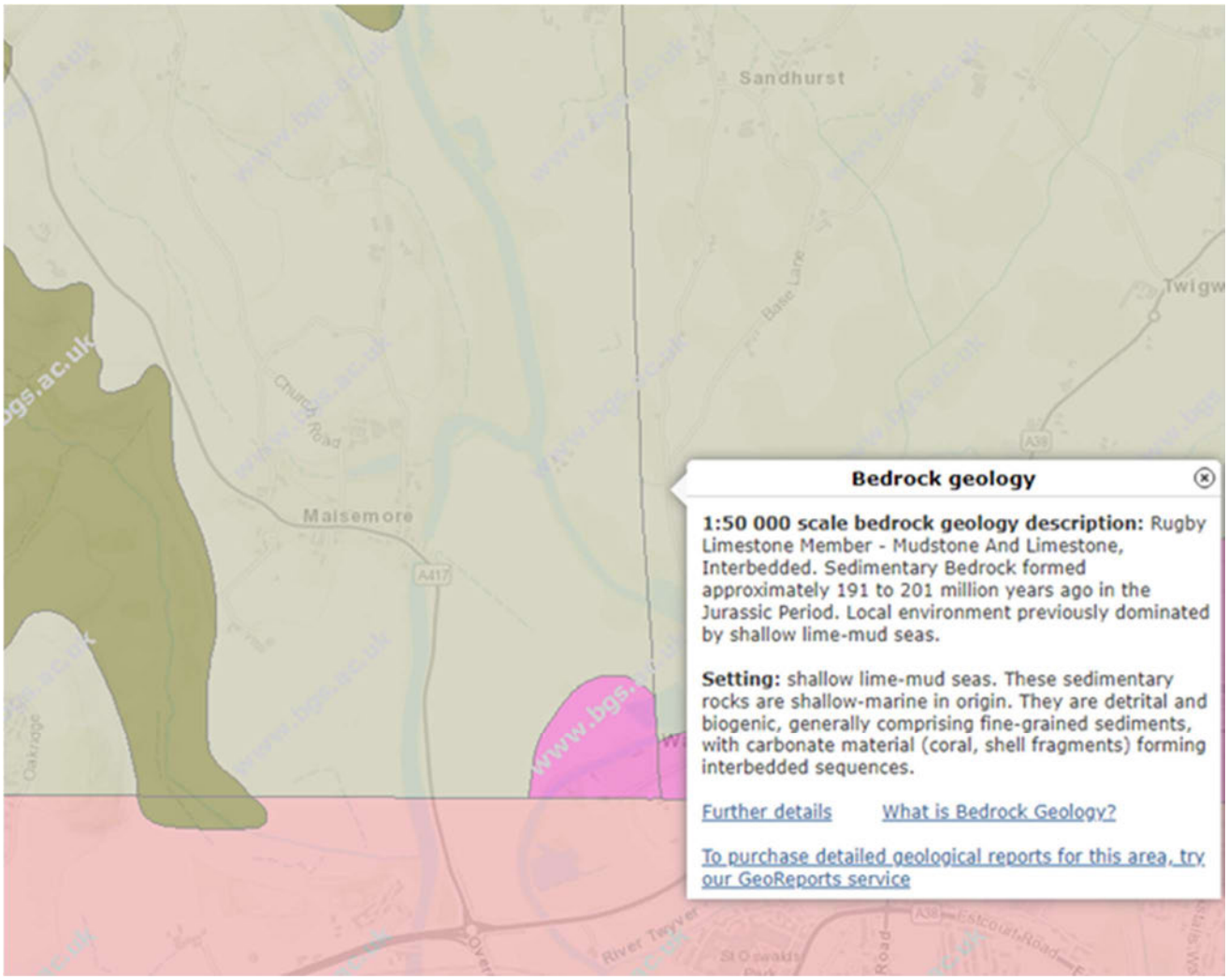


Figure A2: Bedrock Geology Geological Mapping, (BGS Geo-index)

Figure A3: Combined Superficial and Bedrock Geology with Published Borehole Records overlain (BGS Geo-index)

Appendix B

COST SPREADSHEET

Figure B-1 - Option 6 CAPEX Costs (Cost Tool Lite)

SEVERN TRENT WATER

Element Reference:
Date Issued: March 2022

CAPEX Costs

ATKINS ARUP

Notice *Values are rounded*

These on-cost rates may be adjusted from the default values

Rate		B&C	M&E	Mains & Sewers	Total
	Standard Cost	£ 1,579,800	£ 1,387,800	£ 16,035,500	£ 19,003,100
	Non-Standard Cost	£ 2,522,300	£ 1,000,200	£ 1,478,000	£ 5,000,500
19.3%	Non-Standard Adjustment	£ 304,900	£ 267,800	£ 3,094,900	£ 3,667,600
	Construction Cost	**£ 4,407,000**	**£ 2,655,800**	**£ 20,608,400**	**£ 27,671,200**
0.0%	Design Fee	£ -	£ -	£ -	£ -
	Contractor D&B Cost	**£ 4,407,000**	**£ 2,655,800**	**£ 20,608,400**	**£ 27,671,200**
12.8%	Internal Costs	£ 563,700	£ 339,700	£ 2,635,800	£ 3,539,200
18.1%	External Costs	£ 796,800	£ 480,200	£ 3,726,000	£ 5,003,000
	Project Total	**£ 5,767,500**	**£ 3,475,700**	**£ 26,970,200**	**£ 36,213,400**
27.0%	Optimism Bias	£ 1,557,200	£ 938,400	£ 7,282,000	£ 9,777,600
	Business Case Cost Estimate	**£ 7,324,700**	**£ 4,414,100**	**£ 34,252,200**	**£ 45,991,000**

Figure B-2 - Option 7 CAPEX Costs (Cost Tool Lite)

SEVERN TRENT WATER

Element Reference:
Date Issued: March 2022

CAPEX Costs

ATKINS ARUP

Notice *Values are rounded*

These on-cost rates may be adjusted from the default values

Rate		B&C	M&E	Mains & Sewers	Total
	Standard Cost	£ 913,800	£ 803,600	£ 7,658,100	£ 9,375,500
	Non-Standard Cost	£ 2,035,000	£ -	£ 1,000,200	£ 3,035,200
19.3%	Non-Standard Adjustment	£ 176,400	£ 155,100	£ 1,478,000	£ 1,809,500
	Construction Cost	**£ 3,125,200**	**£ 958,700**	**£ 10,136,300**	**£ 14,220,200**
0.0%	Design Fee	£ -	£ -	£ -	£ -
	Contractor D&B Cost	**£ 3,125,200**	**£ 958,700**	**£ 10,136,300**	**£ 14,220,200**
12.8%	Internal Costs	£ 399,700	£ 122,600	£ 1,296,400	£ 1,818,700
18.1%	External Costs	£ 565,000	£ 173,300	£ 1,832,600	£ 2,570,900
	Project Total	**£ 4,089,900**	**£ 1,254,600**	**£ 13,265,300**	**£ 18,609,800**
27.0%	Optimism Bias	£ 1,104,300	£ 338,700	£ 3,581,600	£ 5,024,600
	Business Case Cost Estimate	**£ 5,194,200**	**£ 1,593,300**	**£ 16,846,900**	**£ 23,634,400**

Key output information

	Min utilisation		Max utilisation	
NPV Finance	£ 38,105,825.05	£	38,105,825.05	£
NPV opex	£ 4,331,650.70	£	7,250,532.83	£
NPV WAFU	263,267,297		263,267,297	m3
AIC (p/m3)	16.12		17.23	p/m3

Figure B-3 - Option 6 Net Present Value Summary

Key output information

	Min utilisation		Max utilisation	
NPV Finance	£ 19,734,268.50	£	19,734,268.50	£
NPV opex	£ 3,523,532.41	£	6,001,253.77	£
NPV WAFU	263,267,297		263,267,297	m3
AIC (p/m3)	8.83		9.78	p/m3

Figure B-4 - Option 7 Net Present Value Summary

Appendix C

CARBON TOOL SPREADSHEET

Figure C-1 - STW Carbon Tool Spreadsheet Output (September 2022) – Pipeline Elements only

	Capital Carbon (tCO_2e)						
Element	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Site Preperation	560	560	560	150	560	2242	1681
Foundations	0	0	0	0	0	0	0
Pipeworks	8,993	7,670	2,291	515	202	9413	4471
Manholes	23	22	18	0	0	24	11
Concrete Tanks	134	134	45	24	24	86	56
Buildings	66	66	0	0	0	0	0
Walls	0	0	0	0	0	0	0
Site Access	727	2,694	331	187	54	1125	678
Refurbishment Activities	0	0	0	0	0	0	0
Nature Based Solutions	0	0	0	0	0	0	0
Other Civil Materials	0	0	0	0	0	0	0
M&E	1,428	566	429	27	0	1072	452
Total	**11,931**	**11,713**	**3,674**	**903**	**841**	**13,960**	**7,349**

	Operational Carbon (tCO_2e)						
	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Power	223	174	91	93	25	168	85
Fuel	-	-	-	-	-	-	-
Chemicals - Water	-	-	-	-	-	-	-
Chemicals - Wastewater	-	-	-	-	-	-	-
Sludge Tankering	-	-	-	-	-	-	-
Total	**223**	**174**	**91**	**93**	**25**	**168**	**85**

	Repeat Capital Carbon (tCO_2e)						
	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
M&E (20 years)	1,428	566	429	27	0	1,072	452
Civils (60 years)	9,943	10,587	2,685	727	281	10,647	5,216
Total	**14,227**	**12,284**	**3,972**	**807**	**281**	**13,862**	**6,573**

	Whole Life Carbon (80 year assessment period. 71 year operation period) (tCO_2e)						
	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7
Capital	11,931	11,713	3,674	903	841	13,960	7,349
Operational	=C106*71	12,347	6,455	6,618	1,746	3,350	1,691
Repeat Capital	14,227	12,284	3,972	807	281	13,862	6,573
Total	**41,997**	**36,344**	**14,100**	**8,328**	**2,867**	**31,173**	**15,613**

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