Draft Water Resources Management Plan 2024

Appendix E – Our Options

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Appendix E Our Options

E1 Overview

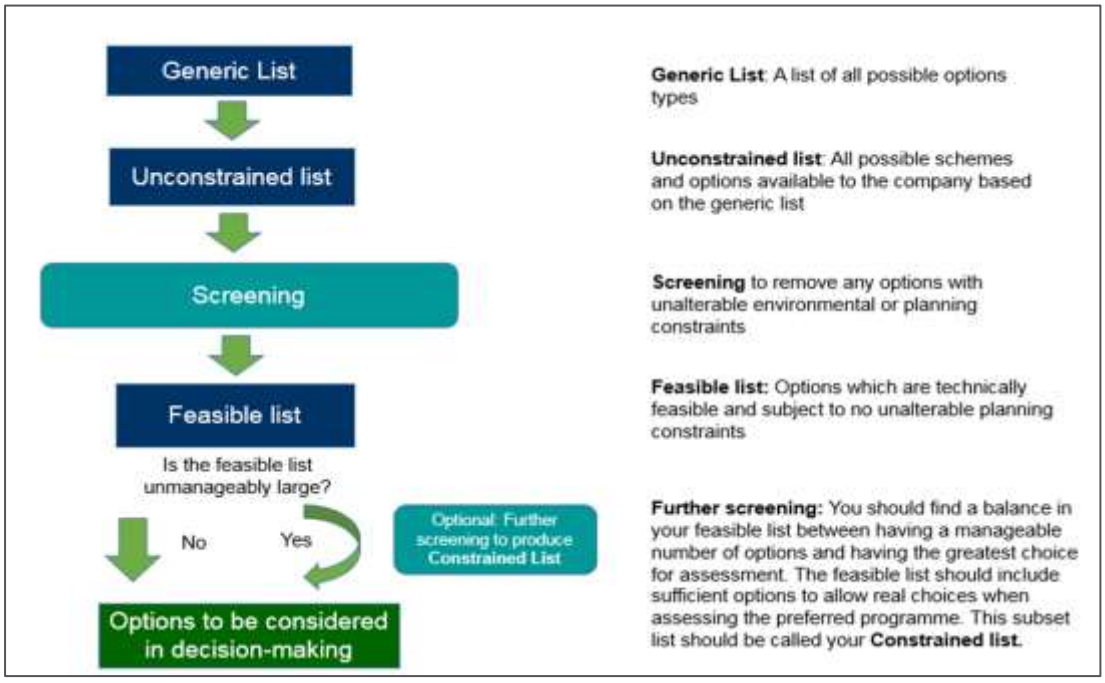
In appendix E we describe the stages we have gone through to assess our potential supply and demand options and the evidence we have gathered to give confidence in the solutions that we are recommending in our draft WRMP24.

Our dWRMP24 describes the actions we propose to take to maintain the long-term balance between supply and demand for water. Before we can make those recommendations, it is important that we can demonstrate that we have considered the widest possible range of potential options that might be available to us, and we need to be able to demonstrate why we believe our chosen options offer the best value.

To help us demonstrate this, we have followed a step-by-step process that allows us to demonstrate what options we have considered, how we have appraised them and whether we have rejected any options. The process we have followed was co-created with the other Water Resources West water companies in order that we can demonstrate a consistent, regional approach to supply and demand options appraisal. We have used common screening criteria for the options appraisal, and we have used common environmental and social criteria to help us quantify the costs and benefits of our different options. We have also considered options at a national and regional scale and not just at the water companies' WRMP scale.

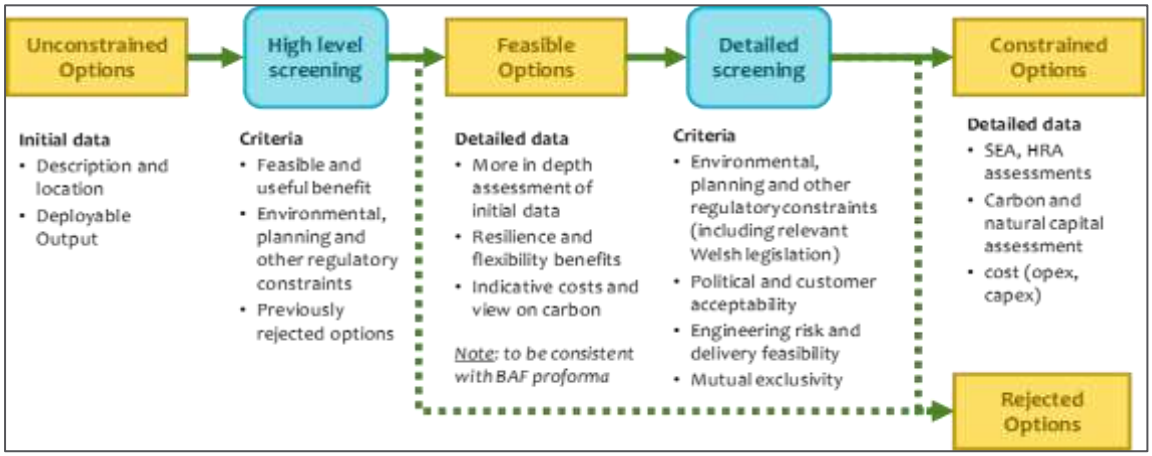
The WRMP options appraisal process is well established and the Environment Agency's water resources planning guidelines set out a series of clear expectations on what evidence should be considered. Figure E1.1 is taken from the water resources planning guidelines and illustrates the key steps in the options appraisal process.

Figure E1.1: The stages in the dWRMP24 options appraisal process



We have further developed the approach to make sure that our options appraisal is fully incorporated into the regional planning work and the wider environmental appraisal of options. Figure E1.2 illustrates the options appraisal stages we and the other Water Resources West companies have followed for our dWRMP24.

Figure E1.2: The stages of our options appraisal process



Source: Water Resources West "Option Development Methodology" v2.1 05Feb 21. (BAF = Bid Assessment Framework, SEA = Strategic Environmental Assessment, HRA = Habitat Risk Assessment).

In the following sections of Appendix E, we describe how we have taken our supply and demand options through each of these stages and how we have gathered the evidence to support the schemes that we are recommending in this draft plan.

E2 Unconstrained Options

The first stage in our options appraisal process is to gather together an unconstrained view of the possible actions that we might take to maintain the future supply and demand for water. This is an important stage in the dWRMP24 process because we need to take care not to reject options based on preconceptions of costs and benefits.

We have gathered information from a wide variety of sources to produce our comprehensive unconstrained list of options. We reviewed the lists of options considered in previous WRMPs, options considered in our Green Recovery investment plan, and we invited third parties to suggest ideas for multi-sector water resource schemes. We also took account of the conclusions from Rapid's review of options rejected at WRMP19 to make sure that we were not excluding options that could have national or regional role to play.

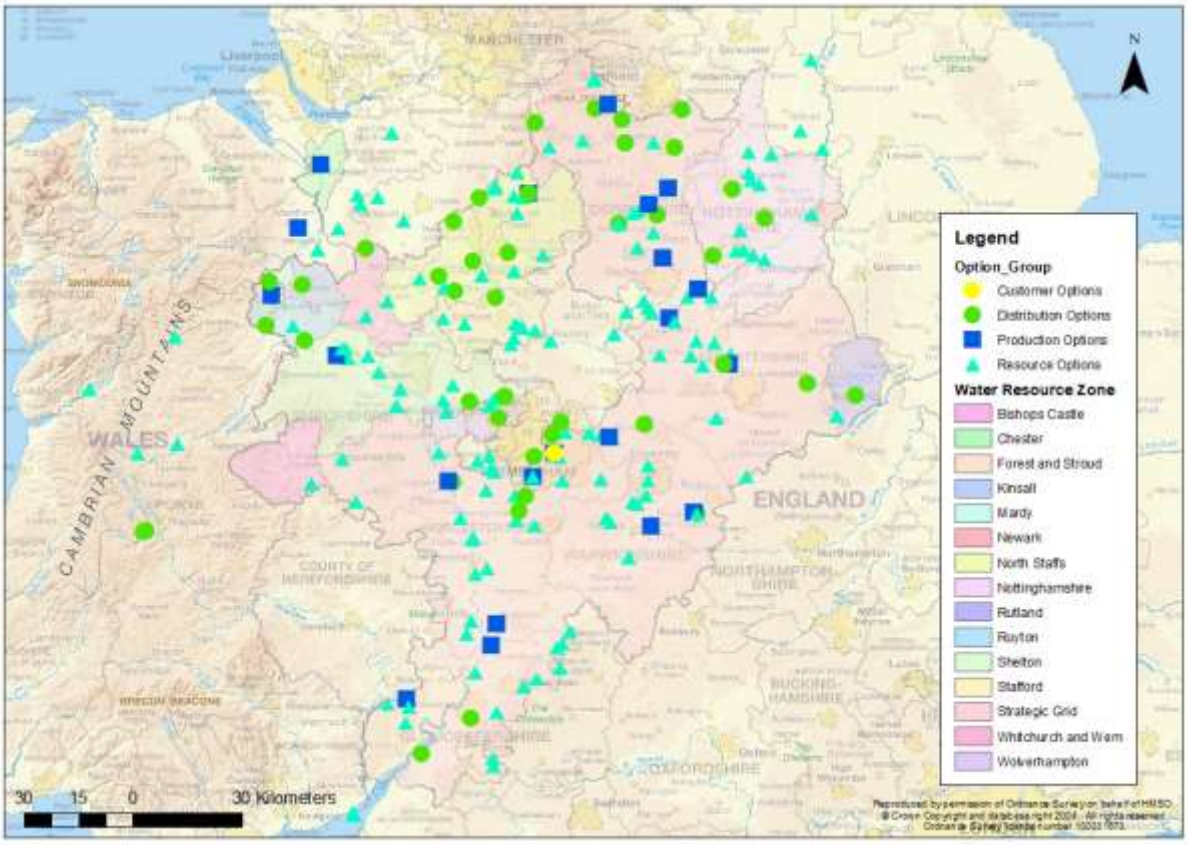
As a result, we generated an unconstrained list of over 325 supply and demand investment options. We have 20 demand options and 305 supply options as detailed in Table E2.1 below.

Table E2.1: Unconstrained Option categories

Option Group	Option Type	Number of Schemes
Customer Options		**20**
	Household water audit	4
	Metering change of occupancy	1
	Metering compulsory	3
	Metering optants	1
	Non-household water audit	1
	Other water efficiency	1
	Rainwater harvesting	2
	Retrofitting indoor water efficiency devices	3
	Water efficiency customer education / awareness	4
Distribution Options		**65**
	External potable bulk supply/transfer	21
	Internal potable transfer	15
	Trunk mains renewal/new	29
Production Options		**30**
	New/Enhanced pumping station	1
	Water treatment works capacity increase	28
	Water treatment works loss recovery	1
Resource Options		**210**
	Aquifer recharge/Aquifer storage recovery	9
	Desalination	1
	External raw water bulk supply/transfer	17
	Groundwater enhancement	73
	Internal raw water transfer	5
	International import	1
	Licence trading	6
	New Groundwater	22
	New reservoir	8
	New surface water	21
	New water treatment works	2
	Reservoir enlargement	21
	Surface water enhancement	13
	Water reuse	11
Total		**325**

The geographical locations of the different supply options are shown in Figure E2.1. The demand options are depicted by centre point as they are for all Water Resource Zones.

Figure E2.1: Location of unconstrained options



We then carried out a high-level screening review of this unconstrained list so that we could exclude any options that have obvious reasons that would prevent them from being constructed. Each of the Water Resources West companies used a common set of screening criteria so that we could be confident that we have a consistent approach to our understanding of options across the region. It is important to note that the capital and operating costs of a potential scheme do not form part of this initial screening stage. The common screening criteria are summarised in Table E2.1.

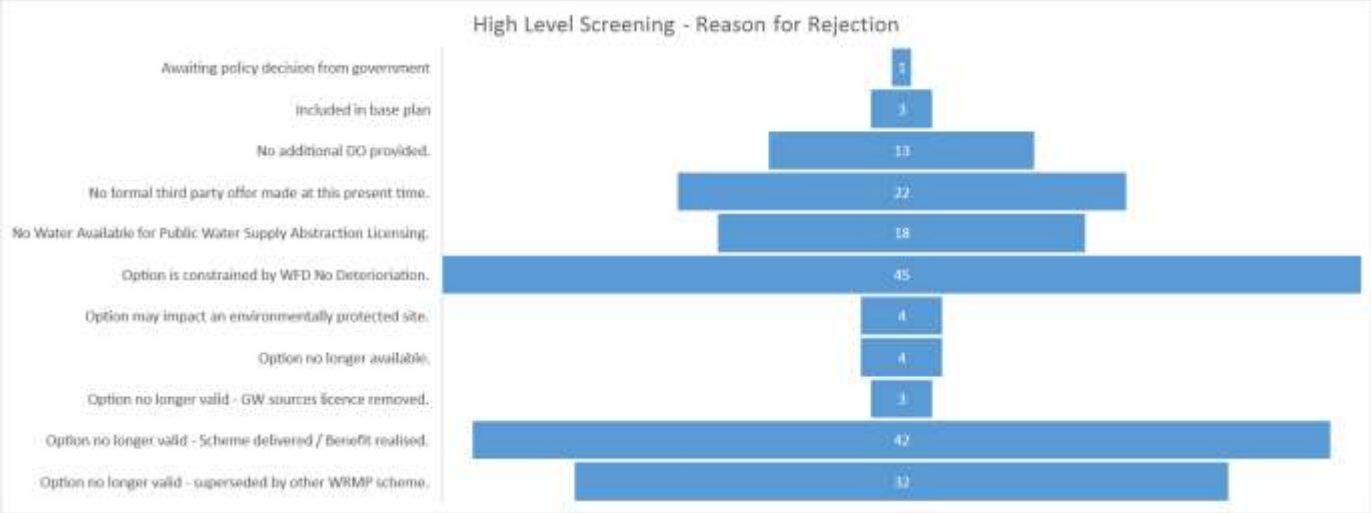
Table E2.2: High level screening criteria used to assess unconstrained options

High level Screening Criteria	
Option benefit	Is the likely scale of supply benefit (yield) to water companies and/or other sectors relative to the supply deficiency sufficient to proceed?
	Is the option in a location that makes deployment practicable?
	Is the option likely to be granted an abstraction licence or other necessary consent?
	Could the option offer supply / demand benefits at a regional or national scale?
Engineering risk and delivery feasibility	Is the engineering complexity such that it is highly unlikely to deliver the benefit stated i.e. is it technically feasible?
	Is the technology established with more than one example of in use at scale worldwide?
Environmental, planning and other regulatory constraints	Does the option cause unmitigable damage to a European designated site (SAC/SPA/Ramsar)?
	Does the option cause unmitigable damage to Nationally designated site (SSSI/NNR/National Park/Ancient Woodland)?

	Does the option cause unmitigable damage to Site with significant heritage or visual amenity value (e.g. Scheduled Ancient Monument or AONB)?
Political and customer acceptability	Is the option politically unacceptable such that it is unlikely to gain planning approval?
	Does it cause significant negative socio-economic impact than cannot be mitigated?

Using these screening criteria, we rejected 187 options from our plan at this early stage of appraisal. Figure E2.2 illustrates how many schemes were rejected for different reasons using the high-level screening criteria, with the majority being rejected due to unacceptable environmental risk largely linked to Water Framework Directive objectives.

Figure E2.2: Reasons for rejection through high level screening



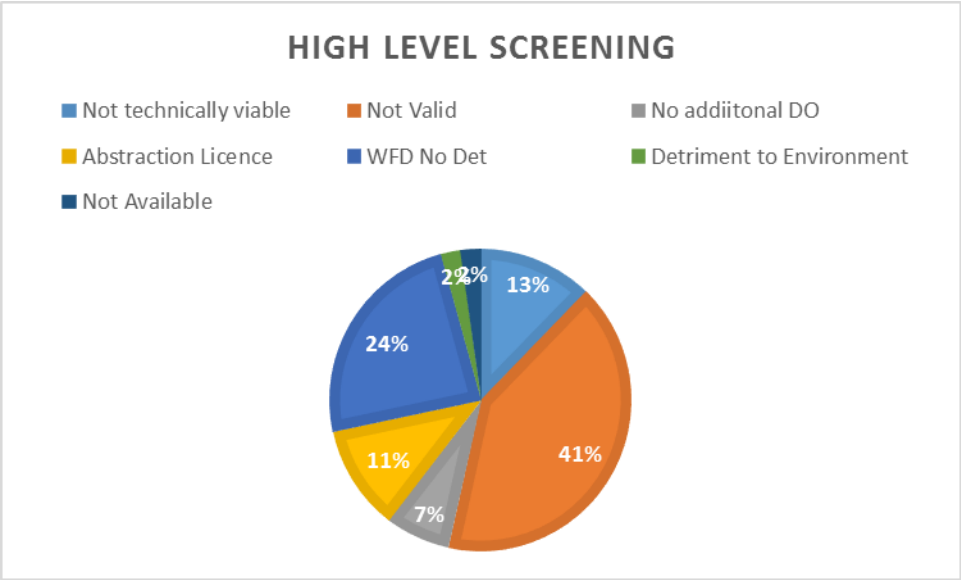
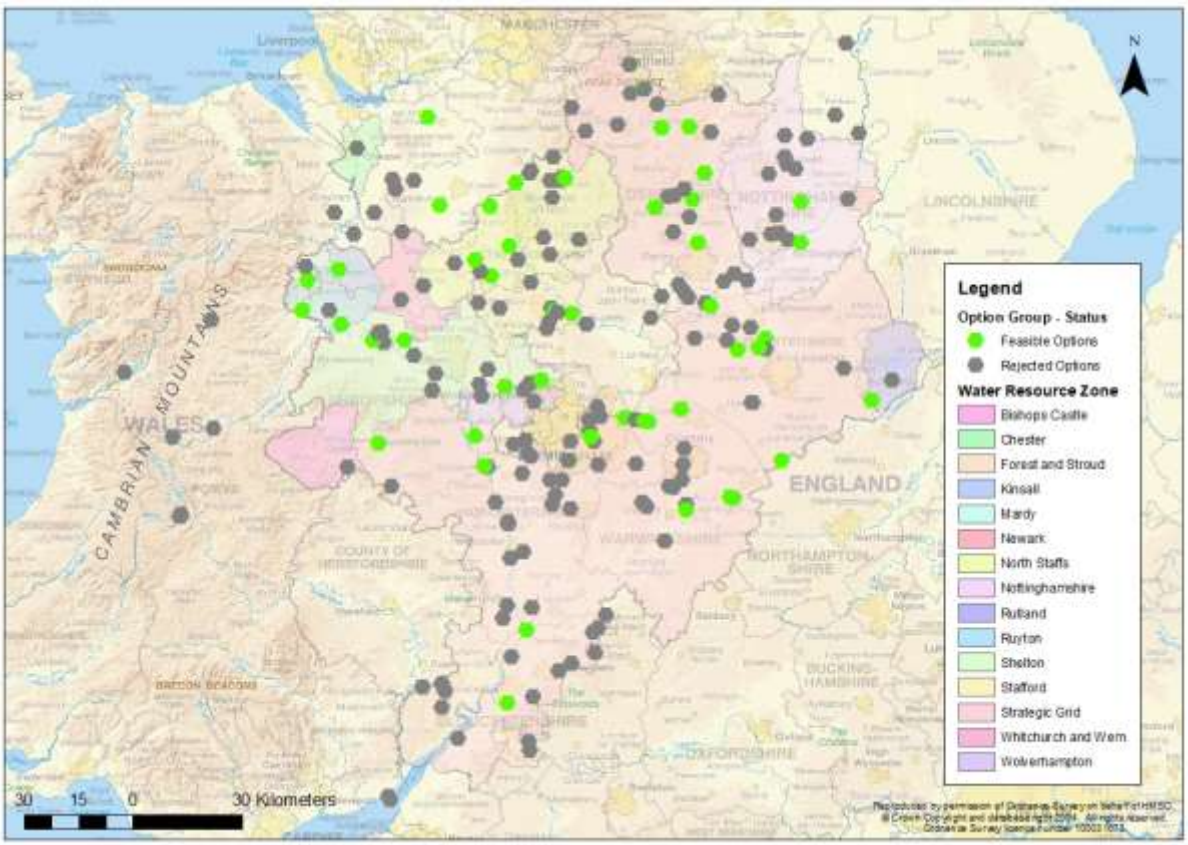


Table 4 in the dWRMP24 data capture system outlines each of the options we have considered and highlights whether they were screened out based on the above criteria.

Figure E2.3 shows the geographical location of the unconstrained options that have been rejected through the screening process out and how these compare with the locations of our remaining feasible options.

Figure E2.3: Location of feasible and rejected options



E3 Types of options

Our options appraisal approach has sought to assess the widest possible range of potential options that could be used to manage our future water supply and demand balance.

Where we have considered options that would involve enhancements to our existing public water supply system, our general preference is to prioritise options that will make more use of our existing, sustainable sources of water supply rather than developing new sources of water abstraction.

The full list of options considered in our draft plan is detailed in Table 4 of the dWRMP24 data capture system, and Table E3.1 below summarises the different types of options we have assessed.

Table E3.1: Option Type – Number of Feasible and Rejected options assessed

Option Group	Option Type	Feasible Options	Rejected (Unconstrained) Options
Customer Options		**10**	**10**
	Household water audit	1	3
	Metering change of occupancy	1	
	Metering compulsory	2	1
	Metering optants	1	
	Non-household water audit	1	
	Other water efficiency	0	1
	Rainwater harvesting	0	2
	Retrofitting indoor water efficiency devices	3	
	Water efficiency customer education / awareness	1	3
Distribution Options		**27**	**38**
	External potable bulk supply/transfer	7	14
	Internal potable transfer	13	2
	Trunk mains renewal/new	7	22
Production Options		**14**	**16**
	New/Enhanced pumping station	1	
	Water treatment works capacity increase	13	15
	Water treatment works loss recovery	0	1
Resource Options		**40**	**170**
	Aquifer recharge/Aquifer storage recovery	0	9
	Desalination	0	1
	External raw water bulk supply/transfer	5	12
	Groundwater enhancement	3	70
	Internal raw water transfer	3	2
	International import	0	1
	Licence trading	0	6
	New Groundwater	1	21
	New reservoir	3	5
	New surface water	8	13
	New water treatment works	0	2
	Reservoir enlargement	14	7
	Surface water enhancement	1	12
	Water reuse	2	9
Total		**91**	**234**

Throughout our options appraisal we have considered options outside of our existing public water supply system that would involve third parties, either through direct water trading, trading of abstraction rights or co-creation of assets. We have also explored what types of innovative new options may be needed in future as water resources become increasingly scarce.

E3.1 Third party options

Severn Trent has a strong track record of working with third parties and other sectors to find opportunities for innovation and water trading. Over recent years we have successfully acquired new water production capacity from other sectors by purchasing water abstraction rights that they no longer needed and we have used these to enhance our supply capability in a cost efficient and environmentally friendly way.

Recent examples include:

- We purchased the 31Ml/d abstraction licence on the River Severn from Ironbridge power station in 2016. This is being used to supplement our Trimpley water treatment works abstraction on the River Severn.
- We bought the 65Ml/d abstraction from Rugeley power station in 2021 and this will be used to enhance the supply capability at our Church Wilne water treatment works.
- We purchased the Buildwas abstraction licence in 2021 on the River Severn from a third party and this can be used to support abstraction during high demand periods.
- We bought a 2Ml/d groundwater licence from another third party in Nottinghamshire and that is being used to support groundwater output at one of our groundwater sources.

We have built on our recent successful third party trading experience and have worked with Water Resources West (WRW) and our stakeholders, to seek out further potential third-party options that could play a role in our long-term plan.

Where options have been identified they have been subject to the same high level screening process to assess whether they should go forward for more detailed feasibility assessment. For third party options to be taken forward for the more detailed decision making stage of our plan, they need to have the appropriate level of technical detail and in many cases the options have not been sufficiently mature for formal screening to be completed. If third party options have not been considered feasible to include the current round of planning, we will continue to work with the relevant parties and hope that more options and be assessed in the future versions of the plan.

Third party / multi-party options typically fall into the following categories:

Inter-company transfers
Inter-company transfers have been treated as bi-lateral trading options between water companies. Negotiations have taken place between the trading parties and the ultimate decision on whether to activate the transfer lies with the selling and buying companies.

We have re-reviewed all inter-company transfer options identified at WRMP19 and if they were screened out at WRMP19 we have reviewed the reason for rejection and whether it still stands. If a transfer option was considered feasible at WRMP19 then we have checked to confirm whether that option is still available. Any new transfer options or offers made since WRMP19 have also been captured.

For any inter-company transfer option, the selling company is responsible for providing a price for supplying the water and we have assessed the capital and operating costs of any asset enhancements needed to deploy this water from the delivery point into our network. Therefore, in the investment appraisal of options, we have assessed the overall cost of the scheme as the combination of capex + opex + price paid to seller.

Along with the other WRW companies, we reviewed the outputs from RAPID's transfer modelling project to identify any potential opportunities not previously identified.

Abstraction licence trading
Abstraction licence trades have been treated as bi-lateral trading options between Severn Trent and other licensed abstractors.

We reviewed our WRMP19 unconstrained options and if potential trades were screened out then we confirmed if that decision still stands. For any offered licences that were considered feasible at WRMP19, then we contacted the trading parties to confirmed that they are still available for the feasible list. We have also captured any new trading offers that have arisen since WRMP19.

We have also used public datasets to identify any other potential tradeable licences in zones with supply / demand needs. We have also screened these licence trading opportunities against the Environment Agency's latest Abstraction Licensing Strategy documents to understand whether there are restrictions on the tradable quantities.

There are close links with WRW's environmental destination and non-public water supply (PWS) workstreams which have also identified future abstraction licence needs and opportunities for other sectors.

Selling / Buying third party assets
We have explored the potential trading of assets with other water companies and other sectors. We reviewed all options identified at WRMP19 and if they were screened out at WRMP19 then we have reviewed the reason and whether it still stands. If a trading option was considered feasible at WRMP19 then we have contacted the trading parties to confirm whether the asset trade is still available. We have also captured any new asset purchase or sale requests that have been made since WRMP19.

If priced at WRMP19 then we have reviewed whether this price is still appropriate for use in optioneering. There is a close dependency with the environmental destination and non-public water supply workstreams – these will reveal local water body needs or constraints.

Multi-sector / multi-use options
Throughout our optioneering, we explored whether we could deliver multiple benefits and meet the needs of multiple sectors. At its highest level, the optioneering work for the plan has explored multi-party / multi-benefit options in the following ways:

I. Designing public water supply solutions in a way that they can provide added environmental and social benefits and then presenting them as part of a 'best value' plan. We have explored the potential added value using natural capital / ecosystem service / biodiversity net gain assessments and valuations to justify why these are 'better value' options.

II. Using catchment and nature-based solutions where these can provide a lower cost / better value way of achieving public water supply needs. These types of solutions will typically require third parties / other landowners and water companies could fund or subsidise them to do so. For example, water companies paying farmers to reduce agricultural runoff through their catchment management programme, paying or partnering with wildlife trusts etc to restore river habitats and therefore protect against the impacts of our abstractions and / or improve flood protection.

III. Explore opportunities to provide new water resources infrastructure that meets the needs of other sectors outside of public water supply. The Environment Agency's River Severn Water Management Scheme falls into this category where Severn Trent has worked with the Agency's flood alleviation project to explore multi-purpose / multi-use infrastructure.

IV. Identify needs and opportunities for shared development of resources in non-public water supply sectors. This has also been informed by WRW's Non-PWS workstream which has identified the shared needs and opportunities for other sectors around the region. Successful delivery of these schemes will rely on multi-sector funding streams and commercial models.

E3.2 Next Generation Options

While our unconstrained list of new supply options is extensive and varied, there are insufficient conventional options to meet the more extreme potential future supply / demand scenarios that we have identified. Environmental policy constraints, such as those required to meet Water Framework Directive objectives, mean that is increasingly challenging to develop conventional solutions that would increase abstraction from the natural water environment.

Therefore, we are investigating the unconventional, technological alternatives we may need to implement in future to maintain security of supply in the very long term beyond 2050. We have termed these 'next generation' options. These are options that are not typically used in the United Kingdom water sector currently, although there are many examples of their use elsewhere in the world.

Because these options are less conventional than traditional schemes, they carry more unknowns in terms of their cost, viability and deliverability. Often this means we have insufficient information with which to appraise them and so they cannot progress to our feasible options list for fuller development.

For this dWRMP24 we have commissioned work to help use better understand a range of next generation options with the intention that these can then be taken forward to our feasible option list at a later date. The types of schemes that we are investigating include:

- Final effluent reuse – we are exploring different options with deployable output estimates ranging from 5 to 90 Ml/d.
    - River augmentation
    - Planned indirect use
    - Industrial greywater reuse
    - Direct reuse
- Mine water reclamation – we are exploring different options with deployable output estimates ranging from 2 to 10 Ml/d;
- Aquifer Storage Recovery – we are investigating six different options with deployable output estimates ranging from 2.5 to 15 Ml/d;
- Desalination
- Other longer-term opportunities such as icebergs + fog harvesting

The scope of our next generation investigations includes:

- An engineering assessment to investigate how to deploy these new sources into the water supply network, manage water quality etc.
- Totex cost estimates
- Carbon impact assessment

- Environmental assessment (SEA, HRA, NCA, WFD, INNS and associated Metrics);
- Estimated deployable output benefit / Yield
- Construction timelines and risks
- Operating and maintenance regimes

We expect the first phase of our next generation options review to conclude by October 2022 after which we hope to have more certainty around which of these options could pass forward to our feasible options list for full consideration in future rounds of water resource planning.

E4 Feasible options

Following the high-level screening of our unconstrained list of options (187 rejections) we are left with a short list of those options we consider to be technically feasible and that should go forward for more detailed appraisal as part of our dWRMP24 (138 options). These feasible options have then been taken forward for more detailed design assessment, cost appraisal and environmental impact assessment. Table E4.1 summarises the more detailed feasibility criteria that we have used to further appraise each of the feasible options.

Table E4.1: Detailed screening criteria for feasible options

Detailed Screening Criteria	
Option benefit	Is the scheme mutually exclusive with a lower cost, higher benefit, less environmentally damaging option?
	Is the option dependent on another option that has been screened out?
	Is the option durable / viable in the long term?
	Is the option flexible to changing circumstances in demand?
Engineering risk and delivery feasibility	Can the option be developed within the required timescale to meet the WRZ deficit
Environmental, planning and other regulatory constraints	Does the option pass HRA compliance risks?
	Does the option increase the risk of flooding that cannot be mitigated and / or is the site at risk of flooding?
	Does it breach any other legislative requirements that would render it illegal?
	Does the option transfer raw water between catchments and represent a non-mitigable INNS risk?
	Does the option transfer water of a different quality that would breach DWI guidance (e.g. metaldehyde)?
	Does the option lead to deterioration of any of the waterbodies classified under the WFD?
	Does the option meet the social and environmental objectives of the relevant SEA?
	If in Wales does the option comply with Welsh Government's SMNR principles
Political and customer acceptability	Is the option likely to be completely unacceptable to customers? for example in terms of taste and odour
	Is the option likely to be unacceptable to stakeholders?
Cost, carbon and natural capital	Capex Cost
	Opex cost
	Carbon impact (embedded and operational)
	Natural capital value
	What if any is the net gain to the environment provided by the option?
	Does the option provide other resilience benefits to water companies?
	Does the option provide benefit for other sectors and is supported by them

The detailed screening stage resulted in the rejection of a further 47 options. The reasons are summarised in figure E4.1.

Figure E4.1: Reason for rejection from detailed screening process

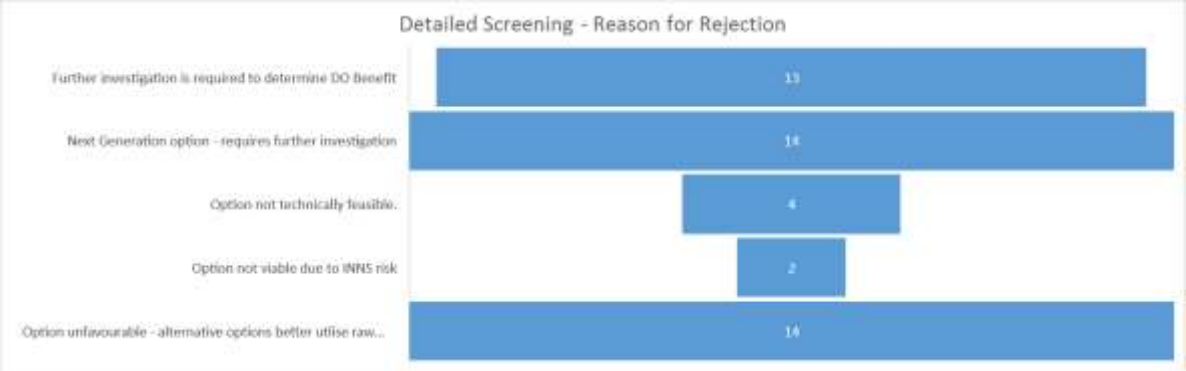
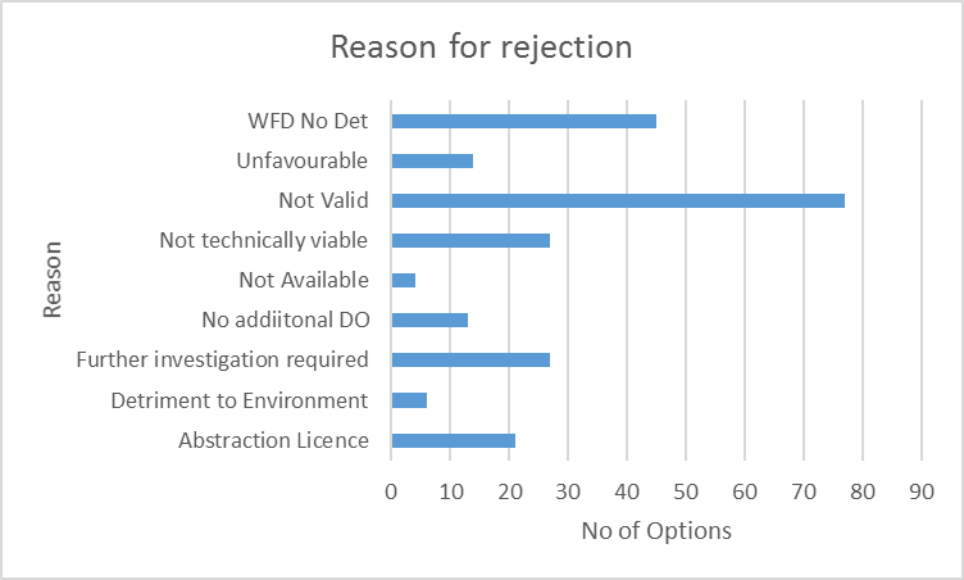


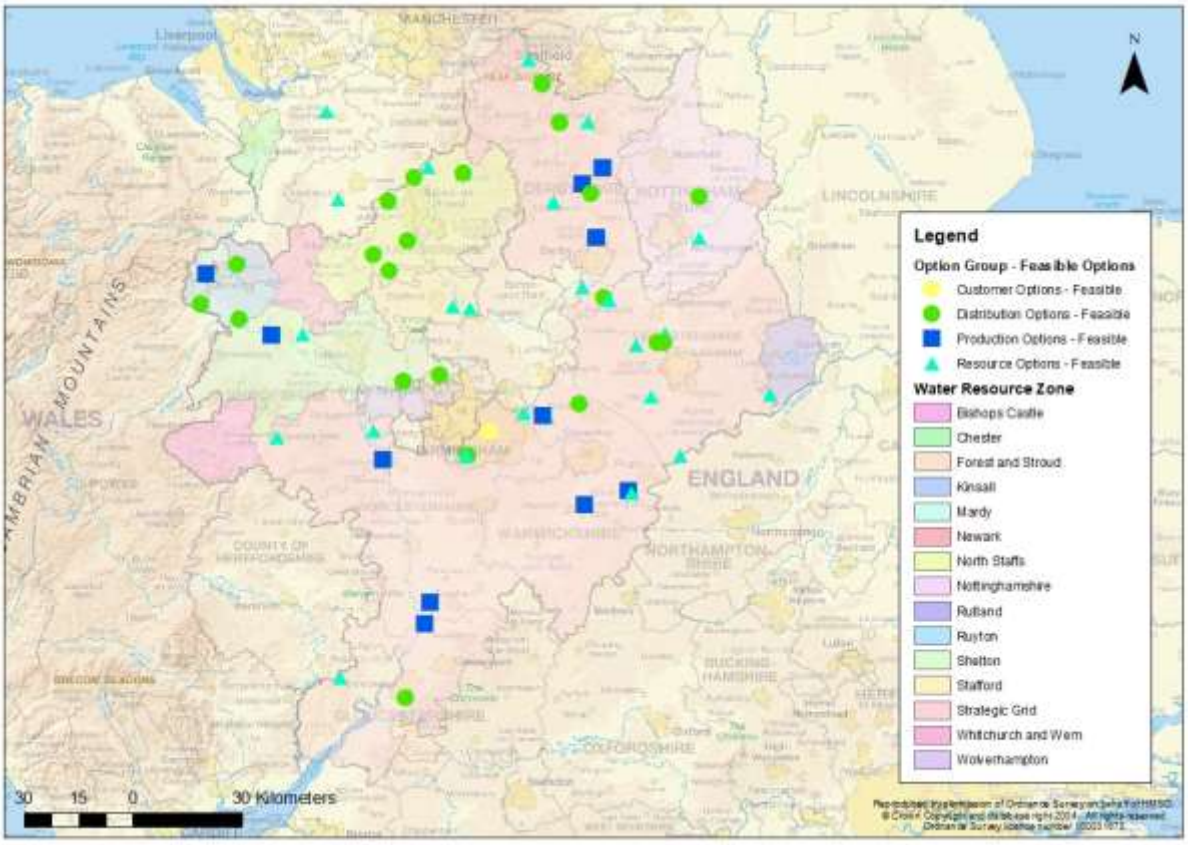
Figure E4.2 summarises the number of schemes that have been rejected at the different stages of our options screening process, while the full list of schemes **rejected,** and the reasons why are detailed in dWRMP24 Table 4.

Figure E4.2: Reason for rejection from both high level and detailed screening process



The options screening process resulted in a short list of those constrained options (91 options) that have then been used to inform our draft WRMP24. The full list of feasible supply and demand options can be found in dWRMP24 data table 4. Figure E4.3 illustrates the geographical spread of these constrained options and table E4.2 summarises the number of the different supply options we have assessed within each water resource zone.

Figure E4.3: Location of our constrained options



Note: Customer Options are shown as a central location but are region wide.

In summary, our feasible options comprise 81 supply options and 10 demand options (see company wide). The details of each option and the associated costs and benefits can be found in dWRMP24 data table 4. A summary of options and their benefits by WRZ are totalled below in Table E4.3.

Table E4.3: Number of constrained options by Water Resource Zone and potential DO benefit

Water Resource Zone	EA Code	No of Options	DO Benefit (Ml/d)
Company wide	Company wide	10	(see data table 4)
Forest and Stroud	SVTFAS	2	20
Kinsall	SVTKSL	1	1
Mardy	SVTMDY	1	1
North Staffs	SVTNST	12	133
Nottinghamshire	SVTNTT	3	90
Newark	SVTNWK	1	5
Ruyton	SVTRYN	1	1
Strategic Grid	SVTSGD	44	1220
Shelton	SVTSHN	7	115
Stafford	SVTSTF	6	68
Wolverhampton	SVTWVH	3	70
Total		**91**	***1724**

**This does not take into account mutually exclusive schemes – Total DO available is likely to be significantly less, dependent on what schemes are selected.*

E5 Strategic Resource Options

In 2019, Ofwat's final determination of price limits included an allowance for expenditure to progress the development of strategic regional water resource solutions. As a result, a number of projects were initiated to gather evidence on the feasibility of delivering Strategic Resource Options (SROs) that could benefit national and regional water long term water security of supply. RAPID was established in 2019 and a partnership made up of the three water regulators – Ofwat, Environment Agency (EA) and the Drinking Water Inspectorate (DWI) – to oversee the delivery of the SRO projects.

For our dWRMP24 we have considered the interactions and dependencies between the options considered within our plan and these SROs. Due to our geography, Severn Trent and Water Resources West play an important role in several of these SROs and so we need to understand how they would interact with our own within-region needs.

A summary of the SROs that interact with Severn Trent's dWRMP24 is given below. You can find out more details about the SROs that we're directly involved with and view the most recently published gate reports here: https://www.severntrent.com/about-us/our-plans/sro-plans/ in which we provide more details on the project scopes and the latest understanding of scheme appraisal.

Grand Union Canal

The Grand Union Canal (GUC) Transfer SRO is currently understood to be a viable solution that would transfer water from Severn Trent's supply area to areas of water deficit in Affinity Water's supply area. A new treatment works, pipeline and existing canal would be utilised to convey raw water from Severn Trent's Minworth waste water treatment works to Affinity Water.

In the southern section of the GUC route, water would be abstracted from the canal and further treated utilising a multiple barrier approach and final conditioning prior to distribution to Affinity Water's customers. The anticipated transfer capacity would be between 57 Megalitres per day (Ml/d) and 115Ml/d to deliver DO of 50 to 100Ml/d

The GUC SRO provides drought deployable output as well as wider supply resilience benefits to Affinity Water.

Severn to Thames Transfer

The Severn to Thames Transfer (STT) system is made up of an Interconnector, treatment plant, mitigation works, the source SROs and conveyance of the source support elements through the river systems of the Vyrnwy, Severn, Avon, and Thames. Figure E5.1 illustrates how this system will be configured.

Figure E5.1: The Severn to Thames Transfer scheme

The Interconnector will transfer treated, unsupported flow from the River Severn to the River Thames when there is a need. When the flow in the River Severn is insufficient or is below the hands-off flow, then source discharges and Interconnector abstraction in line with the proposed permitting road map will operate. The permitting road map will deal with the entire system to ensure the full implications are considered.

The STT SRO relates to all aspects of the Interconnector options, including treatment, mitigation works, the unsupported element and the overall STT system's operation.

Minworth

Minworth SRO is a viable solution that offers a robust and reliable source of raw water support either the Severn to Thames Transfer (STT) SRO, the Grand Union Canal (GUC) SRO, or a combination of the two. Minworth SRO can be 'construction ready' in AMP8 and will deliver a deployable output in a phased approach, to match the requirements of receiving SROs, commencing in 2031.

Minworth SRO will offer support to the receiving SROs by diverting some of its treated wastewater without detriment to its current discharge location in the River Tame. The diverted flow will be subject to additional treatment appropriate to the receiving waterbody and accepted treatment targets will need to be agreed with the Environment Agency. The varying levels of additional treatment will be required at Minworth Wastewater Treatment Works (WwTW) to ensure no detrimental impact on the Water Framework Directive (WFD) status of the receiving waterbodies.

The maximum support available to either or both SROs is subject to further environmental and hydrological investigations. A range of asset configurations have been considered in the design to provide support design outputs of 50, 100, 115, 165 and 230Ml/d being delivered at the receiving waterbodies. Different process configurations of the design have also been considered to review emerging substances which are required to

be removed, noting that with system water losses, the treatment parameters would require higher flows being treated at Minworth before passing into the system.

Severn Trent Sources

Severn Trent Sources (STS) SRO is a viable solution that offers two sources of raw water flow augmentation for abstraction and transfer by the Severn to Thames Transfer (STT) SRO. These solutions include:

- Solution 1: Netheridge Wastewater Treatment Works (WwTW)
- Solution 2: Mythe Water Treatment Works (WTW) abstraction licence transfer

Netheridge SRO offers a robust, reliable, and resilient source of treated final effluent from Netheridge WwTW. It would normally be discharged to the River Severn, to provide raw water support by discharging a volume of treated final effluent to a location near to Deerhurst, whereby the STT SRO would extract the same volume of water and transfer to Thames. Netheridge has been selected as sweetening flow for STT when there is no unsupported flow.

Mythe SRO offers a simple but effective abstraction licence transfer, whereby Mythe WTW has been seen to be under utilising the current permitted abstraction from the River Severn. The permit would be temporarily reduced by 15Ml/d and this in turn allows the STT SRO to abstract 15Ml/d from the river. I.e. the abstraction remains in a status quo, albeit the abstraction point is in a different location.

The two sources of raw water from Mythe WTW and Netheridge WwTW represent 'Put' components of the 'Put and Take' arrangement agreed in principle with the Environment Agency (EA) to support abstraction by the STT SRO:

- Mythe WTW will offer 'Put' support of 15 Ml/d by transferring part of Severn Trent Water's existing River Severn abstraction licence.
- Netheridge WwTW will offer 'Put' support of 35 Ml/d by diverting the Dry Weather Flow (DWF) portion of treated wastewater from its current discharge location in the River Severn.

Additional treatment will be required at Netheridge WwTW to ensure no detrimental impact to the Water Framework Directive (WFD) status of the receiving waterbodies.

Upper Derwent Valley Reservoir Expansion

Upper Derwent Valley Reservoir Expansion (UDVRE) SRO is a new option that offers increased storage to provide additional raw water to support existing and/or new water treatment works operated by Severn Trent Water and Yorkshire Water. The additional raw water source is intended to be transferred by gravity to the point(s) of abstraction, offering a near-zero operational carbon and OPEX support system.

We recognise that the solution presents a significant challenge, given its geographical location in the Peak District National Park. Nonetheless, it is precisely because of its location that we believe the solution offers a significant and unique set of benefits. These would contribute to England's National Framework for Water Resources and the UK Government's legally binding carbon net zero target by 2050.

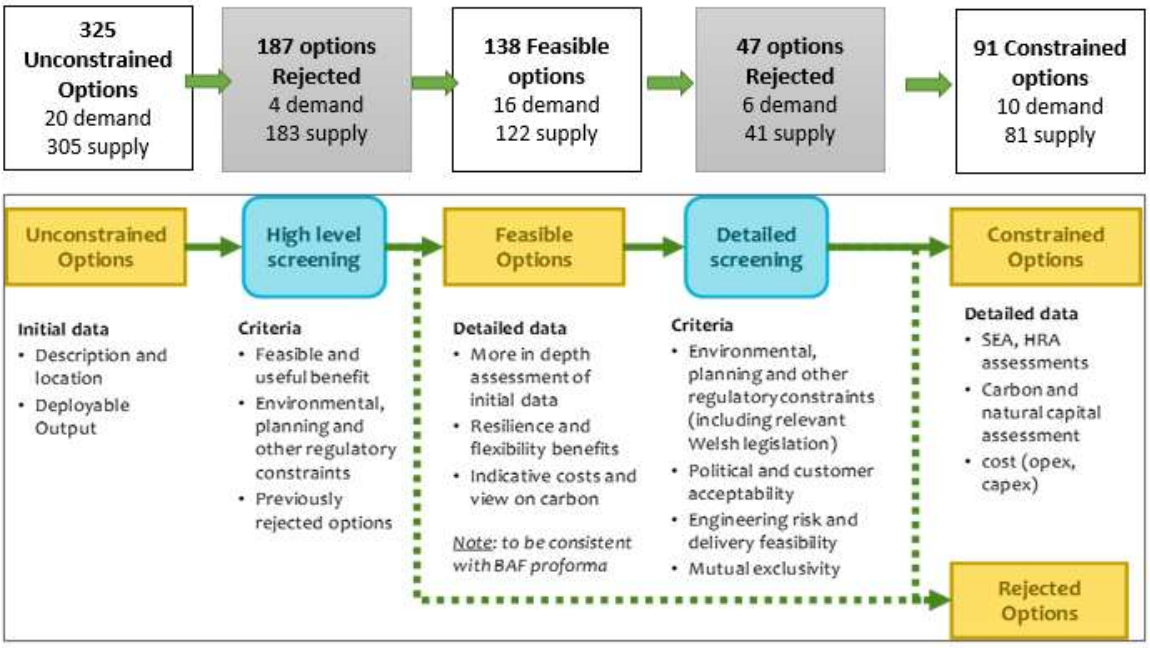
UDVRE SRO would provide additional storage at the Upper Derwent Valley Reservoir group by either raising the existing dam(s), constructing a new dam immediately downstream in close proximity to the existing dam(s), or development of a fourth reservoir with the construction of a new dam. The SRO team is considering a range of new reservoir top water levels (TWL) which result in a range of benefits up to doubling the existing storage capacity of the reservoir group. The SRO also investigates the implications of not expanding the capacity as Yorkshires network / system.

The project has yet to determine the increased yield the scheme could ultimately deliver, and this will be reported in the project's gate-2 submission to RAPID. The increased storage would support existing or increased raw water abstractions used by Severn Trent at Bamford water treatment works and Yorkshire Water at Rivelin water treatment works and would mean that Severn Trent can meet its own supply / demand needs without the need to reduce or terminate the existing bulk export agreement.

E6 Developing our constrained options

Our options appraisal approach follows a process that is common across Water Resources West water companies, and which follows the principles set out in the Water Resource Planning guideline. The process is summarised below in figure E6.1.

Figure E6.1: The stages of our options appraisal process



The final stage of our options appraisal process is to define the final constrained list of feasible options and to carry out an appraisal of the costs, supply benefits and environmental and social impacts of each of these. Each of these options has been through an outline engineering costing exercise and has been appraised using our Strategic Environmental Assessment (SEA), Habitats Regulation Assessment (HRA), Water Framework Directive (WFD), Invasive Non-Native Species (INNS), Natural Capital Assessment (NCA) and Biodiversity Net Gain (BNG) frameworks in order to gain a comprehensive understanding of environmental and social impacts. A summary of our appraisal approach is given in the sections below and the accompanying reports are also available on request.

Working with Water Resources West, we have used a methodology that allows us to convert the outputs of our environmental appraisals into eight common multi-criteria metrics that each company is using to inform the selection of its best value plan. These multi criteria metrics are summarised in table E6.1. More background on these metrics can be found in the Water Resources West draft regional plan while more

information on how these have been used in Severn Trent's decision making process can be found in Appendix F of our dWRMP24.

Table E6.1: Water Resources West's multi criteria metrics

	Metric name	Description
1	**Cost**	Total NPV based on capex (initial and replacement) and opex (fixed and variable).
2	**PWS drought resilience**	Supply-demand balance change at 1 in 500 level (Ml/d)
3	**Carbon costs**	Total NPV of monetised carbon cost.
4	**Flood risk**	Flood risk assessment from SEA converted to a numeric scale.
5	**Human and social wellbeing**	Air quality, climate resilience, economy, tourism and recreation, human health and well-being, cultural heritage and landscape assessments from SEA converted to a numeric scale.
6	**Ecosystem resilience**	Biodiversity, ecosystem resilience, INNS, soils, geodiversity and land use, waste and resource use assessments from SEA converted to a numeric scale.
7	**PWS customer supply resilience**	Customer valuations ("willingness to pay") NPV for supply interruptions and water quality (aesthetics and hardness)
8	**Multi-abstractor benefits**	Water quality and quantity, and water resources from SEA converted to a numeric scale.

Source: Water Resources West "Option Development Methodology" v2.1 05Feb 21. (WRPG = Water Resource Planning Guidelines)

E6.1 Engineering Assessment of our supply options

Each of our constrained feasible options have been taken forward for outline design and cost estimation. For these feasible options we assessed the likely construction and operating cost, the potential volume of supply or demand benefit they might deliver and the likely time it would take to plan, build and commission the scheme. The cost and benefit values were then used in our investment modelling so that we could understand what the optimised balance of leakage reduction, demand management and new supply investment might look like.

We have developed and assessed our feasible options taking a standard approach. This has enabled us to evaluate scheme metrics consistently whilst also allowing us to evaluate their risk to delivery. The areas included in our assessment are as follows:

- Engineering
- Water Quality
- Environmental
- Land and Planning
- Constructability and Operation
- Legal
- Security

Our technical assessment process identified each of the components required to form a scheme from an end to end perspective. The engineering aspects of each scheme component could then be developed in detail. This included the selection of optimum pipeline routes and suitable treatment solutions. A hydraulic analysis could then be carried out in order to suitably size each engineering component. We could then estimate the risk associated with the deliverability of the scheme and complete an estimate of the time taken to deliver the scheme.

Our process for assessing drinking water quality risks and environmental risk is described in section E9. Whilst a full planning appraisal has not been carried out for each scheme, we have completed a high-level assessment to identify land and planning risks. This has made use of the Strategic Environmental Assessment undertaken but also considered potential land purchase that may be needed together with planning permission/development consents that may be required.

Constructability was considered for each component to help identify delivery risk. This also helped inform the scheme costing delivery programme estimates. In parallel to this an assessment of the impact from an operational perspective was carried out, again to help identify risk associated with running of the scheme in conjunction with our existing supply assets.

The final stage of our assessment process was to understand the legal and security implications for each scheme. The legal implications for a scheme have a direct link to the land and planning assessment but also considered other potential regulatory risks and impacts.

E6.2 Capital and operating costs

Ensuring costs are robust

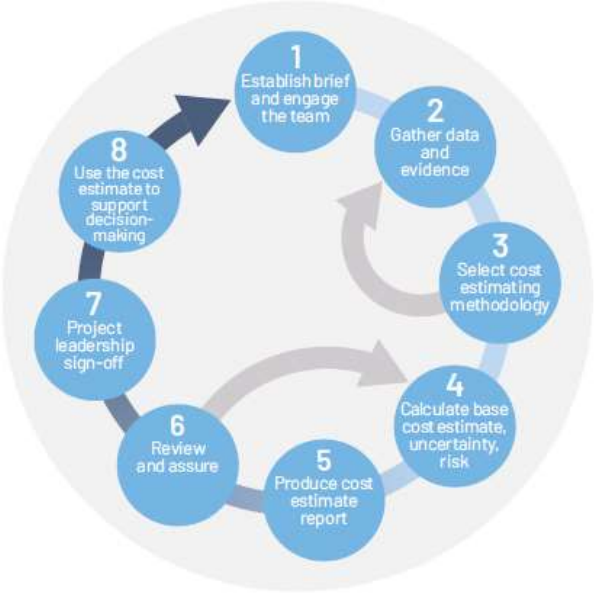
We have a mature and commercially focussed estimating approach which we have used to generate the costs for all of the options included in our draft WRMP. We have benchmarked our approach to the Infrastructure and Projects Authority (IPA) cost estimating guidance to ensure it is consistent with the methodology. We have also identified a number of improvements that we will incorporate into the final WRMP.

In line with best practice we have adopted an iterative process to refining costs, with an aim to reduce the cost estimate range in each iteration. See Figure E6.2 below.

> "*A cost estimate….is not a fixed single figure that is determined at the start of a project, but is a range that evolves over time as the project matures and which should narrow in scope as the level of risk and uncertainty inherent in the project decreases*." [1]

[1] Cost Estimating Guidance, IPA HM Treasury 2021

Figure E6.2: Our iterative approach to producing and refining robust scheme costs



The first stage of the costing methodology is to develop the base cost estimate. This consists of three key components:

- Standard costs (where we have historical data sets)
- Non-standard costs (where our data is limited or the proposed solution is outside the range of our past experience)
- On cost/burden

We have used a combination of standard and non-standard costs and then the on cost/burden rates are applied on a standard percentage basis. This results in the "base estimate".

We then review each option to determine the level of uncertainty. This is currently based on an expert assessment of the level of detail of the scope and cost estimate and then the standard green book[2] uncertainty allowances have been applied. See Table E6.2 below.

Table E6.2: Uncertainty and optimism bias assumptions

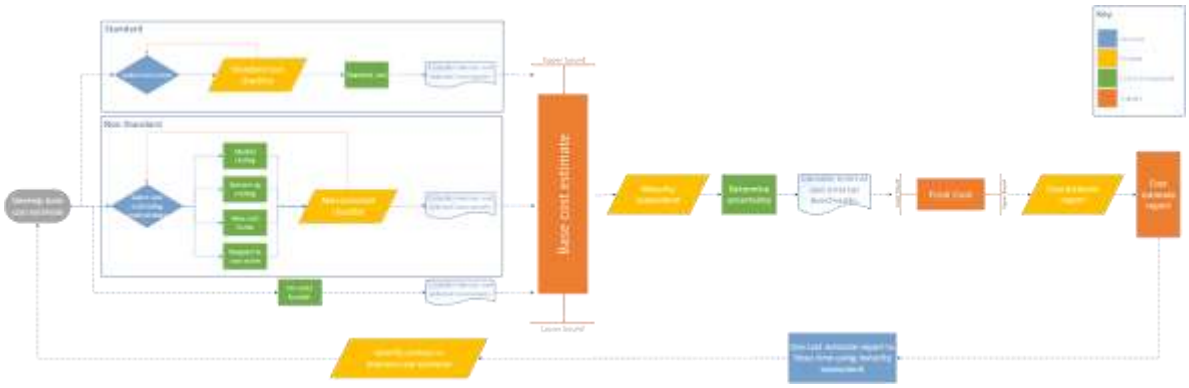
Project Type	Optimism Bias (%)[2]			
	Works Duration		Capital Expenditure	
	Upper	Lower	Upper	Lower
Standard Buildings	4	1	24	2
Non-standard Buildings	39	2	51	4
Standard Civil Engineering	20	1	44	3
Non-standard Civil Engineering	25	3	66	6
Equipment/Development	54	10	200	10
Outsourcing	N/A	N/A	41*	0*

[2] : Microsoft Word - GreenBook_optimism_bias.doc (publishing.service.gov.uk)

This results in a final cost estimate which continues to be a range. The cost values presented in the draft WRMP are a central point, but sensitivity tests have been carried out to understand the impact of the full range on the best value plan selection.

The flow chart in figure E6.3 sets out our overall approach.

Figure E6.3: The stages in our dWRMP24 scheme costing process



Governance and assurance of costs

While we have used Severn Trent's standard cost models, the scheme costs have been produced in line with the EA's WRMP planning guidance. Table E6.3 summarises how our costing approach performs against the expectations set out in the WRMP planning guidelines.

Table E6.3: Expected approach to dWRMP24 scheme costing

Guidance requirement	compliance
Costs have been split pre-benefit and post delivery	✓
Costs and benefits are presents net present values using Treasury standard declining long-term discount rate as set out in the HM Treasury 'Green Book (HM Treasury 2020)	✓
Appraisal period should cover life time of the longest lasting asset	✓
Finance costs have been calculated as a stream of annual costs over the life of the options	✓
AICs are based on the NPV of the costs and outputs	✓
Environmental and social monetised cost impacts have been provided	✓
Carbon costs have been provided	✓
Assumptions have been set out	✓
A worked example has been provided (for a supply option and a demand option)	✓
We have provided evidence that our costs are robust and efficient	✓
We have benchmarked key activities	partially
Board assurance has considered the robustness of the costs and level of efficiency	✓

Our costing approach has been refined and developed over successive price reviews, which means we are building on a strong foundation. We have applied assurance checks on both the methodology and approach and on the resulting costs. The assurance steps we have taken include:

Methodology

- Independent review of the costing methodology by Arup for the 2021 Green economic recovery submission who concluded the approach was robust and appropriate
- Cost consultants Turner and Townsend reviewed our approach and assessed it against the IPA cost estimating methodology and found it broadly aligns to all of the steps recommended in the best practice guide and minor gaps are being improved for the final WRMP.

Cost estimate assurance

- Our costs have been subject to Severn Trent's standard three lines of assurance, including a review by Jacobs as the independent assurer.
- Sensitivity testing through our optimisation process, applying +/- 10% cost variance to assess the extent to which it changes the scheme selection in the best value or lowest cost plans. There are a number of schemes where the uncertainty range was increased to +/- 25%. These were for higher risk, complex schemes where we have less confidence in our estimated cost, for example FE re use and large reservoir expansions.

We have developed and then signed off our draft plan across three levels of governance:

- Subject matter experts
- Senior management steering group (STEC)
- Board

These groups have reviewed, challenged and then approved the methodology and then challenged the application of the methodology and ultimately satisfied themselves that the costs presented in our draft plan are appropriate for this stage in the process.

Improving cost robustness and efficiency for final WRMP

The Treasury guidance recognises that cost estimates should evolve over time as the project matures. Over which time the scope should narrow and the level of risk and uncertainty inherent in the project decreases. Therefore, we will be carrying out a number of iterations of our project cost estimates before publishing our final WRMP and PR24 plan later in 2023.

Across the eight steps summarised in figure E6.2 we have identified two key areas where we want to further improve our approach going forward; Step 5: Produce a cost estimate report and Step 6 Review and assure. Our improvement plans are as follows:

Cost estimate report

For projects or programmes of similar activity we will be producing a standardised report covering:

- General project information
- Cost ranges
- Outputs of maturity assessment
- Uncertainty assessment
- Key concerns
- Next steps

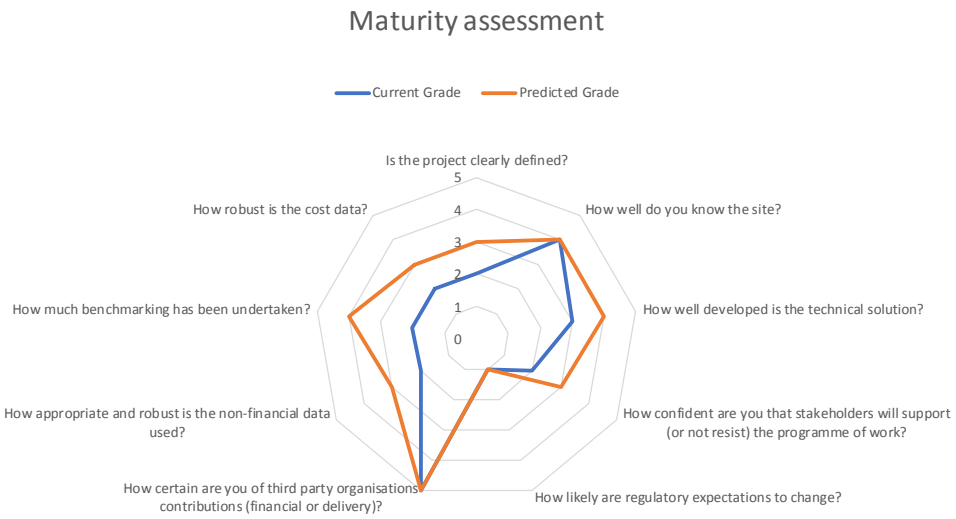
The key improvement is the maturity assessment that we have created with independent cost consultants Turner & Townsend to identify how well developed each project is.
The maturity assessment includes nine questions that are split over three categories that cover both the scope and cost maturity. We have developed guidance to help assessors score the maturity – this is summarised in table E6.4.

Table E6.4: Cost maturity criteria

Category		Assessment Question
DECISIONS	Engineering/ Technical	Is the project clearly defined?
		How well do you know the site?
		How well developed is the technical solution?
	Stakeholders	How confident are you that stakeholders will support (or not resist) the programme of work?
		How likely are regulatory expectations to change?
		How certain are you of third party organisations contributions (financial or delivery)?
DATA	Data	How appropriate and robust is the non-financial data used?
		How much benchmarking has been undertaken?
		How robust is the cost data?

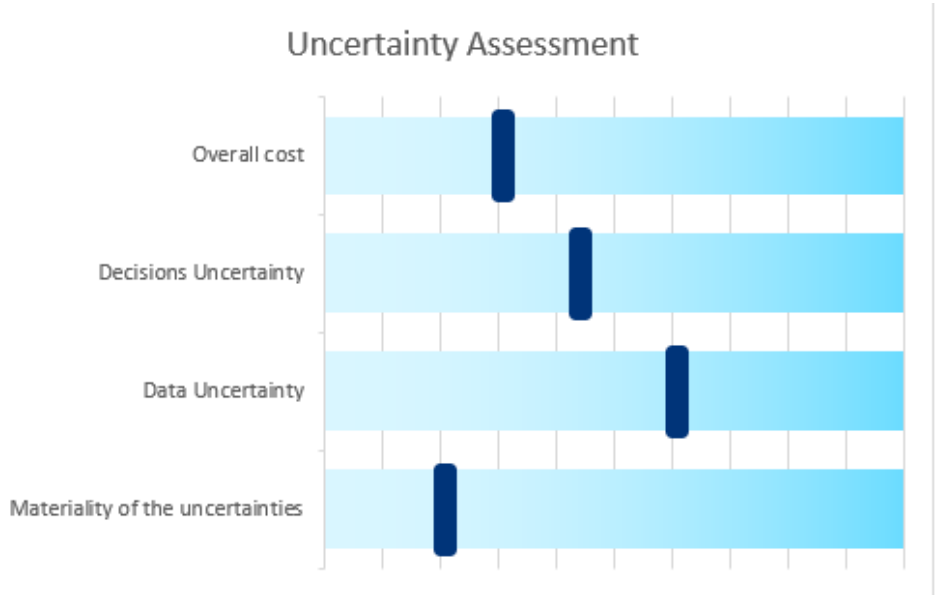
It also requires an assessment of the current maturity and the forecast based on the planned work over the next iteration. An example of our cost maturity assessment is illustrated in figure E6.5.

Figure E6.5: An illustration of our cost maturity assessment.



The cost report also includes a standardised way of assessing the level of uncertainty by looking at the maturity assessment in the context of the wider programme. An example is illustrated in figure E6.6.

Figure E6.6: Cost uncertainty assessment



Review and assure

The second key improvement that we will be implementing between now and the final WRMP is to use the cost reports set out above to more systematically identify where time and effort is best placed to improve the costing. By reviewing this iteratively it will also enable us to identify whether uncertainty is being reduced. We have developed a series of suggested actions that could be taken and these will be reviewed centrally and in consultation with our governance groups.

We will also be bolstering our assurance approach by implementing checklists that we have developed to promote self-review and increase the consistency of the 2nd line assurance checks. These checklists are based on a combination of independent advice from Turner and Townsend and lessons learned from reviewing cost movement between PR19 costs and AMP7 contracts.

We will also be commissioning an independent review and challenge of the costs in the final WRMP to ensure that we have robustly applied our costing methodology.

Cost benchmarking

We will also be continuing to benchmark our scheme costs to ensure that our final WRMP includes more robust evidence to demonstrate our costs are efficient. The key benchmarking activities will include:

- Comparative review of the draft WRMPs and the SRO options
- Market test areas where benchmarking is difficult/ unreliable, for example where the solutions are novel or well outside the range of our previous experience
- Seeking external benchmarking data such as TR61 and the Australian benchmarking that we have been contributing to over the last 3 months.
- Embedding the learning from delivering our green recovery investment – for example of ceramic membranes, smart meters, pre-filtration.

We will also be continuing our assessment of the potential for any of our WRMP solutions to be suitable to progress through the Direct procurement for Customers route.

E7 Environmental Appraisal of Options

We have integrated environmental factors into the development and selection of options and our decision making approach.

Each of our options has had an assessment of the different environmental and social impacts that it could create. To ensure we have a consistent, region-wide understanding of the potential environmental impacts we have followed a comprehensive environmental assessment approach that is common with the other Water Resources West water companies.

The following section outlines the assessments that were undertaken to derive the environmental metrics that were used for our decision-making process when determining our best value plans (see appendix F).

Our WRMP is accompanied by a separate Environmental Report. This is a comprehensive document that encompasses the following assessments:

- Strategic Environmental Assessment (SEA)
- Habitats Regulations Assessment (HRA)
- Water Framework Directive (WFD)
- Natural Capital Assessment (NCA)
- Biodiversity Net Gain (BNG)
- Invasive Non-Native Species (INNS)

The environmental assessments are based on best available option information at the time of assessment. We continue to refine our understanding of these options and any changes to environmental assessment outcomes and will be reviewed and updated as necessary between draft and final WRMP24.

The first stage of option screening included environmental criteria to ensure options with a high potential for negative environmental impact were removed between the unconstrained list and constrained list stages. Options on the constrained list were further developed and prepared to a level of detail to commensurate with the strategic nature of the planning process. Environmental constraints were again considered, and suitable provision made to the option arrangement in order to avoid or mitigate potential environmental impact. This included, for example, alternative routing of new pipelines or adjustments to the location of new assets.

As we have progressed through the screening process we have continued to refine our solutions. We have rejected any options that would increase abstraction over WFD No Deterioration ‘recent actual’ baseline quantities, ruled out any options that would have an unmitigable damage on environmentally designated sites, we have adhered to the abstraction licensing strategy to ensure we only take water where it is available, and we have ensured that INNS risk is minimised (raw water transfers to WTW rather than water bodies that are not within the same catchment). This is high level environmental screening is undertaken before we even take any of our options forward for engineering design stage.

As we have developed the engineering feasibility of our solutions, we have undertaken environmental assessments feeding back any risks to help refine the solutions. This is to ensure we minimise our impact to the environment and incorporate any mitigation measures (where appropriate) within the conceptual design stage.

For some schemes the initial stages of the environment assessment highlighted areas of concern that could be readily mitigated through pipeline re-routing. For example, for 15 of our schemes we have been able modify

the route to minimise our impact/our proximity to ancient woodland, listed buildings, parks and gardens, and scheduled monuments. We are continuing to refine our solutions between draft and final publications.

The following sections outline the different environmental assessments undertaken for our options and ultimately how we have translated these into metrics that are used directly in the decision-making process.

E7.1 Strategic Environmental Assessment

SEA is required under Statutory Instrument 2004 No.1633 - The Environmental Assessment of Plans and Programmes Regulations 2004. Throughout the course of the development of the plan, policy or programme, the aim of SEA is to identify the potential impact of options proposed in the plan in terms of their environmental, economic and social effects.

In this context, the purpose of the SEA of our draft WRMPs has been to:

- identify the potentially significant environmental effects of the draft plans in terms of the water resource management options being considered.
- help identify appropriate measures to avoid, reduce or manage adverse effects and to enhance beneficial effects associated with the implementation of the draft plan wherever possible.
- give the statutory SEA bodies, stakeholders and the wider public the ability to see and comment upon the effects that the draft plans may have on them, and encourage them to make responses and suggest improvements to the draft plans; and
- inform the selection of water resource management options to be taken forward into the final versions of the plans.

In summary the SEA identifies, describes and assesses the likely significant effects arising from the following aspects of the WRW Regional Plan and WRMPs:

- The revised feasible water resource options;
- The preferred water resources options;
- The preferred programme of options selected to comprise the preferred plan to address the supply demand deficit;
- Any alternative plans proposed to address the supply demand deficit;
- The interaction with the Strategic Resource Options (SROs) being taken forward by the companies;
- Any proposed WRW Regional Plan non-public water (non-PWS) supply options;
- Any cumulative, secondary and/or synergistic effects of implementing the plans.

Through the SEA scoping consultation in 2021 we defined a series of 17 headline objectives that we have used to assess each of our supply options. For each of these objectives we have assessed both the negative and positive impacts that each scheme option would have. An example of the initial assessment of the 17 SEA objectives are show in Figure 7.1 below.

Figure 7.1: Example of the initial assessment of the 17 SEA objectives considered

	Construction (negative)	-/?	?	?	0	0	0	-	-/?	-/?	-	-/?	-	-	0	-	0	0
	Construction (positive)	0	?	?	+	0	0	0	0	0	0	+	0	0	0	0	0	0
	Operation (negative)	-/?	?	?	0	-/?	-/?	-	0	-/?	-	0	0	0	0	-/?	0	0
	Operation (positive)	0	?	?	0	0	0	0	0	0	+	++	0	++	+	0	0	0

Integrating environmental considerations into the option development and selection process has meant that our appraisal process takes into account a range of factors including technical feasibility, delivery risks and environmental considerations in an equal manner. The SEA process facilitated review of critical environmental constraints in an agreed and consistent manner, ensuring that we considered the full range of potential environmental impacts of the options.

The mitigation measures that we applied to options in our WRMP are high level commensurate with the early and strategic development stage of the option. As the option development phase progresses through to detail design stage then discussions will be held with Natural England and other stakeholders to agree appropriate mitigation measures following the detailed environmental assessment.

An in-combination assessment of our preferred plan has been carried out and is described in the SEA report that accompanies this dWRMP24. Any material items that arise as a result of the in-combination assessment will be addressed between draft and final WRMP. If we find any material issues, we will seek alternative routes to the preferred pathway that perform better environmentally.

We have carried out an in-combination / cumulative effects assessment of the adaptive pathways that are described in dWRMP24 data table 7. Our adaptive pathways are solutions to more extreme and uncertain future supply/demand situations. We would not pursue these solutions unless they are required. Over the next two AMPs we will complete further investigations and monitoring to understand if these adaptive solutions are required. At that time, we will complete in-combination assessments when we have more certainty that those solutions are required.

Prior to the implementation of options, detailed monitoring plans will be put in place with specific targets and with responsibility clearly assigned. This will mean that the effects of options can be measured, and actions tracked.

E7.2 Habitats Regulations Assessment

Water Resources Management Plans are subject to the provisions of Regulation 63 of the Conservation of Habitats and Species Regulations 2017 (as amended) (the 'Habitats Regulations'). The water company has a statutory duty to prepare a WRMP and is therefore the Competent Authority for the HRA of that plan. For this dWRMP24 we have worked with the other water companies who are part of Water Resources West to ensure we are following a consistent, regional assessment of the WRMPs against the provisions of Regulations 63 and (if required) 64, a process known as 'Habitats Regulations Assessment' (HRA). These HRAs will then support an HRA of our draft WRMP as well as the WRW Regional Plan.

Regulation 63 essentially provides a test that the final plan must pass; there is no statutory requirement for HRA to be undertaken on draft plans or similar developmental stages. However, as with Strategic Environmental Assessment (SEA), it is accepted best-practice for the HRA of WRMPs to be run as an iterative process alongside plan development to ensure that potential effects on European sites can be identified at an early stage and factored into the selection of options. In practice, therefore, HRAs of WRMPs have two functions: they informally guide each water company as it determines which water resource options will be included in the published WRMP (and hence the WRW plan); and they subsequently provide a formal assessment of the published WRMP against Regulation 63.

Our HRA of the feasible options included in our dWRMP24 has highlighted that a HRA Stage 2 Appropriate Assessment (AA) is required for 24 individual options, covering 19 from the preferred plan and 5 alternative plan options. A full HRA has been completed for options that are chosen before 2050 this comprises of 10

options in the preferred plan and 1 in alternative pathway. For those options chosen after 2050, 9 of which are in the preferred plan (and 4 in alternative pathways), high level screening of these options has been completed with an indication of mitigation measures and further assessment required to support a HRA Stage 2 Appropriate Assessment, given there is sufficient time within future WRMP cycles to assess these options.

In addition, 3 in-combinations within plan for River Mease SAC, River Derwent/Peak District Dale SAC, and Severn Estuary EMS HRA Stage 2 Appropriate Assessments have been completed.

Between WRMP in-combination assessments will be required for the Humber Estuary EMS, and the Severn Estuary EMS as draft WRMPs from other water companies are made available. Given the complexities of the abstraction and discharges on these watercourses, additional modelling is likely to be required to confirm effects.

The separate HRA report that accompanies our dWRMP24 is available on request.

E7.3 Water Framework Directive

The Water Framework Directive is an EU Directive establishing a framework for Community action in the field of water policy which aims to protect and improve the water environment. The Directive was brought into UK law in 2003 and subsequently revoked by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 in England and Wales.

Water companies have a duty to have regard to the Environmental Agency's River Basin Management Plans (RBMPs) when producing their statutory Water Resources Management Plans. We must assess our current and future predicted abstractions to ensure they comply with and support the achievement of WFD regulations requirements and objectives set out in the RBMPs. Our dWRMP24 explicitly considers how we will manage the risk of future deterioration caused by our abstractions and how WFD objectives influence the options included in our preferred plan.

Our initial options screening phase removed many options that pose a risk of WFD deterioration and as a result we removed many options that had been considered feasible in previous WRMPs. As we have further developed our understanding of the feasible options available for this dWRMP24 we have carried out a more detailed assessment the risks that they could pose to achieving RBMP and WFD objectives.

Our WFD assessment approach gives a confidence rating (high, medium or low) to all assessments to reflect the amount of uncertainty in the design, environmental baseline and magnitude of impact. If an option is reported as potentially WFD non-compliant it can be appropriate to consider the option further where it is considered that additional evidence to improve confidence in the assessment and/or enhanced design could mitigate the potentially WFD non-compliant issues.

The initial findings from our WFD assessment of the dWRMP24 feasible options has highlighted risks around four options that would impact on groundwater bodies and three options that impact on downstream surface water bodies. We will continue to explore these potential impacts and whether additional mitigation measures may need to be built into the scheme option design.

A separate WFD assessment report accompanies our dWRMP24 and is available on request.

E7.4 Natural Capital and Biodiversity Net Gain

We have worked with the other water companies that make up Water Resources West to develop a consistent methodology for undertaking a Natural Capital Assessment (NCA) and Biodiversity Net Gain (BNG) assessments (including assessment of habitat enhancement opportunities) of our feasible options. We have also ensured that the approach is appropriate for the specific ecosystem resilience ambitions in Wales and wellbeing goals.

Our combined approach draws on the regulators' Water Resource Planning Guideline (WRPG) produced by the along with guidance from UK Water Industry Research (UKWIR, 2021) on the application of natural capital assessment to WRMPs. The methodology also draws on the principles of the Natural Capital Register and Account Tool (EA, 2021) and the approach outlined in Defra's Enabling a Natural Capital Approach (ENCA) (Defra, 2020).

For assessment of the options in Wales, the methodology is consistent with the principles of Sustainable Management of Natural Resources, wellbeing goals and the supplementary guidance note "Setting an environmental destination for water resources: Enhancing ecosystems in Wales", recognising that these are supported by local area statements and associated ambitions. Our approach will consider the principles of ecosystem resilience to ensure that plans in Wales are consistent with Welsh Government policy, as well as aligning to the strategic aims of the all the WRW Companies.

The use of NCA and BNG assessment is an important part of our overall environmental valuation process and can highlight the opportunities for social and environmental gains as well as helping to engage with environmental stakeholders:

- The BNG assessment demonstrates how options and plans can maximise biodiversity gain and facilitate the incorporation of BNG into supply option design. This will underpin delivery of wider environmental net gain through provision of improved habitat quality and quantity.
- The purpose of NCA assessment is to evaluate the benefits and disbenefits to society that arise from changes to natural capital assets. The NCA approach sits alongside the SEA which, traditionally focusses on environmental impacts, and BNG which is concerned with habitat improvement for the purposes of ecosystem resilience rather than for the associated benefits to society.

The NCA, Strategic Environmental Assessment (SEA) and BNG assessments should be seen as complementary and the outputs of all three have been considered in decision-making.

The separate NCA and BNG assessment reports are available on request.

E7.5 Invasive Non-Native Species

Invasive non-native species (INNS) of flora and fauna are considered the second biggest threat after habitat loss and destruction to biodiversity worldwide. The annual cost of INNS to the Great Britain economy was estimated in 2010 to be £1.7billion per year, of which around £5million was attributed to water industry management of INNS. New and existing INNS also pose a threat to achieving Water Framework Directive (WFD) objectives.

When preparing our dWRMP24 we have reviewed whether current abstraction operations and future solutions will risk spreading INNS or create pathways which increase the risk of spreading INNS.

Our approach has considered:

- Pathways of spread (understanding and reducing the risk from different pathways),
- Preventing spread (controlling, eradicating or managing INNS to prevent spread where this will contribute to WFD prevention of deterioration), and
- Action on INNS to achieve conservation objectives of SSSI and Habitats Directive sites.

The outcomes of the high-level risk assessment informed both SEA process and options/scheme design.

The separate INNS assessment report is available on request.

E7.6 Multi-Criteria Metrics

Working with Water Resources West, we have developed a common methodology that uses multi-criteria analysis (MCA) to incorporate a range of environmental and social cost metrics and objectives into our decision making. Water Resources West has developed the Valuestream tool that takes different value metrics which are then weighted and monetised according to relative preferences. Many of these metrics use the outputs from our suite of environmental appraisals. These weighted metrics, as outline in Table 7.1, have then been used to form an optimisation that maximises best value.

Table 7.1: Summary definitions of the Water Resources West metrics

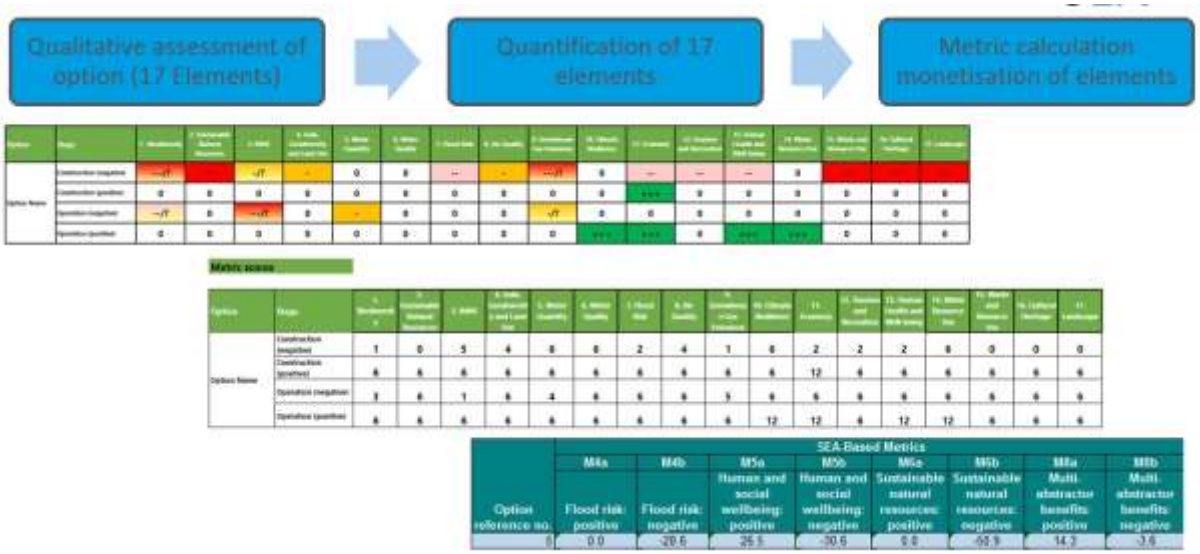
	Metric name	Description
1	**Cost**	Total NPV based on capex (initial and replacement) and opex (fixed and variable). Aligned to water resources planning guideline requirements.
2	**PWS drought resilience**	Supply-demand balance change at 1 in 500 level (Ml/d)
3	**Carbon costs**	Total NPV of monetised carbon cost. Calculated using BEIS carbon values.
4	**Flood risk**	Flood risk assessment from SEA converted to a numeric scale.
5	**Human and social wellbeing**	Air quality, climate resilience, economy, tourism and recreation, human health and well-being, cultural heritage and landscape assessments from SEA converted to a numeric scale.
6	**Ecosystem resilience**	Biodiversity, ecosystem resilience, INNS, soils, geodiversity and land use, waste and resource use assessments from SEA converted to a numeric scale.
7	**PWS customer supply resilience**	Customer valuations ("willingness to pay") NPV for supply interruptions and water quality (aesthetics and hardness)
8	**Multi-abstractor benefits**	Water quality and quantity, and water resources from SEA converted to a numeric scale.

These metrics have been used in Severn Trent's decision-making process to inform the best value programme of supply / demand options. A number of the metrics are derived from our wider Strategic Environmental Assessment, Natural Capital Assessment and Biodiversity Net Gain studies which strengthens how those environmental appraisals directly inform our decision making. For each supply option we have derived positive (benefits) and negative (dis-benefits) metric values and we consider these separately within our optimisation to avoid basing decisions on net values.

Including the metrics based on SEA assessments in the optimisation to select options further integrates the SEA in the decision making. It complements but does not replace other uses of the SEA, to screen options and

to provide an assessment of the overall plan, including cumulative effects. This helps integrate the SEA into the plan preparation process from its early stages as illustrated in figure 7.2.

Figure 7.2: Translating SEA assessment into decision making metrics



Severn Trent has taken these common Valuestream derived weighted metric values and has incorporated them into our DMU investment optimisation tool. Within the DMU these metric values are used alongside capital and operating costs to optimise the overall NPV of the programme to achieve the fundamental supply / demand balance target under a range of scenarios. More information on the DMU tool and our approach is given in Appendix F.

The method of formulating metrics as a numeric scale was developed jointly with the other WRW water companies on a regional scale at facilitated workshops. The participants included water resources planners and decision makers from water companies, environmental regulators from the EA, NRW and RAPID, representatives from industries such as the Canal and River Trust and the National Farmers Union, and specialists in environmental assessment from Wood and Ricardo.

SEA option-level assessment outputs for each supply-demand option range from significant positive effect (+++) to significant negative effect (−−−). This needed to be converted to a numerical value to be used within the Multi Criteria Analysis (MCA) process – see table 7.2 for breakdown. A score was assigned to each level of each SEA metric such that 0 represents the lowest (worst) value and 100 represents the highest (best) value, and intermediate numbers are chosen such that numerical differences are proportional to differences in value. In the workshop, a consensus was sought from the group as to how each of the SEA levels should be mapped to a number between 0 and 100 and aggregated into a metric.

Table 7.2: Score attached to the option-level SEA assessments in the metric derivation.

SEA assessment		Score used to derive the WRW metric	
		Positive	Negative
Significant positive effect	+++	100	
	+++/?	95	
Moderate positive effect	++	50	
	++/?	45	
Minor positive effect	+	25	
	+/?	20	
Neutral / uncertain	0	0	100
	?	0	100
Minor negative effect	−/?		80
	−		75
Moderate negative effect	−−/?		55
	−−		50
Significant negative effect	−−−/?		5
	−−−		0

The SEA considers both construction and operational impacts, which are assessed separately. In the workshops, the group took the view that benefits would be more significant in the operation of the schemes, whereas negative impacts would be more significant at the construction stage. The agreed weighting was 100:75 in both cases, which equates to the weights shown in Table 7.3 below.

Table 7.3: Weighting between

	Positive	Negative
Constuction	42.86%	57.14%
Operation	57.14%	42.86%

The final choice in the formulation of the SEA metrics was how to combine assessments for several SEA objectives into a single metric value. After discussion amongst the group, it was concluded that the SEA objectives would be weighted equally within a metric. For example; the ecosystem resilience metric was formed from five SEA objectives, each weighted 20% of the total metric value. Metrics which covered a broader area, by combining more objectives, would then be considered for a higher weighting (see below).

In this way, the option level SEA assessments were used to derive metric values between 0 and 100 by combining several objectives, operational and construction effects. Negative and positive effects from the SEA were kept separate and reported as separate metrics.

Other metrics are directly monetised: the direct financial costs, carbon costs and water company customer valuations of service levels.

Once the metrics were defined, a set of weights were required. The weights assign relative value between the decision metrics. This is a feature of all MCA assessments. WRW derived weights initially taking a stakeholder view in a facilitated workshop. This was then followed by customer research to inform updates to the weights.

WRW chose to express the value weights in monetised terms. This is not a common approach in MCA and not the same as a cost / benefit assessment, however it adds clarity to the value judgements being made. By monetising the weights, and therefore the scores we are making this more explicit, i.e. easier to see how much monetary value is being placed on different benefits in the MCA results.

Initial stakeholder weights were derived in a workshop of the multi-sector WRW senior management group. This followed on from the formulation of the metrics and again the group was supported by technical experts. The group considered how to weight the different SEA derived metrics, including the separate positive and negative effects relative to each other. The group then considered the inherently monetised metrics (cost, carbon, PWS customer resilience) to see if there was any reason to give additional weight, based on stakeholder and customer views, above the default 1:1 weighting.

The final step was to weight SEA metrics and monetised metrics relative to each other. Carbon was chosen as the linking metric as this is an environmental value, and hence qualitatively more similar to the SEA-based metrics than any of the other monetary metrics. The core question asked was: how important to customers and stakeholders is the maximum impact of carbon relative to negative ecosystem resilience SEA metric? The maximum carbon impact from the draft feasible options data could then be pegged to a point on the 0-100 scale for the ecosystem resilience negative effects metric.

Workshop deliberations by the group resulted in the SEA-derived metrics being weighted in proportion to the number of underlying objectives. An additional weighting, in the ratio 100:75 was applied to give more weight to the ecosystem resilience metric. This was because ecosystem resilience / sustainable natural resources was thought to be the most impactful, based on customer and stakeholder views. The same relative weighting was judged to apply to positive as well as negative impacts, and both positive and negative impacts were considered to have equal importance in decision making. The inherently monetised metrics were all weighted in the default way, and the maximum carbon impact of £140m was pegged to a score of 75 on the ecosystem resilience negative effects metric. This resulted in the stakeholder weights shown in table 7.4.

Table 7.4: Stakeholder derived weights for Value Stream analysis

	Metric		Stakeholder weight
1	**Cost**		1.00
2	**PWS drought resilience**		N/A[3]
3	**Carbon costs**		1.00
4	**Flood risk**	positive effects	0.28
		negative effects	0.28
5	**Human and social wellbeing**	positive effects	1.96
		negative effects	1.96
6	**Ecosystem resilience**	positive effects	1.87
		negative effects	1.87
7	**PWS customer supply resilience**		1.00
8	**Multi-abstractor benefits**	positive effects	0.84
		negative effects	0.84

Using the outputs from our environmental appraisals we generated a suite of positive and negative metric values for each of our feasible options. These were then input to our DMU investment optimisation model alongside the capital and operating costs of the different scheme options.

[3] The PWS drought resilience measure was used as a constraint in the decision making to ensure sufficient Ml/d were selected to resolve the deficits. It was therefore not weighted. Subsequent analysis by the water companies considered levels of service change.

More information about the basis for these MCA metrics and the valuation process can be found in the WRW draft plan.

E8 Carbon costs

The Paris agreement signed by the UK in 2016 aims to address the way in which we tackle climate change in relation to the amount of greenhouse gases that are being produced by human activity. In alignment with the Paris agreement the water industry have committed to reducing their carbon emissions to net zero by 2030.

At Severn Trent we recognise that we need to reduce our direct carbon emissions and influence our indirect emissions. Our long term aim is to continually reduce carbon emissions and generate renewable energy, in a way which provides value for our customers. Considering carbon emissions in our planning processes is a key way to do this.

The price we and others, pay for energy and environmental taxes mean that there is an increasingly close link between cost and our carbon impact. These costs are increasing as the UK moves to a low-carbon economy. So aside from our commitment to play our part in reducing emissions, impact on our customers' bills is a key reason to focus on carbon emissions. Our research shows that customers and stakeholders agree with our overall strategy of prioritising action to reduce carbon where there is a long-term financial benefit to customers.

Our decision making methodology, as agreed between each of the four WRW companies, sets out the multi criteria approach (MCA) we have taken to inform options selection for our WRMP. This is key in helping us decide on our "best value plan". The overall MCA approach is described in appendix F, however one of the key metrics that we consider in our decision making is the carbon value for each of our individual options.

The carbon metric we use is the net present value (NPV) of monetised CO2 equivalent emissions as a result of constructing and implementing the option. It is measured in £m and has been calculated with reference to Water Resources Planning Guidelines (WRPG) together with the information below:

- UKWIR report Framework for Accounting for Embodied Carbon in Water Industry Assets (UKWIR, 2012) (12/CL/01/15).
- For carbon costs associated with the projected emissions - latest government guidance on the cost of carbon including the Green Book Supplementary Guidance.
- The Carbon Accounting (Wales) Regulations 2018
- Environmental Reporting Guidelines: Including streamlined energy and carbon reporting guidance'
- PAS 2080: Carbon Management in Infrastructure
- HM treasury Infrastructure Carbon Review
- Towards a Science Based Approach to Climate Neutrality in the Corporate Sector

The carbon cost for both embodied and operational carbon of each option have been assessed to calculate their value in tonnes of carbon dioxide (tCO2). We have developed a carbon tool to account for the embodied carbon of the assets that are proposed for construction. In addition to this, the tool captures the operational carbon of the proposed scheme and holds an integrated 'materials guidance' document that has been produced using the Inventory of Carbon and Energy (ICE) database of materials. Use of the tool is designed to aid the delivery of more carbon conscious projects and also aligns us with the Regulator requirements for carbon accounting.

Embodied carbon impact has been estimated and aggregated from two different sources to produce a single embodied carbon value. Firstly, the initial implementation of new assets and secondly the capital renewal of those assets as they reach end of life. The tool holds a database of approximately 500 assets and includes comprehensive data on construction materials together with data on construction and installation to provide a sum total of embodied carbon.

The carbon tool also produces an estimate of annual operational carbon for each scheme. This value represents the carbon emissions from the energy utilised by the option's infrastructure and building-integrated systems. It also estimates the process carbon emissions arising from the scheme to enable it to operate and deliver services. The tool divides the inputs into the following categories:

- Power for pipeline pumping operations
- Power for treatment operations
- Fuel
- Chemicals
- Sludge tankering

Once embodied and operational carbon values were calculated we then carried out an assessment to understand the carbon impact over the whole life of the scheme. This is to avoid prioritising a scheme in one life cycle stage which could lead to an increase in carbon in a later lifecycle stage and therefore result in a net increase in whole life carbon. We therefore include the carbon value associated with the replacement of assets that may be required over the whole of the 80 year planning period together with the ongoing operational carbon associated with those assets providing a continuous service.

Once the emissions over the planning period had been calculated for each option these were then monetised and presented as a Net Present Value (NPV). This requires:

- Projected whole life carbon impacts of each scheme
- Monetisation of Embodied and Operational Carbon impacts
- Discounting of the total monetised carbon impacts of each scheme.

The value of carbon has been adopted from the time series issued by the Business, Energy and Industrial Strategy (BEIS, 2021) which presents carbon values, inflated to 2021 prices from 2020 to 2122 assuming an annual growth rate of 1.5% year on year. This time series includes low, central and high values. For the purpose of calculating NPV the central values have been used. Monetised carbon has been discounted using HM Green Book's standard rates as follows:

- No discounting applied to Year 1
- 3.5% applied to each of the years 2 to 30
- 3% applied to each of the years 31 to 75
- 2.5% applied to each of the years 76 to 80

E9 Drinking Water Quality

Solutions developed through our WRMP24 process are subject to the DWI guidance note on long term planning for the quality of drinking water supplies (2017). A key expectation of DWI is that "...all water companies take a source to tap (raw water catchment to customer tap) approach to manage their water supplies to protect the health of their consumers and maintain consumer confidence in the supply and services provided. Central to achieving these objectives is the mandatory use of drinking water safety plans (DWSP)…".

This link has been made within our work by reviewing the DWSPs relevant to each project and the risks considered as part of the solution optioneering process.

Our solution development of options includes proposals to develop new sources of water for public supply. They also include options to transfer water that may change the quality of an existing source. We have therefore taken a risk based approach to water quality which takes into account two general principles:

1. That we will not expose customers to a greater risk of exposure to unwholesome water.
2. That we must always plan to meet our water quality objectives.

Specific matters considered when developing our proposals for new sources (including the reintroduction of an existing source, bulk supplies and transfers that have been out of supply for 6 months or more) have included:

- Risk assessments of potential impacts on public health, wholesomeness, and acceptability to customers
- Consideration on the impact of mixing of different water types in terms of customer acceptability, network operation and maintenance, water stability and reservoir turnover
- Plumbosolvency control and other corrosion related quality risks, fluoridation, minimisation of disinfection by-products
- Increased risk of any non-compliance such as discolouration, taste & odours, nitrates or pesticides
- Collecting water samples for analysis to comply with the range of water quality parameters set out in Regulation 15 of The Drinking Water (Water Supply) Regulations 2016.

To support our scheme specific assessments, we have prepared an overall Water Quality Management Plan. This has provided us with a consistent approach for carrying out the assessment of water quality risk across all options from catchment to tap. The assessments have given consideration to the following:

- Source of water quality data
- Existing Drinking Water Safety plans (DWSP)
- Key water quality risks associated with that source
- Water treatment processes selected as effective control measures
- Mitigation for residual risks not addressed by the selected/existing process stream
- Recommendations for further investigation work with respect the water quality risks

Water quality risks and potential control measures identified during the assessment stage have been recorded on our individual scheme Stage 2 reports. Our assessment also identifies requirements for future work which will help us to quantify and mitigate all residual risks so that solutions can be tailored to known or expected risks.

E10 Demand Options

E10.1 Leakage

Our company direction is to achieve a sustainable 50% reduction in leakage by 2045. This will be done by employing the appropriate mix of interventions and options as listed below. Each option listed has independent cost against leakage benefit values, however there are secondary benefits. Mains renewal will allow us to renew our network and our worst performing pipes in order to keep Natural Rate of Rise (NRR) steady. Active Leakage Control will allow us to find the leakage and fix accordingly.

In AMP7 we were ambitious and set a 15% leakage reduction target for us to achieve which we are on track to deliver. In AMP8 we will continue this ambition, we are committed to deliver in line with customer expectations and reduce leakage by 16%.

The types of options we include in our leakage reduction plans are:

Active Leakage Detection

- Active Leakage detection will continue to be vital in achieving our leakage targets in AMP8.
- Active leakage detection investment levels have increased due to us focussing on delivering the 50% reduction in leakage by 2045.
- We will continue to maintain and upgrade an increasing number of pressure control valves, recognising that proactive maintenance will prolong asset life.
- We will continue to have a rolling programme of water balance improvement initiatives

Mains Renewal & Trunk Mains Renewal

- We will continue to refine our approach to measuring and reporting on trunk mains and service reservoir losses. We are committed to undertake more maintenance and surveys of trunk main assets.
- Mains Renewal investment will increase to achieve a sustainable lower level of leakage. Our aim is to drive leakage down and keep it down. Replacing mains at a rate of ~0.8% per year of AMP8 will enable us to do this.

Pressure Management

- We will continue maintenance of our PRVs and the more sophisticated units which we have installed.
- Installation of PRVs where we have scope to do so in a DMA will continue in order to control pressures.

Metering

- Our ambition is to roll out compulsory metering from AMP8 and achieve near universal household meter coverage by 2035. This will enable us to identify unaccounted for usage, reduce uncertainty in our water flow balance and give us more confidence in our top-down calculation of leakage.
- This is built into our plan for reducing leakage 50% by 2045.

E10.2 Water Efficiency

Overview - Base Plan

In line with customer expectations, our statutory water efficiency duty and regulatory guidance, we are committed to delivering a high quality, innovative and effective water efficiency programme and we propose a base water efficiency programme of 9.21Ml/d in AMP8.

This programme compares our AMP7 household baseline programme in WRMP19 of 15.89Ml/d, with a further 1.5Ml/d of enhancement activity through additional home water efficiency checks with social housing tenants, and an additional 4Ml/d of non-household demand reduction via Green Recovery funding. Our AMP7 baseline included proposed demand savings from education of 10.4Ml/d (8.75Ml/d from our schools' programme and a further 1.65Ml/d from educational activity with the remainder of our customer base). Starting in AMP 8 we have not included any demand saving from this activity due to uncertainty in savings.

To meet our statutory duty water efficiency, we have included the following water efficiency options in our dWRMP24:

- Provide water saving products free of charge to our customers on request. However, we have modified our approach by introducing the requirement for customers to complete a brief question and answer about their current water use and fittings including whether any of these are leaking before they can order free water efficiency products. This helps better target our products by only offering to customers products that are suitable for their property. This should cut the number of unsuitable products being ordered and ultimately wasted, ensuring our customers receive best value from our water efficiency programme
- Advice to our customers on how to use water more wisely delivered through our schools' education programme and for individual household customers using the Get Water Fit portal (GWF) https://www.stwater.co.uk/wonderful-on-tap/save-water/get-water-fit/
- Subsidised water butts
- A home water efficiency check programme (HWEC) -
    - Leak alarms (where we are made aware of continuous flow at a property). We offer to check the fittings at a property and install replacement water efficiency products where the customer agrees, and carry out internal leak repairs where it is simple to do so. This is free of charge
    - Social Housing (we will partner with social housing providers offering the same checks, products and repairs as described in leak alarms above).

We continue to assess the benefits of other options which includes:

- trials with household customers, offering home water efficiency checks (HWEC) to our highest consumers and customers who contact us about high bills
- assessing a tool (VYN) for customers to self-report suspected internal leaks at their property and
- an option to install an in-line flow regulator on the meter of customer properties to reduce the flow rate of water into the property which should reduce water and energy use within the property. We will initially test two different flow regulators before offering to customers.

At our visitor sites we will increase our communication with customers to include a revamp of exhibition areas and giving customers access to product ordering while they are on site.

We also intend to continue assessing the options for promoting and incentivising rainwater harvesting. We believe there is significant potential for using rainwater harvesting for irrigation at sports grounds, potentially starting with golf courses.

In developing our proposals, we have referred to the relevant guidance including 'Water Resources Planning Guideline July 2021', 'Meeting our Future Water Needs: A National Framework for Water Resources' and 'A Green Future: Our 25 Year Plan to Improve the Environment'. We also referred to 'Waterwise Evidence Base Reports', 'Retail Wholesale Group WRMP24: Guidance for retailer involvement in water resource planning' and data from our own water efficiency programmes.

Products

We will continue to offer both free and subsidised water efficient products to our customers although we think that we will phase these out by 2039-40 as water labelling and anticipated more stringent building regulations take effect. We also think we will have all but exhausted the customer base who are sufficiently engaged on water efficiency that they have requested free and subsidised water efficient products meaning the cost of promoting these products is likely to outweigh the benefit of supplying them.

We will continue to offer the same range of products as now, but continue to explore opportunities for introducing new innovative products as they become available. In the past year we have made three new products available to our customers.

- Kitchen stream (a multi-directional 6.8 litres minute flow regulator for kitchen taps)
- Toothy timer (a product which encourages children to brush their teeth twice a day for two minutes and to turn the tap off whilst brushing)
- Garden kit (contain swell gel, water mats, soil discs – all of which retain moisture and release water as plants need it – the kits also include flower seeds).

Free products

In 2020 we made a change to how customers could order free water saving products with the requirement that they now complete a short number of questions on our customer portal GetWaterFit (GWF). This enables us to understand current use which allows us to offer advice on how to reduce the water they use and, understand the current fittings in their property. We made this change so we could offer more tailored advice and to mean customers should only be able to order products they could use thus reducing waste. We have based our expectations of the number of orders, cost per order and savings per order on data reported in the first 6 months of 2021-22 which we assumed was half the number for the year. We will review this in our final WRMP. We have not used data from 2020-21 as we saw an exceptional number of orders during the Covid-19 lockdowns.

Subsidised products

In the main the subsidised products we currently offer are water butts. As the cost of showerheads has fallen, we now offer these free of charge although we still offer a limited range of more expensive showerheads at subsidised prices. These orders did not appear to have been impacted by Covid-19 to the same extent of free product orders, but as they fell slightly, so we have assumed that the annual sales in AMP7 will be the same as in 2020-21.

Home water efficiency checks (HWEC)

We will continue to offer HWEC to our customers. This will be:

- working with housing associations to offer HWECs to their tenants
- leak alarms from our meters.

We continue to assess the costs and benefits of offering these to our highest volume customers and to those customers who contact us about high bills.

Education

Our Education Team will continue to work to educate school pupils on the need to reduce water consumption. This will be through visits to schools and interactive content on our website. Although we will continue to offer this activity, we have decided that the demand savings are so uncertain we haven't included an assumption for savings from this activity for AMP7 and subsequent AMPs.

We will also continue to promote water efficiency messages through our Communications Team and via GWF customer portal – again we have not assumed demand savings from this activity.

Demand savings from our education and general communications to customers about how they can reduce their water consumption are so uncertain we have not assumed demand savings from these activities. However, we will continue with the activity as we still think it is beneficial to our customers and may have some impact on demand. We will assess how we can better understand the impact of our communications activity in the next few years. We have, for example, started to track the impact of our communications campaigns by assigning unique tagging to individual campaigns.

Enhanced options

We have considered additional household water efficiency activities that go beyond our baseline activities either new activity or increases in current activities which we continue to consider and responds to the challenge given to us by customers and stakeholders. The water industry has been set an ambitious long term PCC target of 110 litres/head/day by Defra, and we are presenting in this dWRMP24 the demand management activities we as company can deliver, to help move towards this challenging target. We know that achieving this level of reduction is ambitious and will require significant partnership working with a wide range of stakeholders. Whilst we welcome the desire for further ambition, we also must recognise the challenges of influencing consumer behaviour.

Water efficiency audits with non-households

We are currently trialling water efficiency audits with non-household customers using Green Recovery funding. The first stage was a small trial in partnership with the Department for Education working with schools to carry out water audits and remedial work in schools. A further small trial of other types of non-household customers has begun with both a wholesaler and retailer option being tested in the East Midlands. We have assumed as demand reduction from water efficiency audits with non-household customers of 10.2Ml/d in AMP 8.

Decay of base and enhanced savings

As in our previous WRMP we continue to assume that demand savings from our activity will reduce over time because:

- Customers will change the fittings within their homes as part of upgrades to their properties
- The natural life of retrofit products

We have based our assumptions about the likely decay rate of our water efficiency programme on information on half-life in Waterwise Evidence Reports.

E10.3 Metering

The government has set clear policy expectations that water companies should commit to actions required to reduce per capita consumption to 110 l/h/d by 2050.

To help achieve this target the government expects that:

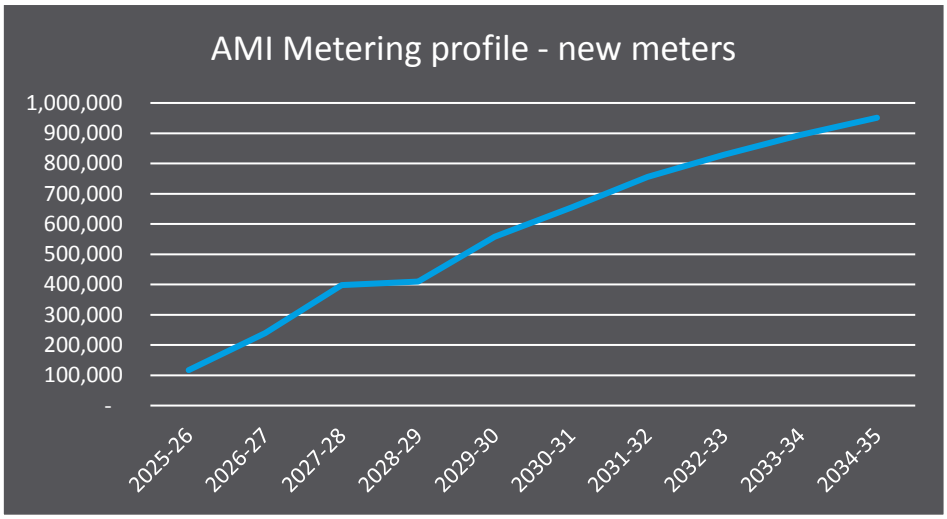
- water companies consider all available water metering options and present their preferred metering programme in the draft WRMP along with evidence of customer support.
- smart meters become the standard meter installed, given the wider benefits or there should be justification for using older technology.
- water companies help customers reduce water demand and water lost through leaks by adopting consistent approaches to support repair and replacement of supply pipes.
- to see more coordinated and strategic communications between companies, regional groups, and retailers to encourage efficient use of water throughout the year and monitor the impacts of these messages on water consumption.

Our draft WRMP builds on the commitments made in our 2019 plan to achieve near universal household meter coverage by 2035. In the 2019 WRMP we demonstrated that universal metering formed part of our best value long term plan, but in that plan, we proposed to achieve this goal using a 'prompted optants' approach.

Since the 2019 WRMP, the Environment Agency has declared that our region is classified as a water scarce area and as such we now are able to use legal powers that allow us to roll out compulsory water meters. Our draft WRMP has also explored the different smart metering technologies available, and our chosen metering technology will allow us to target water lost through leaking supply pipes and leaks on customers' internal fittings, allowing us to build on our work in the past few years of offering free leak repairs on internal fittings when we receive leak alarms as part of our home water efficiency check programme, and will also allow us to provide customers with accurate and up to date information on their water consumption.

In AMP8 we want to install Smart AMI meters to achieve 'universal metering coverage' by 2035. Under our current plan, we will achieve 95% household meter penetration and meet our WRMP24 and PR24 commitments.

Figure E10.1: Our expected meter penetration



E11 Summary of the constrained supply options

The following table E11.1 lists our constrained supply options. These have been developed with multi criteria metrics:

Table E11.1: Constrained supply options

Option ID	Option Name	Description
5	Derwent Valley Transfer Main	Construct a new bi-directional raw water main between the inlet to Bamford WTW and Carsington Reservoir.
6	Upper Derwent Valley Reservoir Expansion (UDVRE)	Raise or construct new dams in the Derwent Valley to increase raw water storage.
22	Recommission Elmhurst GW source	Rehabilitate/redrill boreholes, install WTWs (Nitrate + UV) and deploy to receiving network.
29	Homesford WTW capacity increase	Increase the capacity of Homesford WTW to 54Ml/d to enable treatment of the high flows from Meerbrook Sough (spring/summer), then deployed into DVA via a new booster.
31C	E. Midlands Raw Water Storage (CQ)	Acquire hard rock quarry and convert to a pumped raw water storage reservoir. Supply with raw water from River Soar (option 31C) or River Trent (option 31D). Construct new WTW at Quarry site and deploy to the Strategic Grid via new pipeline.
31D	E. Midlands Raw Water Storage (CHQ)	Acquire hard rock quarry and convert to a pumped raw water storage reservoir. Supply with raw water from River Soar (option 31C) or River Trent (option 31D). Construct new WTW at Quarry site and deploy to the Strategic Grid via new pipeline.
32	Little Eaton Expansion (supported by Carsington Reservoir)	Upgrade Little Eaton WTW to treat an additional 30Ml/d to enable the site to achieve its intended 120Ml/d maximum output. Co-ordinating the release of raw water from Carsington Reservoir will enable a support abstraction of 120Ml/d to be achieved for longer periods.
33Z	Shelton WTW Expansion	Utilise the full river abstraction licence, construct new process stream to treat additional water from R Severn and connect to existing network.
38	Minworth effluent re-use (Large scheme)	New effluent re-use plant (90Ml/d capacity WTW) to deploy potable water into the Strategic Grid WRZ via new pumping stations and pipelines to transfer to the receiving network.
39	Minworth effluent re-use (Medium scheme)	New effluent re-use plant (30Ml/d capacity WTW) to deploy potable water into the Strategic Grid WRZ via new pumping station and pipeline to transfer 30Ml/d to the receiving network.
44	New R Sow abstraction and WTW near Stafford	New river intake, new treatment works and deploy into network.
54	River Soar to Cropston WTW	New river intake on R Soar, new raw water pipeline and pumps to feed Cropston WTW.
58	River Weaver to New WTW at Stoke	New intake on R Weaver, construct small bankside storage and new WTW near Nantwich, new connection to network to reduce demand on existing sources.
64	Rehabilitation Milton GW Source	Recommission the STWL Milton GW source, use the raw water to support Melbourne WTW and supply the Strategic Grid WRZ. Rehabilitation of Milton source (re-drill boreholes if necessary) and abandon the Stanton by Bridge groundwater source. A new pipeline (2.1 km length) to connect to existing pipeline infrastructure

Option ID	Option Name	Description
		that connects with Melbourne WTW and new pumping station.
66	Strensham WTW Expansion	Expand Strensham Water Treatment Works (WTW) by 30Ml/d and is to include the construction of a new intake at Upton-upon-Severn. This additional water will be transferred to the expanded Strensham WTW predominantly in winter when there is greater water availability in the River Severn. Treated water will be deployed to the receiving network.
79A	Wolves-Bham Strategic Link Main (large)	Connect Frankley WTW in the Strategic Grid WRZ to Tettenhall Pumping Station in the Wolverhampton WRZ via the existing network. To enable this transfer, both existing and new assets will be utilised and some modification and recommissioning will be carried out of existing assets. Varying transfers proposed 10 to 20 Ml/d.
79B	Wolves-Bham Strategic Link Main (small)	Connect Frankley WTW in the Strategic Grid WRZ to Tettenhall Pumping Station in the Wolverhampton WRZ via the existing network. To enable this transfer, both existing and new assets will be utilised and some modification and recommissioning will be carried out of existing assets. Varying transfers proposed 10 to 20 Ml/d.
84A	Stanford Minor Dam Extension (84A)	Increase storage capacity of reservoirs by increasing Top Water Level (TWL). Minor works consisting of modifications to spillways, embankments, over flow weir and pipework.
84B	Lower Shustoke Minor Dam Extension (84B)	Increase storage capacity of reservoirs by increasing Top Water Level (TWL). Minor works consisting of modifications to spillways, embankments, over flow weir and pipework.
84C	Whitacre Minor Dam Extension (84C)	Increase storage capacity of reservoirs by increasing Top Water Level (TWL). Minor works consisting of modifications to spillways, embankments, over flow weir and pipework.
88	River Weaver to Tittesworth WTW	New abstraction point on the River Weaver (nr Northwich), new intake and pumping station. Raw water will be transferred (new pipeline) to a new settlement lagoon near Tittesworth WTW prior to treatment (upgraded for new raw water quality) and deployment into the network using existing assets.
95B	Ogston WTW Expansion	Expand WTW through new third process stream and upgrade existing WTW. Enhance raw water pumps at Ambergate (reliable transfer from Ogston and Carsington Reservoir), install pipelines and boosters to transfer additional output from Ogston WTW to the receiving network
101	Kinsall Additional Resource (UU import)	Import from UU's Vyrnwy Aqueduct. Recommission existing connection to main in Kinsall.
103	Mardy Support Link	The scheme is to enable Mardy WRZ to be supported by a transfer of water from Shelton WRZ. This is achieved through operating the existing pipeline in the reverse direction to the current conditioning flow. The resulting reduction in water available at Oswestry will be supported using the existing outputs from Shelton WTW and Pentre WTW.
104	Newark Support Link	This scheme is to transfer water from Nottinghamshire WRZ to Newark WRZ via new 12.4km pipeline.

Option ID	Option Name	Description
105	Ruyton Support Link	New 3.5km main to transfer water from Pentre (1Ml/d Average, 2Ml/d Peak). Transfer from Shelton WRZ to Ruyton WRZ.
108	Stoke to Stafford link main	Transfer water from North Staffs WRZ to the Stafford WRZ. New pipeline and new pumping stations will be constructed.
110	Wolves to Stafford link main	New pipeline (and pumping stations) from Wolverhampton WRZ to Stafford WRZ (sized at 30Ml/d) and onwards to North Staffs WRZ (sized at 25Ml/d).
111	Melbourne to Staffs link main	New pipeline(s) from Melbourne WTW (Strategic Grid WRZ) to Stafford WRZ (sized at 32Mld) and then to North Staffs WRZ (sized at 25Ml/d) and Stafford WRZ (sized at 7Ml/d).
112	Croxton GW to Hob Hill DSR	Refurbish/redrill boreholes (North Staffs WRZ) and transfer 3 Ml/d potable water to Stafford WRZ via new pipeline and pumping station.
117	Peckforton Bulk Import from UU	Import treated water from UUs Vyrnwy Aqueduct via reinstated connection to existing main. Construct new pumping station, install/upgrade chlorination and upscale chloramination plant.
120	River Severn to Draycote	Multiple sub options identified. 120A scheme enables a complex series of operations to manage raw water across various sources. Utilise spare storage capacity at Draycote Reservoir by licensing an additional winter quantity at the R Severn's Trimpley intake. Pump additional water from Trimpley to Draycote via boosters at Frankley, Sugarbrook and Eathorpe. During drought water will be released from Draycote to Longbridge STW in conjunction with abstraction from River Avon before being transferred to Frankley WTW for treatment. New infrastructure is required.
121	Mythe to Mitcheldean main	Utilise unused licence capacity on R Severn at Mythe, new pumping station at Mythe WTW and new raw water main to Mitcheldean WTW.
122A	Draycote Reservoir WL increase (6%)	Multiple options (9 to 15 Ml/d benefit). Increase storage capacity by raising Top Water Level by various modifications dependant on size. 6% capacity increase (1400Ml - 9Ml/d DO benefit), 25% (5800Ml - 12 Ml/d DO benefit) and 50% (11500Ml - 15 Ml/d DO benefit).
122B	Draycote Reservoir WL increase (25%)	Multiple options (9 to 15 Ml/d benefit). Increase storage capacity by raising Top Water Level by various modifications dependant on size. 6% capacity increase (1400Ml - 9Ml/d DO benefit), 25% (5800Ml - 12 Ml/d DO benefit) and 50% (11500Ml - 15 Ml/d DO benefit).
122C	Draycote Reservoir WL increase (50%)	Multiple options (9 to 15 Ml/d benefit). Increase storage capacity by raising Top Water Level by various modifications dependant on size. 6% capacity increase (1400Ml - 9Ml/d DO benefit), 25% (5800Ml - 12 Ml/d DO benefit) and 50% (11500Ml - 15 Ml/d DO benefit).
123A	Raise Dam at Tittesworth Reservoir (5%)	Multiple options (5 to 14 Ml/d benefit). Increase storage capacity by raising Top Water Level by various modifications dependant on size. 5% capacity increase (5Ml/d DO benefit) and 25% (14 Ml/d DO benefit).
123B	Raise Dam at Tittesworth Reservoir (25%)	Multiple options (5 to 14 Ml/d benefit). Increase storage capacity by raising Top Water Level by various modifications dependant on size. 5% capacity increase (5Ml/d DO benefit) and 25% (14 Ml/d DO benefit).
128	Carsington to Tittesworth main (large)	New pumped raw water pipeline from Carsington Reservoir to Tittesworth WTW. Two sub options are proposed 800mm diameter = 30Ml/d and 600mm

Option ID	Option Name	Description
		diameter = 14Ml/d. Additional raw water will enable Tittesworth WTW to operate longer into dry seasons. Additional potable water will be deployed into the North Staffs WRZ via new treated pipeline.
128Z	Carsington to Tittesworth main (small)	New pumped raw water pipeline from Carsington Reservoir to Tittesworth WTW. Two sub options are proposed 800mm diameter = 30Ml/d and 600mm diameter = 14Ml/d. Additional raw water will enable Tittesworth WTW to operate longer into dry seasons. Additional potable water will be deployed into the North Staffs WRZ via new treated pipeline.
132	Whaddon to Forest Transfer	The scheme does not require any capital works, as the assets have been installed previously. However, it requires operational changes to be made at Mythe WTW to allow release of an extra 5Ml/d from the Strategic Grid WRZ to the Forest and Stroud WRZ. It will also require control and operational changes at the pumps to enable the transfer.
134A	Blackbrook reservoir to Cropston WTW	Recommissioning of existing intakes at Blackbrook reservoir and conveyance of up to 8Ml/d raw water to Cropston WTW inlet via new pipeline. The existing Cropston WTW will be upsized to make additional capacity for treatment.
142	Utilise Linacre Reservoirs	New raw water intake at Linacre Reservoir with new pumping station and pipeline to new WTW and new pipeline to deploy treated water.
143	W.Midlands Raw Water Storage	Purchase and convert an existing third-party owned quarry site to a pumped raw water storage reservoir. New abstraction on R Severn during high flows with release of raw water back to R Severn during low flows to support abstraction at Trimpley or Lickhill via a new bi-directional pipeline and pumping station.
150	Little Haywood new WTW on Upper Trent	New abstraction point, intake and pumping station on the River Trent to the east of Stafford that supports a new WTW (sized for up to 30Ml/d) and via new pipeline.
152	Hampton Loade to Sedgley SR	New abstraction point on R Severn near Hampton Loade WTW (currently under utilised licence). New bankside storage reservoir, new raw water pipeline/pumping station to new WTW (sized at 50Ml/d). Treated water to be deployed via new pipeline.
169	Terminate raw water export to Yorkshire Water	Terminate export agreement. This will provide additional raw water in Derwent Reservoirs - to be stored and utilised during dry periods, enabling Bamford WTW to operate at higher capacity during dry seasons.
187A	Expand Carsington Reservoir (10000 Ml)	Multiple options to enlarge Carsington Reservoir to provide an additional storage volume. 187A = 10,000 Ml additional storage (45 Ml/d DO benefit), 187B = 16,000 Ml (75 Ml/d), 187C = 25,000 Ml (110 Ml/d).
187B	Expand Carsington Reservoir (16000 Ml)	Multiple options to enlarge Carsington Reservoir to provide an additional storage volume. 187A = 10,000 Ml additional storage (45 Ml/d DO benefit), 187B = 16,000 Ml (75 Ml/d), 187C = 25,000 Ml (110 Ml/d).
187C	Expand Carsington Reservoir (25000 Ml)	Multiple options to enlarge Carsington Reservoir to provide an additional storage volume. 187A = 10,000 Ml additional storage (45 Ml/d DO benefit), 187B = 16,000 Ml (75 Ml/d), 187C = 25,000 Ml (110 Ml/d).
190	Eyebrook Reservoir and new WTW's	Agree purchase of the Eyebrook Reservoir located to the north-west of Corby. The reservoir, previously

Option ID	Option Name	Description
		supplying industry in Corby, would provide raw water to a new WTW constructed close to the reservoir. Treated water will be deployed to the trunk main system and also towards customers in Market Harborough via two new pipelines.
191	Increase Diddlebury/Munslow GW sources and remove network constraints.	Increase abstraction from Diddlebury and Munslow GW sources resulting in combined output 2.2Ml/d Average and 2.86 Ml/d Peak. Upgrade high lift pumps to enable additional transfer of water from Diddlebury
301A	UU import from Llanforda to Shelton (small)	Import potable water from Llanforda WTW (UU) to Oswestry via the existing link main. It is expected the import will fully replace the transfer in the Shelton Link Main enabling this supply to be utilised elsewhere in the WRZ.
301B	UU import from Llanforda to Shelton (large)	Import potable water from Llanforda WTW (UU) to Oswestry via the existing link main. It is expected the import will fully replace the transfer in the Shelton Link Main enabling this supply to be utilised elsewhere in the WRZ.
303A	UU release from Vyrnwy (75 Ml/d)	This scheme is to enable managed release of an additional raw water from Lake Vyrnwy into the River Vyrnwy that subsequently augments flow in the River Severn to support abstractions at Lickhill (for Frankley WTW).
303B	UU release from Vyrnwy (40 Ml/d)	This scheme is to enable managed release of an additional raw water from Lake Vyrnwy into the River Vyrnwy that subsequently augments flow in the River Severn to support abstractions at Lickhill (for Frankley WTW).
303C	UU release from Vyrnwy (25 Ml/d)	This scheme is to enable managed release of an additional raw water from Lake Vyrnwy into the River Vyrnwy that subsequently augments flow in the River Severn to support abstractions at Lickhill (for Frankley WTW).
304	Ambergate to Mid-Notts transfer	New pipeline the DVA to Nottinghamshire WRZ. New pumping station required.
305	Heathy Lea to North Notts transfer	New pipeline from Derwent Valley Aqueduct to Nottinghamshire WRZ. New pumping station is required.
309	Transfer from Hampton Loade WTW to Nurton DSR (large)	Redirect some of the potable supply received from Hampton Loade WTW towards the Shelton WRZ instead of it being delivered to the Wolverhampton WRZ. .
309Z	Transfer from Hampton Loade WTW to Nurton DSR (small)	Redirect some of the potable supply received from Hampton Loade WTW towards the Shelton WRZ instead of it being delivered to Sedgley Beacon DSR in the Wolverhampton WRZ. .
313	DVA capacity increase to Heathy Lea (reduce Rivelin export)	Improve conveyance in the DVA to increase maximum output flows from Bamford WTW releasing constrained treatment capacity. Triplicate DVA syphon pipes and interstage pumping upgrades at Bamford WTW.
314	Expand Bamford WTW and DVA capacity increase (terminate Rivelin export)	New process stream and upgrades to Bamford WTW (produce up to 235Ml/d). Increase conveyance capacity of DVA, new pipelines, new pipeline from Bamford to Heathy Lea and new pumping station.
406	New abstraction and WTW on River Trent	New river intake on R Trent and new raw water bank side storage reservoir near to Stoke Bardolph to supply raw water to a new WTW near to the abstraction site. New pipeline/pumping station to deploy treated water.
420	Campion Hills WTW DO Recovery	Increase WTW capacity by removing existing constraints to enable abstraction licence to be fully utilised.

Option ID	Option Name	Description
423	Draycote WTW DO Recovery	Increase WTW capacity by removing existing constraints to enable abstraction licence to be fully utilised.
426	Little Eaton WTW DO Recovery	Increase WTW capacity by removing existing constraints to enable abstraction licence to be fully utilised.
429	Mythe WTW DO Recovery	Increase WTW capacity by removing existing constraints to enable abstraction licence to be fully utilised.
430	Ogston WTW DO Recovery	Increase WTW capacity by removing existing constraints to enable abstraction licence to be fully utilised.
431	Shelton WTW DO Recovery	Increase WTW capacity by removing existing constraints to enable abstraction licence to be fully utilised.
434	Trimpley WTW DO Recovery	Increase WTW capacity by removing existing constraints to enable abstraction licence to be fully utilised.
435	Whitacre WTW DO Recovery	Increase WTW capacity by removing existing constraints to enable abstraction licence to be fully utilised.
437	Finham FE to expanded Draycote Reservoir and WTW	Enhanced Effluent Treatment at Finham STW, transfer to expanded Draycote Reservoir for additional raw water storage then treat at upgraded and expanded Draycote WTW. Water then deployed via new pipe line to existing network in Coventry.
439	Longdon Marsh and increase Frankley output by 190 Ml/d	New raw water reservoir at Longdon Marsh, Gloucestershire supplied by a new abstraction on River Severn. New raw water pipeline from Longdon Marsh to Frankley WTW. Upgrade and upsize Frankley WTW. Deploy via new pipeline/pumping station.
523	UU Mow Cop BH Treated water import	Import potable water from UU Mow Cop BH. Scheme WR412 for UU. No capital works for ST just import costs.
528	New GW Source Soar - PT Sandstone nr Coalville	This scheme is to establish two new production boreholes in the Soar - PT sandstone groundwater body located to north of Coalville. Approximately 5Ml/d raw water will be abstracted from these new boreholes and will be transferred to Melbourne WTW using new pumps and pipeline.
549A	Raw water transfer from Congleton to Tittesworth Reservoir (UU import)	Raw water is to be transferred to Tittesworth Reservoir to enable increased utilisation of Tittesworth WTW, particularly during dry seasons. There are no capital assets proposed within the STWL scheme and it includes only the import costs that will be charged by UU to STWL. UU Option WR413
549B	Treated water transfer from Congleton to Tittesworth Reservoir (UU import)	Treated water is to be transferred to Tittesworth WTW, particularly during dry seasons. There are no capital assets proposed within the STWL scheme and it includes only the import costs that will be charged by UU to STWL. UU Option WR413
552	UU Bearstone treated water Import	UU import - Treated water transfer from Bearstone BH
556	ASL Capacity Increase - Hallgates to Oldbury	Increase capacity of network with new bi-directional main.
557	ASL Capacity Increase - Oldbury to Meriden	Increase capacity of network with new bi-directional main.