Strategic regional water resource solutions: detailed feasibility and concept design

Standard gate two submission for London Water Recycling Strategic Resource Option

November 2022

Disclaimer

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

Notice – Position Statement

This document has been produced as the part of the process set out by RAPID for the development of the Strategic Resource Options (SROs). This is a regulatory gated process allowing there to be control and appropriate scrutiny on the activities that are undertaken by the water companies to investigate and develop efficient solutions on behalf of customers to meet future drought resilience challenges.

This report forms part of suite of documents that make up the 'Gate 2 submission.' That submission details all the work undertaken by Thames Water in the ongoing development of the proposed SRO. The intention at this stage is to provide RAPID with an update on the concept design, feasibility, cost estimates and programme for the schemes, allowing decisions to be made on their progress.

Should a scheme be selected and confirmed in the Thames Water final Water Resources Management Plan (WRMP), in most cases it would need to enter a separate process to gain permission to build and run the final solution. That could be through either the Town and Country Planning Act 1990 or the Planning Act 2008 development consent order process. Both options require the designs to be fully appraised and, in most cases, an environmental statement to be produced. Where required that statement sets out the likely environmental impacts and what mitigation is required.

Community and stakeholder engagement is crucial to the development of the SROs. Some high-level activity has been undertaken to date. Much more detailed community engagement and formal consultation is required on all the schemes at the appropriate point. Before applying for permission Thames Water will need to demonstrate that they have presented information about the proposals to the community, gathered feedback and considered the views of stakeholders. We will have regard to that feedback and, where possible, make changes to the designs as a result.

The SROs are at a very early stage of development, despite some options having been considered for several years. The details set out in the Gate 2 documents are still at a formative stage.

Contents

Abbreviations

Acronym	Definition
ACWG	All Company Working Group
AIC	Average Incremental Cost
AMP	Asset Management Plan
AWRP	Advanced Water Recycling Plant
BEC	Beckton Water Recycling Scheme
BEIS	Business, Energy and Industrial Strategy
BIM	Building Information Modelling
BNG	Biodiversity Net Gain
BSA	Bulk Supply Agreement
CAP	Competitively Appointed Provider
Capex	Capital expenditure
CCW	Consumer Council for Water
CDM	Construction (Design and Management)
CDR	Conceptual Design Report
CEC	Contaminants of Emerging Concern
CPIH	Consumer Prices Index including owner occupiers' housing costs
CPRE	Council for Protection of Rural England
DCO	Development Consent Order – planning under the Planning Act 2008
DEL	Drought Event Level
DO	Deployable Output
DPC	Direct Procurement for Customers
DRA	Direct River Abstraction
DWI	Drinking Water Inspectorate
DWPA	Drinking Water Protected Areas
dWRMP	Draft WRMP
DWSP	Drinking Water Safety Plans
DYAA	Dry Year Annual Average
DYCP	Dry Year Critical Period
EA	Environment Agency
EES	Engineering Estimating System
eDNA	environmental DNA
EIA	Environmental Impact Assessment
FAT	Full Advanced Treatment
FBC	Final Business Case (DPC Related)
FRAP	Flood Risk Activity Permit
FRA	Flood Risk Assessment
GARD	Group Against Reservoir Development
GHG	Greenhouse Gas
GIS	Geographic Information System
HRA	Habitats Regulations Assessment
IEA	Initial Environmental Appraisal
IBP	Internal Business Plan
INNS	Invasive Non-Native Species

Acronym	Definition
IP	Infrastructure Provider (under a SIPR arrangement)
KGV	King George V Reservoir
LCK	Lockwood (referring to Lockwood Reservoir Pumping Station / Reservoir connection for Beckton water recycling scheme)
LPA	Local Planning Authority
LSE	Likely Significant Events
LTCD	Lower Thames Control Diagram
LTOA	Lower Thames Operating Agreement
M&E	Mechanical & Electrical
MBR	Membrane Bioreactor
MCZ	Marine Conservation Zones
Ml/d	Mega litres per day
MOG	Mogden Water Recycling Scheme
MOL	Metropolitan Open Land
MSS	Mogden South Sewer Scheme
NAU	National Appraisal Unit
NCA	Natural Capital Assessment
NDMA	N-Nitrosodimethylamine
NE	Natural England
NFU	National Farmers Union
NIC	National Infrastructure Commission
NPV	Net Present Value
NSF	Nitrifying Sand Filters
NSIP	Nationally Significant Infrastructure Project - under the Planning Act 2008
OB	Optimism Bias
OBC	Outline Business Case (DPC related)
Opex	Operating expenditure
PA2008	Planning Act 2008
PAH	Polycyclic Aromatic Hydrocarbons
PD	Principle Designer
PEA	Preliminary Ecology Survey
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctanesulfonic Acid
PLA	Port of London Authority
PMB	Project Management Board
PMO	Project Management Office
PPA	Power Purchase Agreement
PR	Price Review
Pywr	A generalised water resource network modelling tool written in Python
RAG	Red/Amber/Green
RAPID	Regulatory Alliance for Progressing Infrastructure Development
REGO	Renewable Energy Guarantee of Origin
RO	Reverse Osmosis
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment

Acronym	Definition
SINC	Sites of Importance for Nature Conservation
SIPR	Specified Infrastructure Projects Regulations
SOC	Strategic Outline Case
SOLAR	Strategic Overview of Long-Term Assets and Resources
SoS	Secretary of State
SPA	Special Protection Area
SRO	Strategic Resource Option
STW	Sewage Treatment Works
SWQRA	Strategic Water Quality Risk Assessment
T2AT	Thames to Affinity Transfer
TCPA	Town and Country Planning Act
TED	Teddington DRA Scheme
TGWTW	Thames Gateway Water Treatment Works
TLT	Thames Lee Tunnel
TOC	Total Organic Carbon
Totex	Total Expenditure
TTP	Tertiary Treatment Plant
TWG	Technical Working Group
UF	Ultrafiltration
UKHab	UK Habitat Classification
USEPA	United States Environmental Protection Agency
UV	Ultra-Violet
UVAOP	UV Advanced Oxidation Process
UXO	Unexploded Ordnance
WAFU	Water Available for Use
WBS	Work Breakdown Structures
WFD	Water Framework Directive
WIA	Water Industry Act 1991
WLC	Whole Life Carbon
WRMP19	Water Resources Management Plan 2019
WRMP24	Water Resources Management Plan 2024
WRSE	Water Resource South East
WRZ	Water Resource Zone
WTW	Water Treatment Works

Figure 1-1: London water recycling schemes – Overview Schematics

1. Executive summary

Overview

1.1. The London Water Recycling Strategic Resource Option (SRO) (previously referred to as the London Effluent Reuse SRO), comprises four potential schemes of various size configurations: Beckton water recycling scheme, Mogden water recycling scheme, Mogden South Sewer and Teddington Direct River Abstraction (DRA). Abstracted effluent or sewage in these schemes would be treated through an Advanced Water Recycling Plant (AWRP) or a Tertiary Treatment Plant (TTP) and discharged to the River Thames or the River Lee Diversion where it can be abstracted as a raw water resource. This SRO contains a viable set of solution options that includes a range of treatment schemes and conveyance components, which in combination deliver a resilient supply of raw water to the London Water Resource Zone (WRZ).

1.2. Thames Water has worked collaboratively to refine designs, cost and risk of the schemes, undertake appraisals and develop further the work done for Gate 1. The design development through Gate 2 has been in accordance with a set of design principles developed for the SROs.

1.3. All assessments through Gate 2 have used Water Resource South-East (WRSE) and/or the All Company Working Group (ACWG) methodologies where they exist to ensure consistency, with open engagement with key stakeholders.

1.4. Information from the WRSE draft best value regional plan shows the Teddington DRA scheme is required to deliver water to Thames customers from 2031. As part of Thames Water's draft Water Resources Management Plan (WRMP) 2024 the Beckton and Mogden water recycling schemes are selected as part of an alternative plan to the best value adaptive regional plan.

1.5. Thames Water therefore recommend Teddington DRA progress through to Gate 3 with full planning and procurement activities. We also recommend that the Beckton water recycling scheme and the Mogden water recycling scheme should advance to Gate 3 for further development. Both schemes would utilise an AWRP using Full Advanced Treatment (FAT) technologies including, ultrafiltration (UF), reverse osmosis (RO) and ultra-violet advanced oxidation process (UVAOP).

1.6. We recommend the SRO is split into three SROs to allow the development and progress of work through project stages to be based on a proportional suite of activities reflected by the outputs and development of the regional plan and Thames Water's WRMP24.

1.7. For Teddington DRA full planning and procurement activities are proposed to commence immediately to support delivery of a scheme from 2031. Key milestones in our delivery plan include:

- Planning application – Q2 2024
- Planning consent – Q2 2025
- Procurement award – Q4 2025
- Construction work begins – Q1 2027

1.8. Results of environmental investigations in Gate 2 suggest that the maximum capacity of Teddington DRA could be 100 Ml/d (150 Ml/d was progressed from Gate 1). The draft WRSE regional plan has selected the 75 Ml/d sized scheme. In addition, it is recommended that the maximum size capacity of Mogden could be 150 Ml/d (200 Ml/d was progressed from Gate 1). Both size reductions reflect the point at which risks of significant environmental impacts become low. The maximum combined capacity if both Teddington DRA and Mogden water recycling schemes progress would remain limited to 200 Ml/d owing to the available effluent from Mogden Sewage Treatment Works (STW).

1.9. We recommend that Mogden South Sewer exits the RAPID gated process and does not progress into Gate 3 due to the deployable output being significantly reduced based on available flow.

1.10. The table below summarises the key facts and recommendations for scheme progression into Gate 3.

Scheme Name	Description of Scheme	Constraint	Scheme Sub-Options	
Beckton water recycling scheme	Final effluent harvest, recycled water, convey recycled water to River Lee Diversion via a tunnel from Beckton to Lockwood (LCK) and Lockwood to River Lee. Abstraction from River Lee Diversion into King George V (KGV) reservoir	Max capacity of 300 Ml/d	AWRP options	50 Ml/d
				100 Ml/d
				150 Ml/d
			Conveyancing by two tunnels via LCK	Beckton - LCK via tunnel
				LCK-KGV tunnel
Mogden water recycling scheme	Final effluent harvest, recycling water, convey to River Thames upstream of Walton	Combined maximum capacity of 200 Ml/d from a combination of: Mogden – 150 Ml/d max Teddington DRA – 100 Ml/d max	AWRP options	50 Ml/d
				100 Ml/d
			Conveyancing	All streams
Teddington DRA	Final effluent harvest, tertiary treatment and convey to River Thames upstream of Teddington Weir. Upstream abstraction for discharge to Thames Lee Tunnel (TLT)		TTP	50 Ml/d
				75 Ml/d
			Conveyancing	Abstraction & TLT Connection
				Mogden STW - Teddington Tunnel

1.11. The risk of significant environmental impacts through construction of schemes are similar with some negative but largely temporary effects. The risk of significant operational impacts with scheme capacity amendments are low based on the investigations progressed through Gate 2. Where impacts are predicted mitigation measures are available to reduce the scale and magnitude of effect.

1.12. Drinking water quality was reassessed with new water quality monitoring data. The three schemes with AWRPs have mitigated the majority of risk to drinking water safety, with further mitigation to changes in customer perceptions of hardness and corrosivity potentially required. The fourth scheme, Teddington DRA, would not cause a change to drinking water safety due to the discharge location being below all raw water abstraction points.

1.13. We have broadened our stakeholder engagement through Gate 2, engaging with local planning authorities and undertaking further customer focussed engagement regarding changes to drinking water supplies.

1.14. We have refined our planning and procurement approach through Gate 2; our preferred planning route is via a Town and Country Planning Act (TCPA) application to each local authority that interacts with a scheme. We have recommended that the Teddington DRA follows an 'in-house' procurement model and exits the 'Direct Procurement for Customers' (DPC) model. For all other schemes the DPC model remains viable and preferred.

1.15. Each scheme could be construction ready within AMP8 if required, however our recommended activities through Gate 3 reflects the draft WRSE regional plan and alternatives as set-out in Thames Water's draft WRMP24.

1.16. The project finances have been carefully managed through Gate 2, with work aligned to stakeholder expectations. Our total expenditure has resulted in a saving of 44% when compared to the budget available.

1.17. Assurance of this submission has been completed in-line with Thames Water's 3-lines of assurance model and in the context of RAPID's assessment criteria for robustness, consistency and uncertainty. The SRO and the recommendations made within our submission is supported by the Thames Water board.

1.18. The actions and recommendations made in RAPID's final decision at Gate 1 have been addressed in Gate 2; these are summarised in section 9.

2. Background and objectives

Background

2.1. The National Framework for Water Resources developed by the Environment Agency (EA) (March 2020) explores England's long-term water needs. It sets out: (1) the scale of action needed to ensure resilient water supplies are available to meet the needs of all users in the future; and (2) a greater level of ambition for restoring, protecting and improving the environment that is the source of all our supplies. If no action is taken between 2025 and 2050 approximately 3,435 million extra litres of water per day will be needed for public water supply to address future pressures, with around 50% of the national need being in the south-east.

2.2. The Framework promotes the need for regional planning by regional groups, indicating that WRMPs alone are unlikely to deliver the right strategic solutions for the nation as a whole. The intention is that regional plans will deliver a step change in resilience and environmental protection by putting aside company boundaries and considering the needs of the whole region.

2.3. These step changes include increasing supplies – by exploring a range of options, such as inter regional transfers, reservoirs, water reuse schemes and desalination plants. The National Framework recognises that even with the most ambitious demand savings, supply side options will be needed to manage the uncertainty associated with demand reductions and to reduce reliance on drought measures that carry environmental risks.

2.4. The SRO incorporates four schemes progressed from RAPID Gate 1 by Thames Water: Beckton water recycling scheme, Mogden water recycling scheme, Mogden South Sewer and Teddington DRA. These schemes were identified as providing a reliable, and sustainable new source of water to support the flow of the River Thames or Lee and are part of a suite of potential new water infrastructure projects required by the National Framework.

Water resource objectives

2.5. The principal drivers for the need for additional water supply are set-out in table 2-1. These drivers are used by WRSE and by water companies to determine the amount of additional water needed in the future.Table 2-1 Primary water resource drivers

Driver	WRSE Implication
Future Population Growth	Population growth will result in the need to supply water to more customers. Forecast methodologies are prescribed by the UK Government's Water Resources Planning Guidance[1]. WRSE uses the latest regional forecasts produced by the Office of National

[1] Environment Agency, April 2022, Water Resource Planning Guideline v10

Driver	WRSE Implication
	Statistics, local authority housing plans and potential growth in the area between Oxford and Cambridge.
Impacts of climate change	May reduce the available flows in rivers or groundwater recharge thereby reducing the amount of water that can be supplied from existing water sources. River sources are most at risk and are more dependent on rainfall to maintain flows. In WRSE as a region, a median forecast of climate change is estimated to drive the need for an additional 110 Ml/d by 2075
Impacts of existing abstractions	Taking water from rivers, streams and underground sources can cause damage to the environment. Water companies need to reduce how much they take from some of their most sensitive water sources to prevent damage in the coming years and help improve them. This reduces the available supply from existing water sources. Under the EA's National Framework for Water Resources[2], regional water resource groups are required to explore and implement the steps required to achieve a shared Environmental Destination to reduce the most environmentally unsustainable abstractions.
Improved drought resilience	The EA's National Framework for Water Resources[2], requires companies to plan for a higher level of resilience to drought, so that restrictions such as rota cuts and standpipes will be needed no more than once every 500 years on average. The WRSE regional plan includes the additional water that will be needed to replace them. In total, an additional 410 million litres of water are needed to make the region's water supplies more resilient to a one in 500-year drought.

2.6. Overall, the schemes within the SRO are part of the supply-side options set that could be used to meet the combined overall need for an additional 1 billion litres of new water supply per day by 2040, increasing to a maximum of 2.6 billion by 2100 under the highest scenario.

3. Solution design, options and sub-options

Scheme descriptions

3.1. The four London water recycling schemes treat effluent either through an Advanced Water Recycling Plant (AWRP) or Tertiary Treatment Plant (TTP) and discharge to the River Thames or the River Lee Diversion to be abstracted as a raw water resource at a water treatment works (WTW) downstream.

3.2. The options include:

- **Beckton water recycling scheme:** A proportion of final effluent from the Beckton Sewage Treatment Works (STW) in East London would be treated at a new AWRP within the STW site boundary. The recycled water would then be transferred and discharged into the River Lee Diversion above the inlet for King George V Reservoir (KGV) to supplement the raw water supply to the Lee Valley reservoirs. The recycled water conveyance would consist of two tunnels – one from Beckton AWRP to Lockwood (LCK) Reservoir Pumping Station site and the other from LCK to KGV via discharge into the River Lee Diversion. Maximum scheme capacity under investigation through Gate 2 is 300 Ml/d in 50, 100 or 150 Ml/d phases.

[2] Environment Agency, March 2020, Meeting our future water needs: a national framework for water resources

- **Mogden water recycling scheme:** A proportion of final effluent from the Mogden STW would be transferred to a new AWRP located near the Kempton WTW. The recycled water would be conveyed and discharged into the River Thames upstream of the existing Thames Water Walton intake. Maximum scheme capacity progressed from Gate 1 was 200 Ml/d with further investigation through Gate 2 on schemes at 100 and 150 Ml/d (see paragraphs 3.13-3.14).
- **Mogden South Sewer scheme:** Sewage would be abstracted from the South Sewer which discharges into the Mogden STW and transferred to a new STW and AWRP facility near the Kempton WTW for treatment. Recycled water would be conveyed and discharged into the River Thames upstream of the existing Thames Water Walton intake. Maximum scheme capacity under investigation through Gate 2 is 50 Ml/d in one phase.
- **Teddington DRA scheme:** A proportion of final effluent from Mogden STW would be subject to additional tertiary treatment at a new plant on the STW site and then conveyed to a discharge location upstream of Teddington Weir. The discharge would directly compensate flows taken from a new abstraction on the River Thames, upstream. The abstracted water would be pumped into the nearby Thames-Lee-Tunnel (TLT) for transfer to the Lee Valley reservoirs. The maximum scheme capacity progressed from Gate 1 was 150 Ml/d with further investigation through Gate 2 on schemes at 75 and 100 Ml/d (see paragraphs 3.19-3.20). There is a potential to increase water supply resiliency further with connecting or extending the TLT from Lockwood to KGV which is currently filled only by the River Lee Diversion, as proposed in the Beckton water recycling scheme (this is known as the TLT extension). Further work is planned through Gate 3 to examine and investigate the benefits this extension provides.

Table 3-1: Summary of solutions progressed from Gate 1 and investigated through Gate 2.

<table>
<tr><th>Scheme Name</th><th>Description of Scheme</th><th>Constraint</th><th colspan="2">Scheme Sub-Options</th></tr>
<tr><td rowspan="5">Beckton water recycling scheme</td><td rowspan="5">Final effluent harvest, recycled water, convey recycled water to River Lee Diversion for abstraction into KGV reservoir.
Conveyance via LCK pumping station using tunnels or directly to the River Lee Diversion via a pipeline (subsequently rejected through Gate 2)</td><td rowspan="5">Maximum capacity of 300 Ml/d</td><td rowspan="3">AWRP options</td><td>50 Ml/d</td></tr>
<tr><td>100 Ml/d</td></tr>
<tr><td>150 Ml/d</td></tr>
<tr><td rowspan="2">Conveyancing by two tunnels via LCK or a direct pipeline for a smaller sized scheme</td><td>Beckton - LCK Tunnel</td></tr>
<tr><td>LCK-KGV Tunnel</td></tr>
<tr><td rowspan="3">Mogden water recycling scheme</td><td rowspan="3">Final effluent harvest, recycling water, convey recycled water to River Thames upstream of Walton</td><td rowspan="8">Combined maximum capacity of 200 Ml/d made up in any combination of:

Mogden – 200 Ml/d max

South Sewer – 50 Ml/d

DRA – 150 Ml/d max</td><td rowspan="2">AWRP options</td><td>50 Ml/d</td></tr>
<tr><td>100 Ml/d</td></tr>
<tr><td>Conveyancing</td><td>All streams</td></tr>
<tr><td>Mogden South Sewer</td><td>Sewage harvest, treatment, reuse, convey recycled water to River Thames at Walton</td><td>AWRP and conveyancing</td><td>50 Ml/d</td></tr>
<tr><td rowspan="5">Teddington DRA</td><td rowspan="5">Final effluent harvest, tertiary treatment and convey to River Thames upstream of Teddington weir. Upstream river abstraction for discharge to TLT.

Potentially, extension of TLT (as per Beckton water recycling scheme).</td><td rowspan="2">TTP</td><td>50 Ml/d</td></tr>
<tr><td>75 Ml/d</td></tr>
<tr><td rowspan="3">Conveyancing</td><td>Abstraction & Thames Lee Tunnel Connection</td></tr>
<tr><td>Mogden STW - Teddington Tunnel</td></tr>
</table>

3.3. The scheme design developed through Gate 2 has been in accordance with the ACWG publication on Design Principles which comprise of the four principles of the National Infrastructure Commission covering; climate; people; place; and value. A design vision has been developed by Thames Water to create a resilient water supply for customers in Greater London and the south-east that commits to:

- Provide a secure, resilient and high-quality new resource of raw water to Greater London and supplement the water supply to the region, ensuring beautiful and functional design.
- Protect and promote the recovery of nature and achieve environmental net gain, while limiting and mitigating any local effects.
- Develop solutions that provide social amenity value and environmental benefits.
- Work collaboratively with stakeholders to ensure the best value for customers and the environment while meeting the needs of local communities.
- Create a long-term sustainable resource that recycles an existing resource to reduce the water footprint.

Key assets required

3.4. Key components to be constructed as part of each scheme are listed in table 3-2. The concept design of each scheme is provided in annex A1-A4.

Table 3-2: Key components of the London water recycling schemes to be constructed

Scheme Name	Key Components
Beckton water recycling (annex A1)	• Beckton STW final effluent abstraction (pumping station and pipeline located within Beckton STW) • Beckon AWRP (50 – 300 Ml/d) located within Beckton STW • Recycled water conveyance o 3.5m-dia. transfer tunnel (AWRP – LCK Reservoir Pumping Station) o 3.5m-dia. transfer tunnel / TLT extension (LCK Reservoir Pumping Station - KGV) • Recycled water discharge outfall at River Lee Diversion • Waste stream collection and discharge (pumping station and pipeline located within Beckton STW)
Mogden water recycling scheme (annex A2)	• Mogden STW final effluent abstraction (pumping station located in Mogden STW) • Final effluent transfer tunnel (Mogden STW – AWRP) • AWRP located on Thames Water owned land near Kempton WTW (50 – 200 Ml/d, site selection in progress) • Recycled water transfer pipeline (AWRP - River Thames) • Recycled water discharge outfall to the River Thames • Waste stream collection and discharge (pumping station and pipeline, AWRP – Mogden STW)
Mogden South Sewer scheme (annex A3)	• South Sewer sewage abstraction (pumping station located on Thames Water owned land near Kempton WTW • Raw sewage transfer pipeline (South Sewer - AWRP) • New STW located on Thames Water owned land near Kempton WTW (less than 50 Ml/d) • AWRP co-located with the new STW (less than 50 Ml/d) • Recycled water transfer pipeline (AWRP - River Thames) • Recycled water discharge outfall to the River Thames • Waste stream collection and discharge (pumping station and pipeline, AWRP – Mogden STW. Part of waste stream may be returned to South Sewer)
Teddington DRA scheme (annex A4)	• Mogden STW final effluent abstraction (pumping station located in Mogden STW) • TTP located at Mogden STW (up to 150 Ml/d) • Treated effluent transfer tunnel (Mogden STW – Teddington)

Scheme Name	Key Components

	• Treated effluent discharge outfall to the River Thames
	• Teddington river abstraction
	  o Intake from the River Thames
	  o Abstracted raw water transfer (pumping station and pipeline, intake - TLT)
	• Waste stream collection and discharge (pumping station and pipeline located within Mogden STW)

Option configuration and scalability

3.5. Configuration of solution options and sub-option elements for each scheme are set out in table 3-1. Beckton and Mogden water recycling schemes are selectable in multiple sizes based upon phasing or multiple selection of the 50, 100 or 150 Ml/d AWRP options. Mogden South Sewer scheme and Teddington DRA scheme will likely be single phase developments.

3.6. Through the WRSE regional planning process, it will be decided whether one or more of the London water recycling schemes are selected including the scheme size and any future phasing. The configurations, however, are governed by a number of constraints and assumptions made at this stage:

- Schemes using final effluent from Mogden STW are all dependent on sewage flows to Mogden STW (see paragraph 3.13) and a combined scheme capacity of 200 Ml/d was placed to stop the regional modelling selecting more Mogden options than the available effluent could support.
- A size constraint of 75 Ml/d was put in place on the Teddington DRA scheme within the draft WRSE regional modelling as a result of concerns raised by the National Appraisal Unit (NAU) over the potential impact within the River Thames from a scheme up to 150 Ml/d at Gate 1. This constraint was investigated further through Gate 2, and our recommendations reflect a revised position on a maximum scheme capacity (see paragraphs 3.19-3.20).
- The TLT extension is a bulk transfer option which has the capability to convey flow either from the existing TLT to the river Lee upstream of the KGV intake utilising Teddington DRA or from the Beckton to Lockwood tunnel to convey the recycled water from Beckton to the KGV intake. The regional modelling input sheets have dependencies, whereby certain options may only be selected if the prior option is selected. The result means that selecting either Teddington DRA or Beckton water recycling scheme requires the TLT extension to also be selected no matter which scheme is selected first. Therefore, the TLT extension effectively becomes a requirement of both Beckton and Teddington. The need for the TLT extension as part of a Teddington DRA, however, is subject to ongoing work.
- The maximum scheme size for the Beckton scheme is driven by the risk of environmental effects in the Tideway (principally from salinity, water level and sedimentation changes) from the combination of existing and planned schemes reducing freshwater flows in the middle Thames Tideway. Studies through WRMP19 indicated salinity impacts would become a concern with a net reduction in freshwater flows between 275-366 Ml/d. The maximum scheme size for the regional modelling was assumed to be 300 Ml/d as a result and this has been investigated further through Gate 2 (see paragraphs 3.9-3.12)
- There is currently no identified in-combination effect between east and west London schemes therefore scheme size is not constrained by the selection of either option. This will be reviewed again in Gate 3, when further evidence has been collected during the low flow conditions of summer 2022.

3.7. Through Gate 2, a number of studies were carried out with the objective of refining options and supporting assumptions set-out in paragraph 3.6. The findings of these investigations have informed our recommendations for scheme options and progression into Gate 3.

Option refinement and feasibility considerations

3.8. Through Gate 2 we undertook a number of environmental and engineering appraisals and investigations to refine options and provide more certainty and evidence to scheme constraints.

Scheme capacity

Beckton water recycling scheme capacity

3.9. Through our environmental investigations, we undertook spreadsheet based stochastic modelling of the freshwater Enfield Island Loop and 3D hydraulic modelling of the estuarine Thames Tideway to understand the risk of breaching any environment thresholds, Water Framework Directive (WFD) status or EA guidance for different scheme sizes up to 300Ml/d. The details of this work are set-out in section 6 and annex B2.2 and the results show only negligible impacts to the River Lee Diversion Channel from a 300 Ml/d sized Beckton scheme.

3.10. Environmental investigations in the Thames Tideway identified no significant effects resulting from a reduced Beckton STW final effluent discharge associated with a 300 Ml/d Beckton water recycling scheme.

3.11. Available evidence at Gate 2 indicates that the limited salinity effects associated with reduced STW final effluent discharge effects from a 200ML/d Mogden water recycling scheme and a 300Ml/d Beckton water recycling scheme under 1 in 20-year low flow conditions are spatially distinct and would not lead to a significant cumulative effect. Other schemes included in WRMP19 / WRMP24 (for example Deephams Reuse, Beckton desalination and Crossness desalination schemes) also have the potential to reduce freshwater inputs into the middle Tideway. These schemes combined with a Beckton 300 Ml/d scheme would contribute to decreasing freshwater inputs into the middle Tideway by about 18%. Analysis at Gate 1 estimated that a freshwater reduction of 20% (c. 366 Ml/d) or greater would result in a high risk of significant effects. Therefore the maximum size Beckton scheme remains at 300Ml/d.

3.12. Site appraisal work examined the footprint of multiple AWRPs and the space available within the boundary of the Beckton STW. It was determined that a capacity up to 300 Ml/d could be located within the STW boundary but that sizes in-excess of this would need additional land outside the STW boundary.

Mogden water recycling scheme capacity

3.13. Maximum Mogden scheme size at Gate 1 was assumed to be at 200 Ml/d which would require ~300 Ml/d of effluent from the STW taking account of the losses through the recycling process. According to Thames Water's Strategic Overview of Long-term Assets and Resources (SOLAR) analysis, a projection of domestic flow to be received by the Mogden STW in 2031 would be 305 Ml/d. This value does not include infiltration or trade flows which may reduce significantly in drought conditions. As it could be assumed that domestic flows are relatively stable and all inflows to the Mogden STW essentially leave the site as final effluent, this value is considered as a conservative estimate of available effluent from the Mogden STW during drought conditions.

3.14. As part of our environmental investigations, we undertook 1D fluvial water quality modelling of the River Thames and 3D hydraulic modelling of the outfall locations and weir pools in the fluvial Thames and 3D hydraulic modelling of the Thames Tideway to understand the risk of breaching any environmental thresholds, WFD status or EA guidance for different scheme capacities. The details of this work are set out in section 6 and annex B2.2. The results show a significant risk from a 200 Ml/d scheme breaching EA thermal plume characteristics where the extent of the 2°c temperature change from a discharge extends greater than a 25% cross sectional area of the river. At 150 Ml/d capacity breaches occur in only extreme scenarios

whereas at 100 ml/d the modelling showed no risk of breaching guidance. The constraint therefore on maximum scheme size for Mogden is driven by the potential environmental impacts rather than the available final effluent and therefore for future scheme investigations the maximum capacity of a Mogden water recycling scheme would be capped at 150 Ml/d, Although the temperature impact of a smaller 150 Ml/d scheme is reduced and infrequent, mitigation in the form of operating procedures that implement cessation of operation during periods of significant temperature difference between the recycled water and the receiving water body when under low river flow conditions may need to be considered further in Gate 3.

Mogden South Sewer scheme capacity

3.15. As part of our option feasibility evaluation, source flow of the Mogden South Sewer scheme (i.e., raw sewage from South Sewer near Kempton WTW) was monitored at 2-minute intervals from March 2021 through to 2022. The results show a dry weather flow ranging between 33 and 36 Ml/d which is substantially below the flow required to support a 50 Ml/d scheme. The maximum size a Mogden South Sewer scheme could support would therefore be ~ 25 Ml/d based on this evidence.

3.16. Re-evaluation of costs for a smaller scheme showed increasing Average Incremental Cost (AIC) and did not show value for money when compared to the costs for other water recycling schemes with larger yield.

3.17. However, it was determined early in Gate 2 that the South Sewer scheme does provide an undefined wastewater benefit, as it provides headroom in Mogden STW by intercepting and treating flow that would be destined for Mogden STW.

3.18. Despite this however, Thames Water took the decision early in Gate 2 to pause the direct design development of a Mogden South Sewer through Gate 2 purely from a water resources planning perspective owing to the above aspects. This pause on direct design development limited unnecessary spend at this stage and until a point when the wastewater benefits of a joint scheme could be understood. Therefore, the concept design for Mogden South Sewer is largely the same as at Gate 1; however, where conveyance routes, discharge infrastructure and operational philosophy have been refined for Mogden water recycling scheme it is equally applicable to Mogden South Sewer scheme and these updates have been included in the concept design (annex A3) and reflected in updated cost calculations submitted to WRSE in February 2022 and presented in section 8.1.

Teddington DRA scheme capacity

3.19. Maximum scheme size of Teddington DRA at Gate 1 was 150 Ml/d however concern was raised by the NAU on a scheme of this size based on the mass-balance modelling completed at Gate 1. Through Gate 2 we undertook detailed 3D hydraulic modelling and 1D fluvial water quality modelling to understand the risk of effects for different capacity schemes to both the freshwater and estuarine Thames. The modelling results are presented in annex B2.2 and the results show that there is a significant risk of exceeding a 2 °c temperature change across greater than a 25% cross sectional area of the river for a 150 Ml/d scheme. Results for the 100 and 75 Ml/d show a very low risk of breaches to thermal plume characteristics and therefore, based on the requirement to not exceed EA guidance, future scheme progression for Teddington DRA would be capped at a maximum of 100 Ml/d. Although the temperature impact of a smaller 100 Ml/d scheme is reduced and infrequent, mitigation in the form of operating procedures that implement cessation of operation during periods of significant temperature difference between the recycled water and the receiving water body when under low river flow conditions may need to be considered further in Gate 3.

3.20. Site appraisal work also examined the footprint of different sized TTPs at Mogden STW. The results confirmed the site where the existing storm tanks are located in Mogden STW could accommodate 100 Ml/d TTP. Because a part of the footprint for the existing storm tanks will be

used for TTP, some of the other existing storm tank may need to be deepened to maintain the required stormwater storage capacity for the STW. Alternatively, the TTP could be built on a platform built above the existing storm tanks. An optimal design will be developed through Gate 3.

Scheme site and conveyance route appraisal

3.21. Site and conveyance route appraisal was undertaken through Gate 2, reviewing all sub-options identified for schemes at Gate 1. The appraisal process followed a methodology adopted from Thames to Southern Transfer SRO used at Gate 1 and adapted to reflect the urban setting of London. The process utilised professional judgment and expertise of a multi-disciplinary team comprised of engineers, environmental assessors, town planners and land experts and followed a systematic process of appraisal covering the steps shown in figure 3.1

Figure 3-1: Site and conveyance route appraisal - key steps

Beckton conveyance options

3.22. Two conveyance route options were carried forward from Gate 1, a combination of tunnels from Beckton to KGV via LCK for schemes up to 300 Ml/d and a direct pipeline route from Beckton to KGV for transfers up to 100 Ml/d. The later sub-option was introduced at Gate 1 to confirm whether a smaller and potentially cheaper capacity conveyance would make a Beckton water recycling scheme more viable compared to the tunnel option.

3.23. The route appraisal for the pipeline sub-option showed a number of conflicts between land use and planning policy designation that could not be fully mitigated. Where mitigation did exist this resulted in increasing scheme cost to the point that the pipeline conveyance AIC cost exceeded the tunnel option. Significant environmental impacts were also identified that could be mitigated but would have resulted in extending construction programmes to avoid key periods and delaying when a scheme could be operational.

3.24. As a result of this appraisal Thames Water wrote to RAPID to formally request the removal of the pipeline sub-option from Gate 2[3], which RAPID approved in May 2022 [4]

3.25. A combination of the two tunnel sub-options (Beckton – LCK tunnel and LCK – KGV tunnel) for the Beckton water recycling scheme was also appraised and was confirmed as representing a preferred conveyance option, with ongoing progression to be informed by regional modelling outcomes, consultation and option appraisal refinement.

[3] https://www.ofwat.gov.uk/wp-content/uploads/2022/05/Thames-Water-letter-to-RAPID-Beckton-pipeline-route-rejection-version2.1.pdf

[4] https://www.ofwat.gov.uk/wp-content/uploads/2022/05/Letter-from-Paul-Hickey-to-Rob-Bromley-20-May_2022.pdf

Mogden and Mogden South Sewer conveyance and AWRP location

3.26. Appraisal of the conveyance options identified that the general alignment for the conveyance route was considered to be acceptable, subject to adjustments to avoid interfacing with special category land.

3.27. With regards to the AWRP site, a series of locations owned by Thames Water near Kempton WTW were appraised. It was identified that this scheme and its AWRP provisions would require further review against three possible location areas for delivery of the AWRP in Gate 3.

Teddington DRA conveyance

3.28. The sites and conveyance route appraisal identified that the majority of Gate 1 conveyance route alignment for Teddington DRA scheme was acceptable, subject to the adjustment of possible site areas for intermediate shafts, and relocation of the discharge outfall location and river abstraction intake to take account of environmental modelling, land use and ownership. The river abstraction intake was identified as requiring further detailed design review and stakeholder engagement with its interface with the public realm setting and its connection to TLT.

Summary of refined options at Gate 2.

3.29. Table 3-3 summarises the refinement of options through Gate 2 following the engineering and environmental investigations work completed on scheme capacity and site and route conveyance appraisals.

Table 3-3: Summary of refined options at Gate 2.

Scheme Name	Constraint	Scheme Sub-Options	
Beckton water recycling scheme	Max capacity of 300 Ml/d	AWRP options	50 Ml/d
			100 Ml/d
			150 Ml/d
		Conveyancing by two tunnels via LCK	Beckton - LCK Tunnel
			LCK-KGV Tunnel
Mogden water recycling scheme	Combined maximum capacity of 200 Ml/d from a combination of: Mogden – 150 Ml/d max Teddington DRA – 100 Ml/d max	AWRP options	50 Ml/d
			100 Ml/d
		Conveyancing	All streams
Teddington DRA		TTP	50 Ml/d
			75 Ml/d
		Conveyancing	Abstraction & TLT Connection
			Mogden STW - Teddington Tunnel

Solution operation

Operating philosophy

3.30. The water recycling schemes would operate intermittently as required during periods of drought in the Thames Water Drought Plan framework. Anticipated operational utilisation rates are set out in section 4.

3.31. It was assumed that the water recycling schemes would be utilised and operated as one of the strategic drought schemes and that the trigger of utilisation would be same as the strategic drought schemes in the current Drought Plan. Strategic drought schemes are sources of water that are permitted for use during drought period but are not used as part of day to day' baseline supply. Thames Water Draft Drought Plan 2022 lists five strategic drought schemes including Thames Gateway Water Treatment Works (TGWTW).

3.32. As per the Thames Water Drought Plan, strategic drought schemes are brought into service when reservoir storage drops lower than typically observed at the time of year. The following triggers for utilisation of strategic drought schemes are identified in the Lower Thames Operating Agreement (LTOA):

- Naturalised flow over Teddington Weir receding down to 3000 Ml/d on average for 10 days during the course of a drought event (defined as having a Drought Event Level (DEL) equal to or greater than DEL1), and
- Reservoir storage levels having fallen to the Teddington Weir 800-700/600 Ml/d flow requirement defined in the Lower Thames Control Diagram (LTCD).

3.33. Several operating models have been considered in Gate 2, and it is recommended that the water recycling schemes be operated in a continuous sweetening flow model illustrated in figure 3-2Figure 3-2. Refer to annex A1 to A4 for details of different operating models.

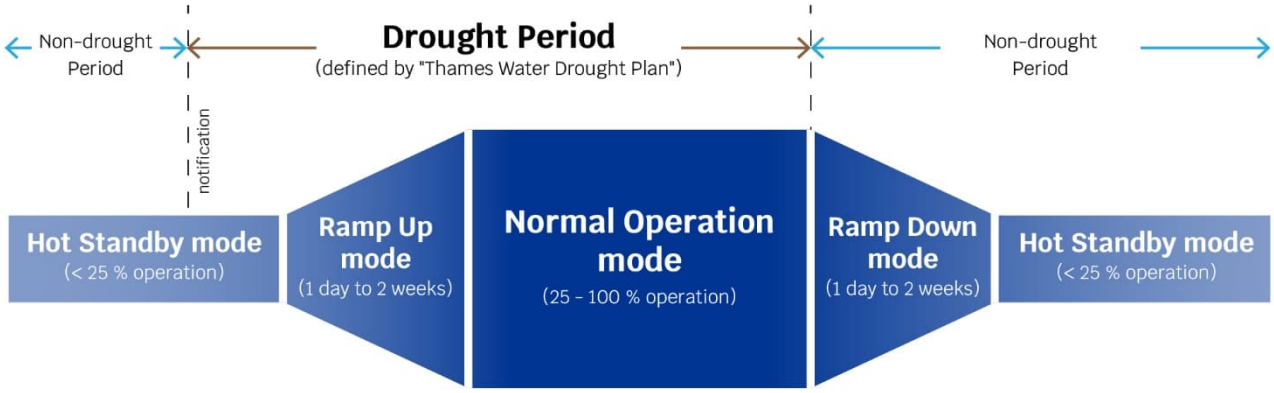


Figure 3-2: Continuous sweetening flow model

3.34. In the continuous sweetening flow model, the system will be in a hot standby mode during non-drought periods and will generate recycled water at lower rate (i.e., 25% of full capacity or less) to enable timely recommissioning when supply is required.

3.35. If operation is stopped completely during non-drought periods, AWRPs would require at least 8 to 9 weeks for recommissioning, while Nitrifying Sand Filters (NSFs) in a TTP for Teddington DRA would require 6 to 8 weeks or more to re-establish biomass in the NSFs.

3.36. It is also preferable to maintain a small amount of flow constantly throughout the conveyance systems to avoid stagnant and biological growth within the pipes/ tunnels (i.e., sweetening flow). Therefore, in Gate 2, it was assumed that the generated recycled water flow at 25% of plant capacity would be used for sweetening flow and discharged into the receiving water bodies during non-drought periods for Mogden and Teddington scheme and a sweetening flow of 15 Ml/d for Beckton to avoid potential flooding risks downstream of the River Lee Diversion.

3.37. Optimal flow rates generated in the AWRP/ TTP and used for sweetening flow during non-drought periods will be further investigated through Gate 3.

Maintenance

3.38. Maintenance requirements for the water recycling schemes include items listed in table 3-4.

Table 3-4: Maintenance requirements

Area	Element	BEC	MOG	MSS	TED	Maintenance
Sewage Treatment	Inlet works and primary settlement tank			✓		Including preventative and reactionary maintenance, chemical handling, sludge handling and effluent quality monitoring. Thames Water have experience with these technologies. Weekly membrane maintenance chemical cleaning – MBR Biannual membrane recovery chemical cleaning – MBR
	Activated sludge plant with biological nutrient removal			✓		
	Membrane Bioreactor (MBR) and sludge stream			✓		
Advanced Water Recycling Plant (AWRP)	Ultrafiltration (UF)	✓	✓			Including preventative and reactionary maintenance, chemical handling, sludge handling and water quality monitoring. Infrequent (monthly) membrane chemical cleaning – UF and RO. Continual maintenance for all mechanical and electrical (M&E) equipment. Every 5 years – RO membrane, UF membrane and UV lamp replacement
	Reverse Osmosis (RO)	✓	✓	✓		
	UV Advanced Oxidation Process (UVAOP)	✓	✓	✓		
	Remineralisation and chemical dosing	✓	✓	✓		
	Waste stream	✓	✓	✓		
Tertiary Treatment Plant	Nitrifying sand filters				✓	Including preventative and reactionary maintenance, chemical handling and water quality monitoring. Continual maintenance for all M&E Every 5 years – Replacement of pile cloth media for mechanical filter Every 10 years – Replacement of Nitrifying Sand Filter media
	Mechanical cloth filters				✓	
	Ancillaries (chemical dosing, waste stream, etc.)				✓	
Conveyance	Abstraction (effluent/sewage)	✓	✓	✓	✓	Annual inspection of all pumping station equipment and valves, and inspection of abstraction and discharge structures. Annual walkover and exercising of pipeline/tunnel valves and inspection of shafts. Continual maintenance for all M&E
	Tunnel / pipeline (by hydraulic head)	✓			✓	
	Tunnel/ pipeline (pressurised)	✓	✓	✓	✓	
	River intake screen				✓	Annual inspection of all pumping station equipment and valves. Annual inspection of (or inspection after major storm events) intake screen. Removal of silts/ debris as required. Continual maintenance for all M&E equipment.
	Outfall	✓	✓	✓	✓	Annual inspection (or inspection after major storm events) of structure, access cover, valves, build-up of silt/ debris. Removal of silts/ debris as required

Interaction with existing assets and other SROs

3.39. There are multiple interactions with existing assets for the water recycling schemes and this is described in annex A1 – A4 and annex E. The key interactions include:

- For Teddington DRA scheme:
- A connection into the final effluent stream at Mogden STW
- A TTP constructed over existing storm tanks at Mogden STW which would require an outage during construction.
- A connection into the TLT near Teddington which would require an outage.
- A connection into the TLT extension at Lockwood, if this is progressed as part of the scheme.
- For Mogden water recycling scheme:
- A connection into the final effluent stream at Mogden STW.
- A waste stream discharge into Mogden STW headworks.
- Construction of an AWRP near Kempton WTW and on operational land.
- Abstraction of water through existing intakes on the River Thames.
- For Beckton water recycling scheme:
- Connection into the final effluent stream at Beckton STW.
- Construction of an AWRP on operational land at Beckton STW.
- Waste stream discharge into Beckton STW headworks.
- Connection into the TLT at LCK.
- Abstraction through the existing intake for KGV reservoir.

3.40. The water recycling schemes are able to provide a water resource to Affinity Water through the Thames to Affinity Transfer SRO if required.

3.41. Exclusivity or dependency within the water recycling schemes include:

- The combined Deployable Output (DO) is limited by effluent availability for the West London schemes (Mogden water recycling, Mogden South Sewer and Teddington DRA).
- Mogden water recycling and Mogden South Sewer schemes are inter-connected due to the shared location of the AWRP and there may be mutual exclusivities due to constraints on space and by footprint and access requirements depending on scheme size.
- Teddington DRA scheme is potentially linked to the Beckton water recycling scheme depending on which scheme builds the TLT extension from LCK to KGV. Further work is planned through Gate 3 to examine the benefits of transferring DO from Teddington DRA to KGV reservoir through a TLT extension.

3.42. Water resource options may require several elements (from source to treated water transfer) to be implemented for the resource option to deliver benefit. This could include enhancements to raw water systems, WTW's and distribution networks. This is being considered separately by Thames Water via WRMP24 projects. There are no foreseen implications for the water recycling schemes due to any planned upgrades at the source STWs.

4. Water resource assessment

Utilisation

4.1. The London WRZ has a list of supply-side measures in which several strategic drought schemes augment the water resources available to the WRZ. The strategic drought schemes are labelled

"Strategic Schemes in Use" and it is assumed that water recycling schemes would become a Strategic Scheme in Use", with the same trigger mechanisms in place to bring it into operation in times of drought.

4.2. The trigger for switching on the existing London Water Resources "Strategic Schemes in Use" is based on the earliest point in time at which London reservoirs start to lose storage at the beginning of a potentially serious drought. It has been assumed that the conditions for the trigger of water recycling schemes will be the same as those for the TGWTW, otherwise known as the Gateway Desalination Plant. The Thames Water Process Team for the Gateway Desalination Plant shared outcomes from their own historical assessments of droughts and the frequency of triggers during that time based on the criteria above. Between the period of 1920 to 2013, the plant would have been triggered on 40 occasions. Therefore, in a 93-year period, the plant would have been used, on average, just under once every 2 years. The late summer and autumn months were the most common for a trigger to occur, with August and September having the highest frequency of trigger events.

4.3. In addition, at Gate 2, water resources models have been used to identify representative periods of strategic schemes in use to represent SRO operation. The WRSE Group's Pywr water resources model has been used, specifically the north area model. The WRSE WRMP24 GR6J stochastic flow series has been used for the current water resources assets, with a 1:200 demand and with drought permits off. The GR6J stochastic flow series comprises 400 stochastic representations of 48 calendar years, which total a set of 19,200 years of river flows and water resources asset utilisation. GR6J is underpinned by alternative versions of current climate and is considered more appropriate for water resources planning than historic climate and flow series, as referenced above for the Gateway Desalination Plant. The model runs export the dates of strategic schemes in use, from which the environmental modelling teams have identified characteristic patterns, for each of the return periods selected for scenario representations, at key model nodes. Representative years from the stochastic dataset have then been selected that fit well to the characteristic patterns, and as a 47 water resources year ensemble of different return periods.

4.4. As shown on expected water recycling scheme usage would typically be in the months August to November, peaking at 37% of days in September. Outside this period, there would be less regular usage in July and December, with usage very rare in June and January and not anticipated in February, March, April or May. As shown in Figure 4-2 usage would be every other year, on average – with 22 of the 47 water resources years showing scheme usage. At a return frequency of once every five years, usage would be around 99 days (A82 moderate low flow year selected as representative 1:5 from the full 19,200 stochastic flow series). At a return frequency of once every twenty years, usage would be around 166 days (M96 very low flow year selected as representative 1:20 from the full 19,200 stochastic flow series). At a return frequency of once every fifty years, usage would be around 189 days (N17 extremely low flow year selected as representative 1:50 from the full 19,200 stochastic flow series). Usage periods are typically seen to be continuous duration, with intermittent use only rare – observed in only three of the 47 water resources years shown. The modelling determined that strategic schemes could be in use for a duration of up to 189 days (over 6 months) at a return frequency of once every 50 years but would not be likely to continue for the duration of 16 months noted in the historical review period (this 16-month duration was during a historic major environmental drought in the first half of the 20th century).

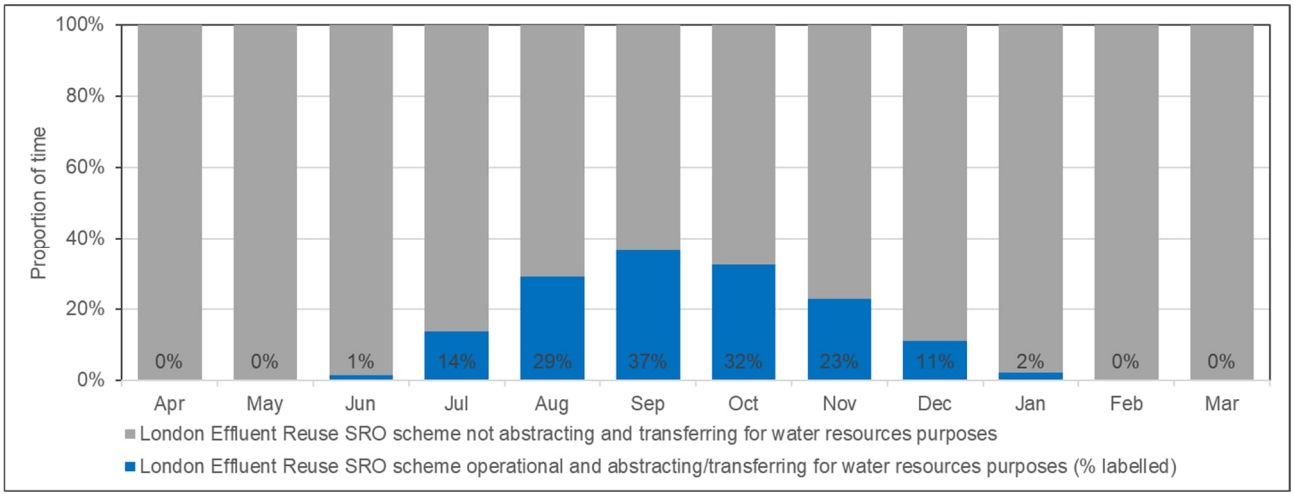


Figure 4-1: Based on Pywr Water Resources Modelling Using Strategic Schemes Trigger, expected usage of a water recycling scheme per calendar month

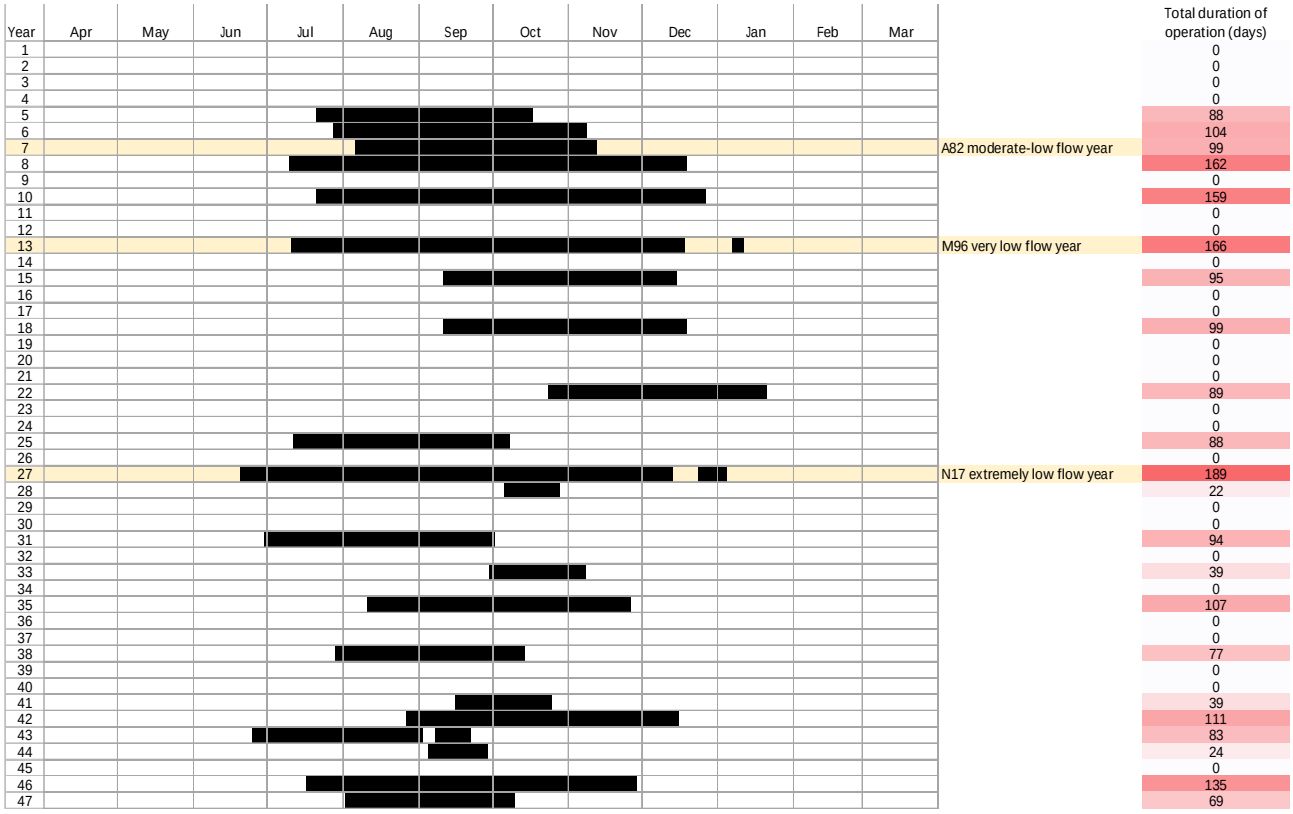


Figure 4-2: Based on Pywr Water Resources Modelling Using Strategic Schemes Trigger, expected duration of usage of a London water recycling scheme per water resources year

Water resource benefit

4.5. The water recycling schemes would be operated largely during the time in a dry year when demand is greatest, e.g., Dry Year Critical Period (DYCP). Details of the estimation of DO for the water recycling schemes could be found in the Thames Water draft Water Resources Management Plan 2024. The estimates of DO values for the Dry Year Annual Average (DYAA) and the DYCP are same and are shown in table 4-1.

4.6. The DO modelling has established that the DO benefit for the water recycling schemes is the same for 1:2, 1:200 and 1:500 year drought scenarios as the schemes provide the full capacity yield in all scenarios.

4.7. DO values presented in table 4-1 assumed that benefit from the SRO will be received by the London WRZ. DO may also be received by Affinity Water's WRZ through Thames to Affinity Transfer (T2AT) SRO. Refer to T2AT SRO Gate 2 Report for the potential benefit received by Affinity Water's WRZ.

Table 4-1: Deployable Output (DYAA and DYCP for 1:500 year drought) from London water recycling schemes

Scheme capacity/ yield (Ml/d)	Deployable output (DYAA/ DYCP) (Ml/d)			
	Beckton	Mogden	Mogden South Sewer	Teddington DRA
50	46	46	Less than 46*	46
75	-	-	-	67
100	89	88	-	92
150	130	129	-	-
200	172	169	-	-
300	252	-	-	-
Note: * Flow monitoring in Gate 2 showed inadequate source flow to supply 46Ml/d DO for Mogden South Sewer scheme. Actual DO would be ~25 Ml/d and subject to further design and analysis.				

Long term opportunities and scalability

4.8. A number of opportunities exist within the SRO. These include:

- An opportunity for Teddington DRA scheme to increase water supply resiliency further with connecting or extending the TLT from Lockwood to the River Lee Diversion, as proposed in the Beckton water recycling scheme. Raw water system modelling analysis is currently underway to evaluate the water resource benefit of this TLT extension.
- For all schemes, where multiple sizes and phases exist, the specification of tunnels and pipelines could be designed for the maximum scheme size in the first phase of development. This would allow schemes to increase in size as required with minimal impact on communities as tunnels and pipelines would already be in place at the correct size. For the Beckton and the Mogden water recycling schemes, the cost differential of treatment plant development in different sizes have been evaluated for consideration of scalability and are presented in section 8 and annex A5. These scalability costs are included and considered in the WRSE regional modelling which has selected the optimised combination of options, considering these scalability costs and wider resilience benefit.
- Discussion of long-term scalability beyond the current maximum scheme capacities may not be applicable as the maximum capacities are primarily determined by environmental impacts on the receiving water bodies. However, changes to environmental legislation or more learning and experience within the industry of how schemes operate as they develop may allow schemes to increase further in size. Therefore, there is a potential to increase the scheme capacity with minimal impacts on the communities if the environmental restrictions/ impacts are removed or mitigated in the future.
- The development of schemes within London will provide local legacy benefits such as new job opportunities, training and apprenticeships for local communities that the schemes serve. These jobs and skills opportunities are seen as a critical component of scheme progression by local planning authorities.

- Each recycling scheme provides a new source of water that does not rely on transfer from other regions nor is restricted during droughts. Schemes are able to provide flow argumentation to rivers if required therefore, enhancing and improving existing habitats downstream of the discharge.

Infrastructure resilience to the risk of flooding and coastal erosion

Coastal erosion

4.9. The London water recycling schemes do not impact on coastal erosion, they create raw water resource from effluent and reduce the amount of treated effluent discharge to the Thames Tideway.

Flood resilience

4.10. A high-level flood risk screening of all proposed infrastructure sites from the four schemes was undertaken as part of Gate 2. The highest flood risk identified from this assessment are linked to the impacts from fluvial, sea, surface water and groundwater flood sources during the operational phase of a scheme. This requires further assessments to be carried out in Gate 3 to assess and mitigate these risks, with potentially five Flood Risk Assessments (FRAs) and ten drainage strategies required for the Mogden water recycling scheme, nine FRAs and two drainage strategies for Teddington DRA, and twelve FRAs and one drainage strategy for the Beckton water recycling scheme. Ground investigations will be required to assess groundwater flooding at a number of sites. Mitigation is likely to be achievable to ensure schemes are resilient and flood risk is not increased.

4.11. The construction phase may also have an impact on flood risk for each scheme, although if best practice guidance is followed with a Construction Environmental Management Plan, these risks can be appropriately mitigated. The other flood risk sources (sewers, reservoirs and artificial sources) and the change in river flows as a result of each scheme are considered to have a low or negligible flood risk impact, with no further assessments required for these aspects.

5. Drinking water quality considerations

5.1. The Strategic Water Quality Risk Assessment (SWQRA) identifies limiting hazards, assessing their risks across the water supply system for London water recycling schemes based on a drinking water safety approach. At each stage from catchment to consumer (i.e. catchment, abstraction, conveyance, treatment, storage, distribution and consumer), pre-mitigated risks were assessed, mitigation measures were proposed, and resultant post mitigated residual risks were identified using methodologies in the ACWG's Strategic WQ Risk Framework.

5.2. A plan for future work to develop Drinking Water Safety Plans will be through development and update of the SWQRA as new information and data is obtained as the schemes progress through Gate 3 (from Nov 2023) and beyond. Development will be in collaboration with DWI and take into consideration existing and future customer feedback as set out in annex D.

5.3. In Gate 2, Gate 1 limiting hazards were reassessed as well as additional limiting hazards were included in the Gate 2 SWQRA based on the new available data and information (e.g., water quality data, DWSPs, Regulation 28 reports and process flow diagrams). Annex C provides details of methodologies, results and future work of SWQRA.

5.4. The Gate 2 SWQRA found that pre-mitigated risk scores at catchment for most of the limiting hazards are high (red) or medium (amber).

5.5. For several of the limiting hazards, the residual risks posed to consumer are low (green). There are, however, limiting hazards for which the residual risks to consumer remain high (red) or medium (amber). Identified key risks and proposed mitigations, which have been discussed with the company drinking water quality team, are as follows with details set out in Annex C.

- Limiting hazards which pose a risk that consumers could experience a change in perception of their water - these include change in source type assessed as high risk (red) and change in alkalinity/hardness and corrosivity assessed as medium risk (amber). The possible mitigation of these risks would be early customer engagement, which has been initiated, and treatment/ blending to minimise corrosion.
- Limiting hazards related to CECs (PFOS, PFOA, 1,4-Dioxane and NDMA) – PFOS and PFOA were assessed as amber based on limited but currently available data. As for 1,4-dioxane and NDMA, they were rated as amber because no data was available, and the risk scores assigned reflect the uncertainty from this gap in data. As additional water quality monitoring has been initiated, the risks would be reassessed in Gate 3 with more available data. It is expected that further water quality data will reduce the associated risk assessment scores. These CECs are commonly found in wastewater effluent and difficult to be treated in conventional STWs. In view of the above uncertainty, Full Advanced Treatment (FAT), incorporating reverse osmosis (RO) has been proposed for Mogden and Becton water recycling schemes as a recognised treatment mitigation for CECs.
- Other limiting hazards rated as red or amber residual risk because of descriptions in Thames Water DWSP, including *Cryptosporidium*, Iron, Total Pesticides, Metaldehyde, Pathogens (bacteria, viruses and protozoa), Benzo(a)pyrene, PAH, TOC, Ammonium, Turbidity, Aluminium, Lead and Mercury – as these risks had been identified in Thames Water DWSP, they were already mitigated or eliminated via the current Thames Water DWSP process and are therefore not considered as currently posing risks to the existing system or to these schemes going forward.

5.6. The SWQRA (annex C) was issued, and a workshop was held with the Drinking Water Inspectorate (DWI) to consult and present SWQRA findings. No specific concerns were raised by DWI during Gate 2. Stakeholder engagement, including with DWI, is detailed in annex D.

5.7. Compliance with drinking water quality Regulation 31 is a requirement for materials in contact with drinking water. It is generally not relevant to the water recycling schemes where water would be discharged into the environment (rivers). However, the section between the river intake and the TLT connection in Teddington DRA scheme will require Regulation 31 approval as TLT discharges into the Lee valley reservoirs. Any materials used for this section will conform to Regulation 31.

5.8. The catchment to consumer approach in the SWQRA process also aligns with the objectives of the Drinking Water Protected Areas (DWPA), which are:

- to meet the requirements of the Water Supply (Water Quality) Regulations 2016;
- to protect supply by avoiding deterioration in water quality in order to reduce the level of purification treatment required; and,
- to meet good chemical status and reverse upward trends in pollution of groundwater. Reducing pollution at source is more cost effective than removing pollutants or blending with clean water.

5.9. Overall, the SWQRA shows that the risks to drinking water quality from the limiting hazards identified could be mitigated by the measures proposed. However, for CECs, if in future the UK water quality regulations were to be tightened in line with recent USEPA guidance, compliance will be very challenging for most of UK new and existing water treatment works.

6. Environmental assessment

6.1. This section summarises the environmental assessment completed for Gate 2. The environmental assessment has been undertaken in accordance with the methodology set out in the ACWG and WRMP environmental guidance and was undertaken to inform both gate 2 and the WRSE environmental metrics, to ensure consistency across the two processes.

6.2. To ensure a robust and proportionate approach at Gate 2, we have extensively engaged with multiple stakeholders to develop an agreed evidence base and shape environmental assessments and plans for future work through Gate 3. In this way it also ensures we provide best value outcomes and opportunities for social and environmental benefits.

Water Framework Directive (WFD) assessment

6.3. In accordance with the RAPID Gate 2 guidance[5], an updated WFD assessment has been produced in support of the SRO Gate 2 submission. The WFD assessment builds upon the Gate 1 WFD assessment, using the refined Gate 2 scheme designs and operating philosophies, consolidated water quality monitoring programme dataset, river and estuarine modelling, the Physical Environment, Water Quality, Fish, Aquatic Ecology and Invasive Non-Native Species (INNS) assessment reports.

6.4. A summary of the WFD findings for each of the London water recycling schemes are provided in the following sections. Annex B4 provides the full WFD assessment.

Beckton water recycling scheme

6.5. An assessment has been undertaken of the WFD compliance of a Beckton scheme sized at 100 Ml/d, 200 Ml/d or 300 Ml/d.

6.6. The effects on the Enfield Island Loop of the Lee Diversion channel from flow augmentation from a scheme outfall are deemed to be WFD compliant with respect to physico-chemical and WFD chemical water quality, while potential changes in velocity and depth are not considered to be of a magnitude to result in impacts on aquatic ecology. The affected water course is ~100m of the larger WFD water body Lee (Tottenham Locks to Bow Locks/Three Mills Locks) (GB106038077852) and any effects in the reach are not significant at a water body scale.

6.7. No potential for status deterioration or introducing impediments to target status were identified in the Thames Middle (GB530603911402) transitional water body from effluent flow reductions at Beckton STW.

6.8. This assessment has been supported by bespoke modelled and measured data on pathways of impact and has a medium to high confidence.

Mogden water recycling scheme

6.9. An assessment has been undertaken of the WFD compliance of a Mogden water recycling scheme sized at 50 Ml/d, 100 Ml/d, 150 Ml/d or 200 Ml/d.

6.10. Minor changes to physico-chemical water quality were noted in the River Thames (GB106039023232), while the parameters currently less than good, e.g phosphate, receive benefit across all scenarios and do not impede achieving the objective. Minor localised impacts may also occur around a Mogden outfall.

[5] Strategic regional water resource solutions: detailed feasibility and concept design. Gate Two Guidance, NRW, NE, NEAS, April 2022.

6.11. No potential for status deterioration or introducing impediments to target status were identified in the Thames Upper (GB530603911403) water body for any sized Mogden scheme.

6.12. This assessment has been supported by bespoke modelled and measured data on pathways of impact and has a medium to high confidence.

Teddington DRA scheme

6.13. An assessment has been undertaken of the WFD compliance of a Teddington DRA scheme sized at 50 Ml/d, 75 Ml/d, 100 Ml/d and 150 Ml/d.

6.14. At Gate 2, no expected potential for status deterioration or introducing impediments to target status was identified in the Thames (Egham to Teddington) (GB106039023232). However, minor changes to physico-chemical water quality were noted at the 100 Ml/d and greater scheme size. Potential mitigation (treatment) options are outlined in the annex B.2.2 which will need to be further refined in Gate 3.

6.15. No potential for status deterioration or introducing impediments to target status were identified in the Thames Upper (GB530603911403) water body for any Teddington DRA size.

6.16. This assessment has been supported by bespoke modelled and measured data on pathways of impact and have a medium to high confidence.

Informal Habitats Regulation Assessment (HRA)

6.17. In accordance with the RAPID Gate 2 guidance[5], an Informal HRA has been produced in support of the Gate 2 submission. The informal HRA builds upon the Gate 1 informal HRA, using the refined Gate 2 scheme designs, regulatory assessments (INNS, Biodiversity Net Gain (BNG) and Natural Capital Assessment (NCA)) and environmental assessment reports (Fish, Aquatic Ecology and Terrestrial Ecology). The regulatory and environmental assessment reports have been developed using additional monitoring, modelling and assessments completed through the course of Gate 2.

6.18. A summary of the HRA findings for each of the London water recycling schemes are provided in the following sections. Annex B3 provides the full HRA.

Beckton water recycling scheme

6.19. The informal Stage 1 Screening identified the risk of Likely Significant Effects (LSE) associated with the construction of the Beckton scheme tunnel to qualifying features of the Lee Valley Special Protection Area (SPA) and Ramsar site and Thames Estuary and Marshes SPA and Ramsar site. The risk of LSEs were also identified during the operation of the Beckton scheme on the Thames Estuary and Marshes SPA and Ramsar site.

6.20. The informal Stage 2 Appropriate Assessment concluded, that with implementation of appropriate mitigation measures to minimise permanent land take, noise and visual disturbance, and dust and vehicle emissions, the impact pathways could be suitably controlled such that the scheme would not result in an adverse effect on the integrity of any European site alone or in-combination.

Mogden water recycling scheme

6.21. The informal Stage 1 Screening identified the risk of LSE associated with the construction of the Mogden scheme pipeline was identified for the qualifying features of South-West London Waterbodies SPA and Ramsar site.

6.22. The informal Stage 2 Appropriate Assessment concluded, that with implementation of appropriate mitigation measures to minimise noise and visual disturbance, and dust and vehicle emissions, the impact pathways could be suitably controlled such that the scheme

would not result in an adverse effect on the integrity of the European site alone or in-combination.

Teddington DRA scheme

6.23. The informal Stage 1 Screening identified the risk of LSE associated with construction of Teddington DRA was identified for qualifying features of Richmond Park Special Area of Conservation (SAC).

6.24. The informal Stage 2 Appropriate Assessment concluded, that with implementation of appropriate mitigation measures to avoid removal of deadwood habitat, the impact pathways could be suitably controlled such that the scheme would not result in an adverse effect on the integrity of the European site alone or in-combination.

Initial Environmental Appraisal

6.25. In accordance with the RAPID Gate 2 guidance[5], an Initial Environmental Appraisal (IEA) has been produced in support of the Gate 2 submission. The IEA builds upon the Gate 1 informal Strategic Environmental Assessment (SEA), using the refined Gate 2 scheme designs and Gate 2 regulatory assessments (WFD assessment, HRA, INNS assessment, BNG and NCA). The IEA and wider regulatory assessments have been developed using the additional monitoring, modelling and assessments completed through the course of Gate 2.

6.26. A summary of the IEA findings for each of the London water recycling schemes are provided in the following sections. Annex B5 provides the full IEA.

Beckton water recycling scheme

6.27. The Beckton scheme requires a significant length of conveyance route (c 22.3 km) transferring water from the treatment plant at Beckton STW to the River Lee Diversion Channel north of the KGV reservoir. The conveyance route will be constructed in two parts: Beckton Advanced Water Recycling Plant (AWRP) to Lockwood Reservoir Pumping Station and Lockwood Reservoir Pumping Station to KGV (TLT Extension). The multi-disciplinary team has worked to create a design that minimises potential environmental impacts by utilising hardstanding or poorer quality habitats along the conveyance route for shaft locations and considering construction techniques to minimise traffic on the local road network by removing spoil from the tunnel boring works at the start and end points. The majority of construction related impacts are considered to be mitigatable with best practice measures and in some cases specific additional mitigation measures.

6.28. Operationally, impacts are limited to c.600 m of the Enfield Island Loop where there will be major increases in flow and velocities, under very low flow conditions. This is in the context of the baseline low flow conditions being non-natural, and the channel being heavily modified (steep banks and limited bed variability). The Beckton scheme would not associate with effects on the Thames Tideway from reductions in Beckton STW final effluent input into the middle Tideway.

6.29. Key risks from the Beckton scheme identified at this appraisal stage, which will require further investigation at Gate 3 and/or additional mitigation, are:

- Temporary disruption to recreational facilities and impact to landscape and visual amenity where shafts are constructed in, or in close proximity to open land.
- Potential loss of habitats (including a small amount of priority habitat) and disturbance to a range of protected species at the site of the treatment plant, with further surveys required to determine presence/likely absence.
- Flood risk and potential need for compensation at Beckton AWRP site and River Lee Diversion outfall. Flood risk assessments and drainage strategies required for these sites, and some shaft locations.

- Increased levels of traffic movements around the Enfield Island Loop discharge location. Further consideration of the haul routes to be used and exact traffic numbers to be undertaken for Gate 3.
- Risks from air quality are considered to be significant without further mitigation, however further refinement will be required with modelling work undertaken once more detail is available around construction programme, methods and plant requirement which will allow refinement of some of the conservative assumptions made in Gate 2 and enable identification of any exceedances in targets and further mitigation requirements.
- Risk of ground gas is high at two potential conveyance locations and conveyance route intersects two landfills which may require significant mitigation. Further investigation (e.g., Envirocheck report, establish conceptual model) required to refine risk.
- Careful management of construction activities will be required when working at Lockwood Reservoir as this is within the Lee Valley SPA and Ramsar site, requiring a small area of permanent habitat loss. Construction of infrastructure and shaft sites along the Lee Valley Reservoir complex (e.g., Thames Water Coppermills site) will need to ensure disturbance and habitat degradation is minimised.
- There is the potential for permanent negative effects on the setting of heritage assets, including the Grade II listed building Retort House and King George Pumping Station, at the River Lee Diversion Channel outfall site.

Mogden water recycling scheme

6.30. The Mogden scheme requires two sections of conveyance route, one trenchless between Mogden STW and the site of the new AWRP near Kempton WTW. This will be one corridor but containing two pipelines: final effluent to the AWRP and reverse osmosis waste-stream back to Mogden STW for discharge. The second section of conveyance route takes the recycled water from the AWRP treatment plant to the discharge location at Walton Bridge. This route, c5.9 km, will be predominantly trenched, with small sections of trenchless (e.g. under the River Ash).

6.31. The key risk associated with this scheme is the use of the potential AWRP site near Kempton WTW for the treatment plant, given the location next to the South-West London Waterbodies SPA and Ramsar, its designation as a Site of Importance for Nature Conservation (SINC) and the habitats and potential for protected species on the site. The layout within the site has been devised to minimise habitat loss, however between Gate 2 and Gate 3, alternative sites for the treatment plant are to be optioneered to ensure that the site with the least environmental, planning and engineering constraint is selected. Due to the built-up nature of the latter section of the conveyance route, approximately 1.4 km of trenching will be required in highways/road network which is likely to lead to increased disturbance and disruption to local residents. The majority of construction related impacts are considered to be mitigatable with best practice measures and in some cases specific additional mitigation measures.

6.32. Operationally, moderate impacts on flows are predicted when compared to the baseline conditions in the River Thames. However, these changes are negligible when considering impacts to water level, depth and average flow velocities. No impacts have been identified on fish pass barrier passibility, wetted habitat, water level and suspended sediment concentration in the Thames Tideway.

6.33. Key risks from the Mogden scheme identified at this appraisal stage, which will require further investigation at Gate 3 and/or additional mitigation, are:

- Loss of habitat within the vicinity of Kempton WTW for the treatment plant, which consists of lowland calcareous grassland priority habitat and deciduous woodland priority habitat.
- Temporary construction, and potential permanent (e.g. lighting, noise) disturbance to the South-West London Waterbodies SPA and Ramsar given direct proximity.
- Majority of sites will need further consideration of flood risk and potential for drainage strategies to reduce surface water runoff.

- Risks from air quality are considered to be significant without further mitigation, however further refinement will be required with modelling work undertaken once more detail is available around construction programme, methods and plant requirement which will allow refinement of some of the conservative assumptions made in Gate 2 and enable identification of any exceedances in targets and further mitigation requirements.
- Risk of ground gas is high as the two shaft locations and the conveyance routes intersects four landfills. Further investigation (e.g. Envirocheck report, establish conceptual model) is required to refine the risk.
- Potential permanent negative effect upon setting of Rosecraft Gardens Conservation Area.
- Permanent change in character of the immediate area around the new AWRP near Kempton WTW and Walton Bridge discharge. Visual amenity changes at Walton Bridge for recreational users of local rights of way, the Thames Path and users of Walton Bridge.

Teddington DRA scheme

6.34. The Teddington DRA scheme involves the rearrangement of storm tanks at Mogden STW to accommodate a tertiary treatment plant (TTP) to treat a portion of the final effluent. A short conveyance route (c. 4.7 km) is required between Mogden STW and the proposed outfall south of Ham, above Teddington Weir. A new abstraction on the River Thames to the existing Thames Lee Tunnel is proposed c.140 m upstream of the outfall.

6.35. The key risk associated with this scheme relates to the new infrastructure required at the intake and outfall location. The multi-disciplinary team has worked to minimise the environmental impacts of this part of the scheme, by placing the main structures outside the boundaries of the SINCs where possible, noting the River Thames and tidal tributaries SINC extends along the banks of the River Thames where the intake and outfall will be sited, and minimising habitat loss. Further work will be required to Gate 3 around the connections to the Thames Lee Tunnel and investigating any alternative locations, that would still meet the engineering requirements for the connection. Although new infrastructure is required at Mogden STW, this will be within the existing site boundary rather than occupying a previously undeveloped space.

6.36. The majority of construction related impacts are considered to be mitigatable with best practice measures and in some cases specific additional mitigation measures. Operationally, the Teddington DRA scheme may lead to moderate reduction in flows when compared to the baseline conditions in the c.140 m of the River Thames between the intake and outfall. However, these changes are negligible when considering impacts to water level depth and flow velocities. No impacts have been identified regarding fish pass barrier passibility, wetted habitat, water level and suspended sediment concentration in the Thames Tideway.

6.37. Key risks from the Teddington DRA scheme identified at this appraisal stage, which will require further investigation at Gate 3 and/or additional mitigation, are:

- Potential permanent negative effect upon setting and character of Riverside North Conservation Area (intake and outfall location).
- Permanent change in the open character of the riverside as a result of the intake structure, with views for the local community and recreational users permanently altered. However, intake and outfall structures are not uncommon across the whole stretch of the River Thames, but the design and landscaping of the area will need careful consideration to Gate 3.
- Conveyance route intersects one landfill site. Further investigation (e.g. Envirocheck report, establish conceptual model) required to refine risk.

Other environmental considerations.

6.38. In accordance with the RAPID Gate 2 guidance[5], BNG assessment has been completed to identify how the London water recycling schemes can support the actions of the Government's

25-year Environment plan. A NCA has been completed to identify best value solutions. Both assessments use the refined Gate 2 scheme designs and supporting environmental assessments reports.

6.39. A summary of the BNG and NCA findings for each of the London water recycling schemes are provided in the following sections.

Biodiversity Net Gain

6.40. The area impacted due to permanent and temporary loss and area required for mitigation for each scheme is summarised below. As part of the BNG assessment, six potential biodiversity areas were identified for mitigation, the habitat type and condition of these areas should be ground-truthed. Furthermore, stakeholder engagement will be required to ensure the areas are available for mitigation. Therefore, a stakeholder engagement plan to support development and opportunities will be developed further with planning authorities to identify ambitions after 2030, and wider stakeholders to identify any mitigation opportunities.

6.41. The BNG assessment of Beckton identified that 6.14 ha of habitat will be lost permanently, (equating to 43.82 biodiversity units), which due to the habitat types of sites identified for mitigation, will require a total area of 15.5 ha of off-site habitat mitigation (equating to 48.8 biodiversity units) to provide 11.39% BNG uplift. Temporary habitat loss of 8.05 ha due to construction zones will be reinstated post-construction (equating to 28.55 biodiversity units), the area of off-site habitat enhancement required to achieve 10.27% BNG is much smaller at 2.8 ha (equating to 8.66 biodiversity units). The majority of permanently lost habitat is mixed scrub, as a result of this enhancement of mixed scrub areas will contribute the largest area towards mitigation.

6.42. A total of -0.04 river unit losses were estimated for the installation of permanent infrastructure such as pumping stations and abstraction and outfall locations associated with Beckton, with operational impacts of increased water flow creating a further loss of -0.39 river units within the Lea Navigation Enfield Lock to Tottenham Locks Water Body.

6.43. The operational impacts of Beckton have not been considered to impact the river condition at this stage and therefore, mitigation would be required only to compensate the permanent construction impacts.

6.44. The BNG assessment of a Mogden scheme identified that 4.5 ha of habitat will be lost permanently (equating to 40.93 biodiversity units), which due to the habitat types of sites identified for mitigation, will require a total area of 29 ha of off-site habitat mitigation (equating to 45.6 biodiversity units) to provide 11.40% BNG. Temporary habitat loss of 32.4 ha (equating to 102.10 biodiversity units) due to construction zones will be reinstated post-construction. 29.5 ha will be required for mitigation (equating to 46.86 biodiversity units) to achieve a 10.03% BNG. The majority of permanently lost habitat is broadleaved woodland, with a large proportion of temporarily lost habitat also being broadleaved woodland. As a result of this, habitat enhancement from modified grassland to moderate condition broadleaved woodland will require the largest area for mitigation to achieve 10% net-gain.

6.45. Design changes since the UKHab survey at Mogden STW site were undertaken meant that certain areas are outside of the surveyed area and therefore, no baseline UKHab data was available. UKHab surveys and BNG habitat condition surveys should be undertaken to provide a complete baseline data set to inform the Biodiversity Metric calculations and reduce the assumptions required to determine the impacts and off-site mitigation requirements.

6.46. The Mogden scheme has no temporary construction impacts of river units but does create a permanent loss of -0.04 river units. However, it has negligible effect on water flow, so no operational impacts are expected. Permanent construction impacts from the Mogden water recycling scheme will require respectively the enhancement of 0.6km of 'other river and stream' located outside the catchment. Enhancement may include the removal of structures

within the watercourse to reduce the encroachment, planting, removal of invasive non-native species or restoration measures. Further MoRPh surveys will inform the enhancement measures required to enhance the river from 'poor to moderate condition'.

6.47. The assessment of the Teddington DRA scheme identified that 1.94 ha of habitat will be permanently lost (equating to 2.35 biodiversity units) due to construction of new above ground infrastructure, which due to the habitat types of sites identified for mitigation, will require a total area of 3.65 ha off-site habitat mitigation (equating to 2.67 biodiversity units) to provide 13.52% BNG. A total of 5.13 ha of habitat will be lost temporarily (equating to 14.37 biodiversity units) to construction zones, however since it is to be reinstated post-construction, the mitigation effort required to achieve 14.27% BNG is 13 ha (equating to 8.17 biodiversity units).

6.48. The Teddington DRA scheme will create a loss of -0.12 river units through the creation of permanent structures, but has no temporary or operational disbenefits. Permanent construction impacts from Teddington DRA will require the enhancement of 1.8km of 'other river and stream' located outside the catchment. Enhancement may include the removal of structures within the watercourse to reduce the encroachment, planting, removal of invasive non-native species or restoration measures. Further MoRPh surveys will inform the enhancement measures required to enhance the river from 'poor to moderate condition'.

Natural Capital Assessment

6.49. The overall environmental benefits for each London water recycling scheme is summarised below. The NCA methodology does not take into account the monetary cost of land acquisition and management for the required mitigation. The current zone of influence for the assessed components extends to the assumed construction zones. Whilst acceptable for a high-level approach, greater detail will be necessary following stakeholder engagement, refinement of design and surveys to determine current habitat conditions as part of further scheme development in Gate 3. At Gate 3, a wider benefits assessment using the six-capitals approach will identify areas that can provide the widest range of benefits.

6.50. The overall environmental benefits for the Beckton scheme in relation to climate regulation, natural hazard regulation and agriculture ecosystem services over the 80 years is £40,883. Water purification benefits will be negligible. As the larger scheme size (300 Ml/d) has been assessed, any small sized scheme would require less land and associated management costs.

6.51. The overall environmental benefits for the Mogden scheme in relation to climate regulation, natural hazard regulation and agriculture ecosystem services over the 80 years is £1,082,155. As the larger scheme size (200 Ml/d) has been assessed, any smaller sized scheme would require less land and associated management costs.

6.52. The overall environmental benefits for the Teddington DRA scheme in relation to climate regulation, natural hazard regulation and agriculture ecosystem services over the 80 years is £485,268. As the larger scheme size (150 Ml/d) has been assessed, any smaller sized scheme would require less land and associated management costs.

Carbon

6.53. Table 6-1 below summarises the estimated whole life carbon (WLC) emissions from the London water recycling schemes. The capital (embodied) carbon and operational carbon were estimated using Thames Water's Carbon Engineering Estimating System (EES) which holds over 6 million carbon values against Thames Water's common asset structure. WLC carbon emissions were then estimated, taking into consideration capital carbon emissions and operational carbon emissions for 80 years of operations. WLC cost was calculated using the factors in the HM Treasury Green Book.

6.54. It should be noted that the estimated carbon values include carbon from electricity consumption. However, operational GHG emissions from electricity demand would be zero

because all electricity purchased would be zero carbon via either a Renewable Energy Guarantees of Origin (REGO) contract or Power Purchase Agreement (PPA) as per Water UK Net Zero 2030 commitment.

Table 6-1: Carbon estimates for the London water recycling schemes (excluding replacement of assets at the end-of-life stage)

Scheme Name	Scheme Sub-Options		Capital carbon (tCO_2e)	Operational Carbon (tCO_2e/yr.)	Whole Life Carbon (tCO_2e)	WLC Cost (£M)
Beckton water recycling scheme	AWRP	50 Ml/d	32,713	5315	463,188	£66.10
		100 Ml/d	55,176	6271	563,129	£82.05
		150 Ml/d	70,361	16836	1,434,038	£201.23
	Conveyancing (Combined two tunnels)	Beckton - LCK Tunnel	62,230	114	71,424	£16.49
		LCK-KGV Tunnel	46,090	90	53,399	£12.28
Mogden water recycling scheme	AWRP	50 Ml/d	37,006	5427	476,569	£68.37
		100 Ml/d	49,475	11044	944,041	£132.82
	Conveyancing	All streams	57,795	320	83,745	£17.66
Mogden South Sewer scheme	AWRP and conveyancing	50 Ml/d	106,691	5291	535,275	£83.96
Teddington DRA scheme	Tertiary Treatment Plant (TTP)	50 Ml/d	39,320	1377	150,885	£24.69
		75 Ml/d	44,409	2121	216,206	£34.06
	Conveyancing	Abstraction & Thames Lee Tunnel Connection	5,433	16	6,734	£1.51
		Mogden STW - Teddington Tunnel	13,723	66	19,102	£4.09

6.55. To maximise alignment with PAS 2080 and the Water UK Net Zero 2030 Routemap, the emissions hierarchy will be followed when deciding which approach to prioritise to mitigate emissions. This prioritises in order demand reduction, efficiency gains and renewable energy integration before pursuing offsets to remove residual carbon emissions. Due to the complexity and long lifetime of these schemes, it is important to take a holistic approach to carbon mitigation, which uses a combination of approaches.

6.56. Capital carbon emissions represent the majority share of total GHG emissions in the short term - as such, focusing on reducing capital carbon will likely yield significant reductions across the early stage of a site's operational life. A focus on 'designing out' carbon can reduce both capital and operational emissions, in particular for building heating and plant efficiency.

6.57. While annual operational emissions are less than those released due to material sources, over time, across the lifetime of a site, operational emissions will contribute more than capital carbon emissions in all schemes. Therefore, reducing operational emissions will achieve the great reduction of GHG emissions in the long term. This approach is also line with the Water UK and Thames Water targets of net zero operational carbon by 2030.

6.58. Table 6-2 below summarises the potential carbon mitigation approaches identified in Gate 2, providing a high-level ranking of their potential impact on emissions reduction, including potential influence on reduction of scope 2 and scope 3 carbon, and alignment with the emissions hierarchy.

Table 6-2: Summary and ranking of potential carbon emission reduction approaches for London water recycling schemes.

Approach to mitigate carbon emissions	Emissions Hierarchy Category	Potential for emissions reduction	Ability for Thames Water to Influence	List of options
Energy management & efficiency (highest priority)	Emissions reduction	High	High	- Improved pump efficiency - Metering - Smart control systems - Catchment level analytics
Renewable energy on site	Renewable energy	High	High	- Solar - Wind - Storage
Procured Renewable Energy	Renewable energy	High	High	- Sleeved PPA - Synthetic PPA - Private Wire PPA - REGO-backed Green Tariffs
Resource Efficiency and Chemical Supply	Emissions reduction	High	Low	- Supply chain contracts - Reduced resource use
Embodied emissions reduction	Emissions reduction	Moderate	High	- Low carbon concrete - Low carbon steel - Recycled materials - Locally sourced materials
Engineering design	Emissions reduction	Moderate	Moderate	- Conveyance routes - Land use - Building size - Building heating
Construction emissions	Emissions reduction	Low	Moderate	- Reduced transport - Vehicle energy use - Renewable onsite power - Temporary buildings
Insets	Offset	Low	Moderate	- Peatland restoration - Grassland restoration - Tree planting
Offsets (lowest priority)	Offset	Low	High	- UK Emissions Trading Scheme - Voluntary Offset Market

7. Programme and planning

Scheme delivery plans

7.1. We have developed a series of project stages and outcomes, in table 7-1, that conceptualises a water recycling project into a series of linked stages from Gate 2 through to WAFU. At any stage in the delivery plan a scheme could be deferred or accelerated to deliver against the regional plan.

Table 7-1: Conceptual overview of project stages and outcomes from Gate 2 to WAFU.

Project Stage	Example outcomes and key activities
Gate 2	• Draft WRSE Regional Plan • Alignment to draft WRMP24 • RAPID Gate 2 submission
Gate 3 or mid-Gate 3 checkpoint depending on scheme progression	• Alignment of scheme need timing and scale to draft WRSE Regional Plan and revised draft WRMP24 • Continued design and environmental development with scale of work dependant on when a scheme is required • Address gaps identified at Gate 2 • Undertake options engagement / consultation to determine preferred alignment / construction sites • Prepare consultation response document • Confirm procurement mechanism and value for money case **Prepare mid-Gate 3 checkpoint statement or for schemes selected by draft WRSE regional plan commence planning and procurement activities to Gate 3 to include:** • Seek and setup Planning Performance Agreements with each local authority • Obtain Environmental Impact Assessment (EIA) Scoping Opinion from each local authority • Draft Planning, Construction, Design and Access considerations • Draft parameter plans and environmental masterplan • Draft procurement Strategic Outline Case (SOC) and Outline Business Case (OBC) or equivalent • Market testing (where required), early contractor engagement and procurement preparation • Prepare Direct Procurement for Customers (DPC) documentation for Ofwat Control Points B and C (or equivalent where in-house procurement is followed) • Submit RAPID Gate 3 submission
Gate 4	• Confirm alignment of scheme need with draft or final WRMP24 and WRSE regional plan. • Undertake further consultation / engagement on final consenting design • Finalise design for planning and procurement • Finalise Planning, Construction, Design and Access considerations • Finalise Environmental Statement • Finalise plans and masterplan • Prepare consultation response report • Submit procurement specifications aligning to scheme delivery model • Submit Planning application to each local authority • Prepare RAPID Gate 4 submission
Gate / Phase 5 - project consent	• Support future consultation events held by local authorities through planning determination • Prepare and discharge planning conditions • Complete legal agreements • Commence compulsory purchase order inquiry process (if required) • Achieve Ofwat Control Points D and E (where DPC model is followed) • Obtain planning approval
Phase 6 – Procurement	• Issue contract tender • Contract tender finalisation • Scheme tender award • Approval of Full Business Case (FBC) (if required based on procurement model)

Project Stage	Example outcomes and key activities
Phase 7 – Construction	• Submission and approval of detailed design • Enabling works commitments discharged • Construction begins
Phase 9 – Operation	• Scheme commissioning ready for full operation

Earliest delivery programme

7.2. In all cases, each water recycling scheme remains on track to proceed through planning, procurement and the gated process in parallel to be 'construction ready' in AMP8 if required (see figure 7.1). This assumes the planning route is via a Town and Country Planning Act (TCPA) application, procurement is via the most appropriate route as set out in annex E and all processes progress in parallel. There is no quantified schedule risk allowance in this programme.

7.3. The earliest projected WAFU dates for schemes, if planning started immediately, are shown below and the differential in dates is determined by the procurement model and the duration of construction activities.

- Beckton water recycling scheme –2031/32
- Mogden water recycling scheme – 2031/32
- Mogden South Sewer – 2031.
- Teddington DRA - 2031

WRSE-based delivery programme

7.4. The draft WRSE regional plan provides an indication of if and when a scheme is required. The draft plan currently shows Teddington DRA is required to deliver water into supply in 2031 (see section 8). To achieve this date the following milestones need to be achieved within the above project phases.

- Planning application - Q2 2024 and within Gate 4
- Planning consent - Q2 2025 and within Gate/Phase 5
- Procurement award/ scheme construction ready – Q4 2025 within Phase 6
- Construction start – Q1 2027 within Phase 7

7.5. Figure 7-2 provides an indicative delivery programme for Teddington DRA aligned to the requirements to supply Thames Water customers in 2031.

7.6. Key programme dependencies and assumptions in achieving the programme are set out in annex F.

7.7. Where schemes are not selected in the final regional plan, we envisage a period of scheme deferral following a mid-Gate 3 checkpoint. This would be following finalisation of the regional plan and WRMP24, expected between late 2023 to early 2025 depending if there is a public inquiry on the plan. We currently estimate a mid-Gate 3 checkpoint mid-2024. In the scenario of deferral post mid-Gate 3 checkpoint all project design information, environmental data and engagement logs would be catalogued and archived, and the scheme deferred.

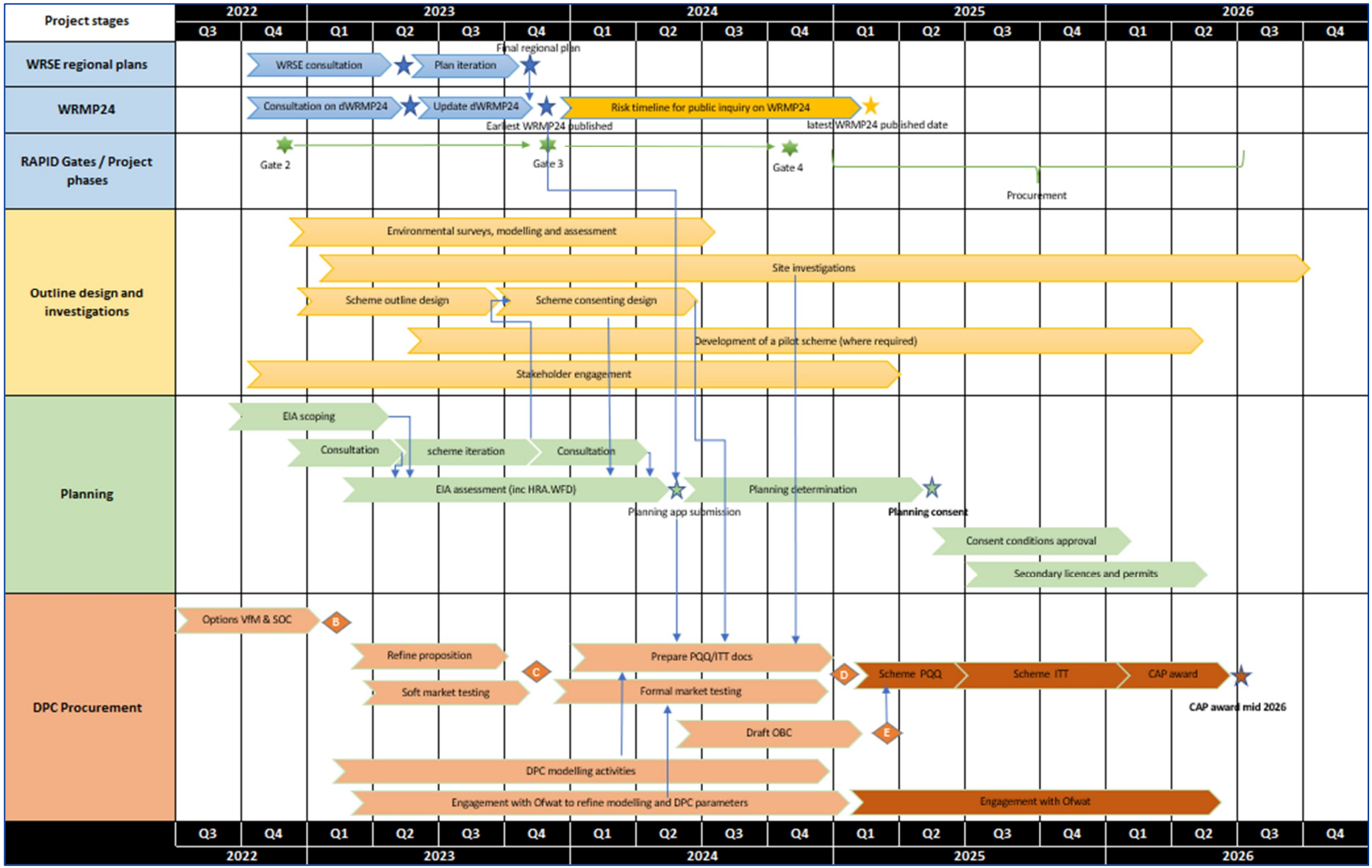


Figure 7-1: Earliest scheme delivery plan showing a water recycling scheme being construction ready in AMP8 utilising a TCPA and DPC process

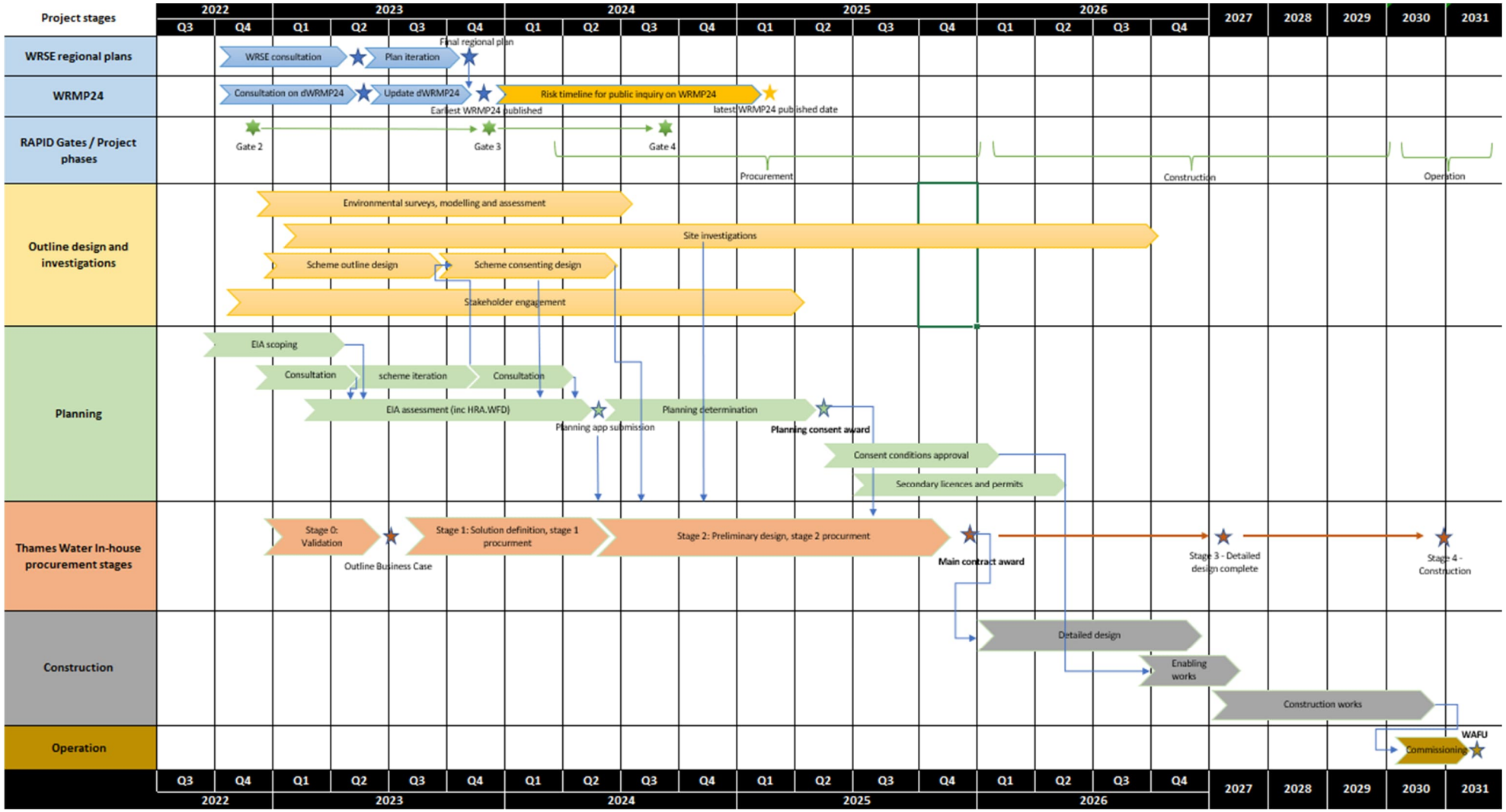


Figure 7-2: Indicative scheme delivery plan showing key project stages and activities for Teddington DRA.

Programme risks and mitigations

7.8. At this relatively early stage in the project life-cycle, it is difficult to accurately predict programme risk elements that might cause delay. A number of programme assumptions have been made in preparing the scheme delivery plan and together with key planning, procurement and engineering risks and mitigation are captured in annex F.

7.9. Planning delays may extend the overall consenting of a scheme shown in figure 7.1 between 3 months to 36 months as a result of either or all risks materialising:

- Need to collect further baseline data, or more detailed modelling and assessments through 2024 resulting in a delay to a planning application submission of up to 6 months
- Different timeframes for each Local Planning Authority (LPA) to approve the planning application, owing to differences in governance process within each LPA. This may extend the programme presented in figure 7-1 by 3 months
- Planning committee refusal followed by appeal and subsequent approval ('permission granted on appeal') could extend the programme by up to 12 months although it should be noted there is no statutory time limit to this process
- Judicial review of LPA decision to grant planning permission could extend the programme significantly and between 12 to 36 months depending on the nature of challenge.

7.10. Key mitigation to the planning risks posed will be an open and transparent approach to engagement with regulators and planning authorities and engaging with the public early through the pre-planning process.

7.11. The procurement phase represents the critical path to scheme delivery. Key procurement risks include:

- For DPC, delays at Ofwat Control Points which are dependent on engagement with Ofwat and providing a suitable level of information to progress.
- Delays in obtaining external support from legal and commercial advisors in drafting contractual agreements.
- Commercial challenges around specific scheme risks, for instance construction challenges highlighted in the Teddington discreetness assessment (see annex E).
- Delays or extension to engagement with potential construction contractors in order to establish how best to design the procurement process, while maximising value for money.

7.12. In each case one or all risks may materialise resulting in delays to scheme procurement award of between 3 -12 months.

7.13. Key mitigation to the procurement phase is agreeing early with Ofwat the procurement approach and avoiding abortive work. Commencing the required procurement activities early in 2023, market testing and early contractor engagement will be key to achieving a contract award on time for schemes progressing within AMP9.

7.14. For the construction stage the recommended allowance for non-standard civil engineering activities is in the range of 3-25% which would cover elements such as supply chain issues, delays on site, unexpended ground conditions and issues around commissioning a scheme. Overall, the delay risk through the construction and commission is expected to be at a worst-case up to 12 months.

7.15. Specific scheme risks also exist, in particular for Teddington DRA the construction programme will need to be phased with existing operations and avoid any emergency situations for example drought or storm conditions. As a result construction of key elements will need to be manged carefully and with flexibility. It is likely specific outages will be required to integrate into existing infrastructure and as result subsequent very wet winters followed by dry summers could delay this integration by up to 12 months.

7.16. Opportunities exist to mitigate construction delay for example overlapping enabling works, construction and commissioning activities. Contractors will look for opportunities to accelerate work and mitigate any delays to programme.

Gate 3 activities

7.17. Thames Water recommend three water recycling schemes progress beyond Gate 2 as individual SROs. These are Teddington DRA and Beckton and Mogden water recycling schemes. We envisage a core set of activities through Gate 3 that will advance the design and environmental understanding of the schemes. Key differences between our outputs in this phase of works will be in the level of development and progress made through Gate 3 which will be governed by when a scheme is required. Teddington DRA will include more detailed design refinement and environmental investigation as well as the progression of the number of planning and procurement activities as outlined in table 7-2. Conversely Beckton and Mogden schemes would continue with scheme investigations, closing gaps and addressing uncertainties to generate a preferred scheme design. Where schemes are not required in the final regional model and final WRMP a period of scheme deferral is expected following a mid-Gate 3 checkpoint mid-2024.

7.18. The key tasks which form the WBS for Gate 3 are summarised in table 7.2 below (refer to annex F for detailed list and programme).

Table 7-2: Key Gate 3 activities and tasks per water recycling SRO.

WBS	Key activity / task	Mogden	Beckton	Teddington
Programme and Project Management	Strategic and project level management	✓	✓	✓
	Technical, independent and board assurance	✓	✓	✓
Feasibility assessment and concept design	Update conceptual designs including preferred options for site selection and conveyance routing	✓	✓	✓
	Process design development	✓	✓	✓
	Cost estimating, risk reduction and development of mitigation	✓	✓	✓
	Hydraulic modelling and process design	✓	✓	✓
	Drinking water safety plans	✓	✓	✓
	Hydrogeology and geotechnical studies			✓
	Structural and safety assessments/ calculations			✓
	Development of a transportation strategy		✓	✓
	Flood and drainage risk assessment		✓	✓
Environmental assessment	EIA scoping			✓
	Technical engagement and consultation	✓	✓	✓
	Regulator input and advice	✓	✓	✓
	Development of planning application documents (construction methods, planning balance)			✓
	Environmental modelling, assessment and reporting including carbon and sustainability	✓	✓	✓
	Development of environmental masterplan, environmental controls and remediation plans.			✓
	Development of secondary permits and licences agreements			✓
	Environmental surveys	✓	✓	✓

WBS	Key activity / task	Mogden	Beckton	Teddington
Data collection, sampling and pilot trials	Development of digital services (digital twin, BIM etc)			✓
	Ground investigations (groundwater / contamination risk / UXO / topographic / utility)			✓
	Water quality bench testing / pilot trials			✓
Procurement strategy	Development of procurement vehicle and value for money case			✓
	Progression with key procurement steps, early contractor engagement and market testing			✓
Planning	Planning application activities			✓
	LPA support / engagement			✓
Stakeholder engagement	Engagement and consultation activities	✓	✓	✓
	Customer engagement activities			✓

7.19. Based on the proposed scope of works and programme outlined above and detailed in annex F our proposed target dates for future RAPID gates is shown in table 7-3.

Table 7-3: Provisional Gate 3 and Gate 4 submission dates for each London water recycling scheme.

Scheme	Gate 3 target date	Gate 4 target date
Teddington DRA SRO	November 2023	September 2024
Beckton water recycling SRO	May 2024*	N/A
Mogden water recycling SRO	May 2024*	N/A

* Mid-Gate 3 checkpoint date rather than formal Gate 3 submission

Planning and consenting strategy

Planning strategy and consents

7.20. Annex G considers in detail the use of different planning regimes for the water recycling schemes. None of the schemes automatically qualify as Nationally Significant Infrastructure Projects (NSIPs) as defined by the Planning Act 2008 (PA2008), and so two available options for planning consent exist:

- Development Consent Order (DCO) following a request that the relevant Sectary of State (SoS) under Section 35 of the PA2008 that the scheme is one for which development consent must be sought, or,
- Planning permission granted under the TCPA by all LPAs within whose local authority area the development will take place.

7.21. The preferred planning consent route favoured by Thames Water is for applications to be made to the relevant planning authorities for planning permission to be granted under the TCPA. The key steps in the planning process are shown in figure 7.3.

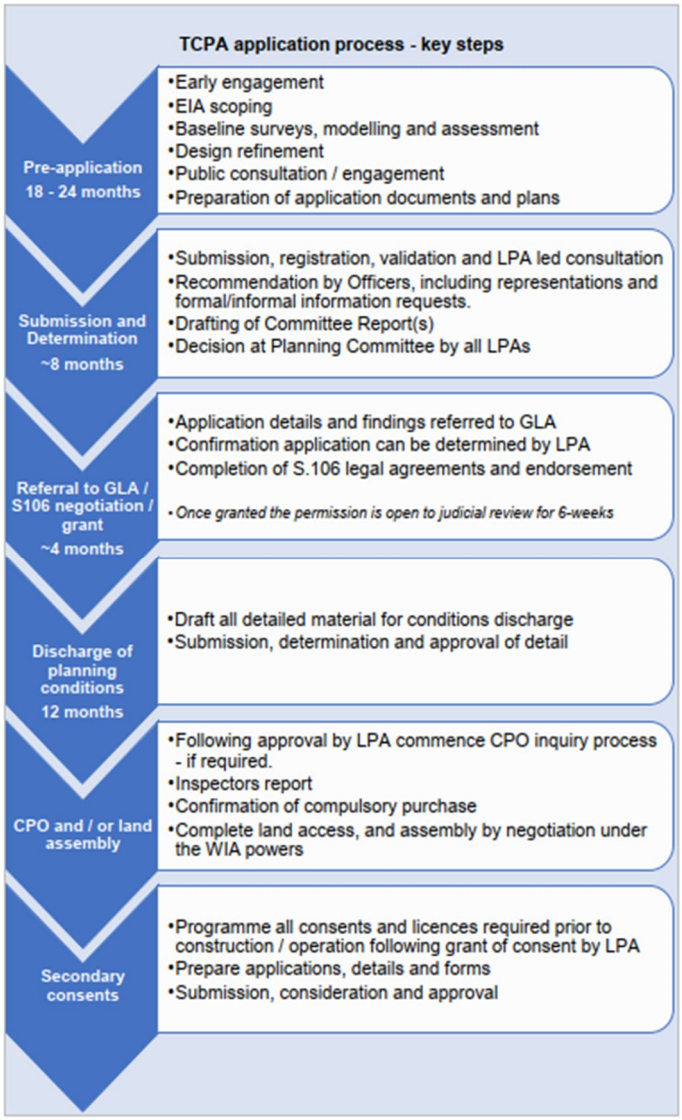
7.22. For all schemes Thames Water are able to make use of land under their ownership and control for delivery of the majority of the main treatment infrastructure, either the AWRP or the TTP. Most of the remaining off-site development is either to be constructed as a tunnel or pipeline bore at medium depth (circa 20m), or as discreet intermediate construction shafts along the conveyance alignments. In these circumstances, Thames Water is able to draw upon the rights afforded to it under the Water Industry Act to install pipelines and tunnels and associated infrastructure including taking access to and constructing within land owned by third parties

7.23. It is only where discharge outfalls or intake screens are required that more notable structures must be introduced on land owned by others, in each case anticipated to be within open space under Local Authority control. Accordingly, the likelihood that pursuing acquisition of such sites by compulsory purchase would form the primary strategy for delivery of any of the water recycling schemes is currently considered to be low.

7.24. It is feasible for the range of parallel consents and approvals required for a scheme can be obtained in parallel to the TCPA consent and in place prior to the related activity being implemented. The scheme delivery programme (figure 7.1) shows that sufficient time exists to secure the necessary planning and non-planning permissions, licences and consents necessary to confirm scheme delivery and land assembly within the timescales required to facilitate scheme delivery.

7.25. Should a decision be taken to pursue consent through the NSIP regime, then it will be necessary to request from the SoS a direction under Section 35 of the Planning Act 2008 to make a water recycling project of national significance. This direction would then require a DCO application for a scheme. While this remains a viable option for Thames Water, this currently is not the preferred approach for schemes.

Figure 7-3 Key planning steps



Licensing and other consents

7.26. Substantial changes to the operation of water resource management on the River Thames is expected as a result of new SROs, changes to existing licences, changes in flood management and new bulk transfers of water between water companies. Although at this early stage of scheme delivery the details of all regulatory consents and permissions have not been finalised. Preliminary work has been undertaken for the purposes of providing assurance to regulators and stakeholders that the various SROs can be licensed in the future and that there are no showstoppers in that licencing.

7.27. Thames Water's licensed abstractions (M2 Licence) are managed under an existing operating agreement[6] – the LTOA and an associated control diagram which sets out protocols for abstracting water from the river under different flow conditions. The operating agreement also

[6] Under Section 20 of the Water Resources Act 1991

includes requirements to manage abstraction in order to allow navigation of the river by boat users[7] and to support environmental and water quality requirements in the upper Tideway.

7.28. We have worked with the EA to identify the permitting requirements for London water recycling schemes.

- For Teddington DRA the EA's view is that the abstraction is permitted as a separate abstraction to M2 (i.e. new abstraction licence). The operation of the scheme would be based on a simple 'take and put' basis with a licence condition to link the abstraction quantity to the volume discharge (i.e. no net change in flows). The scheme would be captured as an additional operation under the LTOA and associated control diagram.
- The Mogden water recycling scheme makes use of the existing intakes, principally Walton and Hampton; abstraction at Surbiton would normally be at its maximum when this scheme would operate. This scheme could be licensed as a 'put and take' arrangement although use of the existing intakes under the M2 licence might lead to complications in accounting for water normally abstracted compared to that provided from Mogden. This might suggest the scheme would be better included as a variation to M2 Licence.
- The Beckton water recycling scheme would operate outside of the River Thames regulation and LTOA as in the Tideway and likely just require a discharge permit into the River Lee.

7.29. In addition to the above other permits are likely to be required, including a flood risk activity Permit (FRAP) where there are works on, over under or within eight metres of the river.

Lands strategy and plan

7.30. Thames Water have statutory powers under S159 of the Water Industry Act 1991 (WIA) to lay and repair pipelines through private land, and similar powers under S158 to lay pipelines in/under highways, including powers to enter land for the purposes of surveys and investigations. Powers of compulsory acquisition of land are also afforded to water undertakers under S155 of the Act.

7.31. The key requirements for land assembly will be to ensure that the construction and operation of each intermediate shaft can take place, and to ensure that the buried tunnel or pipeline infrastructure are not prejudiced by other developments or land uses. As the operational access to each shaft will be minimal, and the tunnel or pipeline constructed at depth, it is anticipated that reliance upon statutory powers will be a key element to assembling the necessary rights over each site. These rights can be implemented irrespective of whether the planning consent is obtained via the PA2008 or the TCPA.

7.32. For the Teddington DRA scheme there will be a requirement for a new discharge and a new intake and screening structure to be installed within the riverbank of the River Thames, and for the Mogden scheme a new outfall structure will need to be installed within the riverbank of the River Thames. All of these items would be constructed on third party land understood to be under Local Authority control. Subject to the statutory powers described above, should use of such land require either acquisition by agreement or compulsory acquisition that process can be delivered prior to the start of construction in 2027. Where required, Thames Water would always prefer to seek land by agreement rather than following a compulsory acquisition process. Rights or temporary use of land would be sought taking into account the provisions of the WIA, in particular Section 155. Annex F provides further details on our land strategy.

[7] As required under the Thames Conservancy Act, 1933

Strategy implementation and engagement

7.33. Through Gate 2 Thames Water has started to build an experienced PMO team to define future requirements, establish governance, develop process and procedures and build delivery capability from Gate 2. As part of this wider delivery structure into Gate 3 a consent, engagement and property team will implement the planning and lands strategy to ensure key milestones in the scheme delivery plan are met, including time for the required levels of engagement, and time to undertake Compulsory Acquisition via Inquiry should that be necessary. This team will interface with the individual SROs and ensure plans and strategies are aligned and any commonality across projects is shared.

7.34. All LPAs within whose Borough one or more of the potential water recycling schemes could be situated were engaged with through 2022 to provide background context on the purpose of the scheme, the nature of work being undertaken and the potential route corridor for options. The sessions were an opportunity to provide a briefing on schemes and to open future discussions with relevant LPAs once the draft WRSE regional plan has been consulted upon. They also provided an opportunity for LPAs to provide any initial view of key challenges and risks to planning for a scheme. The outcomes of this engagement are set-out in annex D.

7.35. Thames Water will seek to set up Planning Performance Agreements with each relevant LPA to facilitate ongoing formal and informal advice on a future planning application. Further work planned from autumn 2022 will capitalise on progress made through Gate 2 and commence activities to support the following aspects for scheme identified early in the draft regional plan:

- Engagement: planning, technical and land assembly engagement to establish working relationships, key issues and grounds for negotiation.
- Baseline data collection: organisation and commencement of seasonally affected or constrained data (e.g. over-wintering birds), or data requiring long term collation and analysis.
- EIA Scoping: identification of information required to prepare an EIA of the selected scheme, along with assessments required under planning validation, preparation of a draft EIA Scoping Request report for submission early in Gate 3.
- Reference design refinement: initial revisions to design assumptions, parameters and intentions to inform engagement, data collection and scoping.

Planning risks and issues

7.36. Planning risk, challenges and issues are described in full in annex G and risks to the planning process summarised in paragraph 7.9. To date no significant planning or land assembly risks have been identified that are not capable of being mitigated through ongoing technical and environmental assessment work or early scheme engagement.

7.37. The key planning risks identified are all comparable to the stage of evolution of schemes and with continued technical and environmental feasibility work, including necessary stakeholder engagement beyond Gate 2, a number of the risks will be capable of further mitigation.

7.38. At the scheme level, the most significant planning constraints are:

- The location of part of the Beckton conveyance at Lockwood is in a Special Protection Area.
- The loss of Metropolitan Open Land (MOL), SINC and committed habitat to deliver the Beckton conveyance and AWRP.
- The loss of Green Belt land, SINC and indirect impacts upon the South-West London Waterbodies SPA to deliver and operate the Mogden water recycling scheme.
- The loss of open space and SINC to deliver the Teddington DRA scheme river intake and screen structure.
- Shaft construction at various Green Belt and MOL locations.

7.39. Ongoing assessment and design including consideration of habitat quality and appropriate mitigation is considered likely to identify an appropriate means of delivering development either within or adjacent to the identified SPAs. This will include consideration of alternatives means of construction alongside appropriate compensation where necessary.

7.40. It is also considered that a case to demonstrate that both the loss or temporary loss and reinstatement of areas of Green Belt and MOL can be made where that proposal is for operational purposes associated with a London water recycling scheme under Section 263 of the TCPA.

7.41. Where open space and SINC land is to be lost, either temporarily prior to reinstatement or in some small areas permanently, it is again considered possible to justify such land use in the context of the selected scheme and the need that scheme will meet, and the provision of appropriate design and mitigation measures to minimise the effect of and impacts.

Overview of the procurement, ownership and operational strategy

Procurement strategy

7.42. Annex E outlines the procurement and commercial strategy for schemes.

7.43. Our work through Gate 2 has built on our initial Gate 1 assessments and examined in more detail each scheme in relation to Ofwat's DPC criteria of; size; discreteness; and, value for money. We have also assessed whether each scheme meets the criteria for SIPR procurement and developed a procurement plan and commercial strategy that aligns with the wider programme and reflects the draft regional modelling.

7.44. In summary, all schemes would meet the £100m size threshold for DPC delivery set out in Ofwat's PR19 methodology, as well as the £200m size threshold set out in the draft PR24 methodology[8].

7.45. The Teddington scheme does not pass the discreteness test. The construction of the scheme includes features that require complex interfaces with existing operational Thames Water assets, including:

- Constructing the scheme's tertiary treatment plant above existing operational storm tanks at Mogden STW. This requires significant modifications to the existing structure to provide space for the new tertiary treatment facility, during the construction of which the existing tanks will need to be taken offline. Further, deep piling close to the existing structures is likely to be required which could lead to disturbance.
- Sinking the outflow shaft onto the existing TLT. The original construction technique for the TLT makes use of surrounding ground pressure to achieve structural integrity. The condition of the tunnel is not clearly understood and sinking the new shaft for this scheme will disturb the surrounding ground. Mitigation would need to be in place during construction to prevent any weakening of the tunnel or structural issues at a later date. The large volumes transferred by the TLT make it key to the west-east water transfer supplies for London and as such it is a critical asset to Thames Water's operations.

7.46. These features introduce considerable interface risks that it is likely to be poor value to contractualise into a DPC contract. Based on these considerations, we consider that DPC procurement should not be considered further beyond Gate 2 for the construction of

[8] Creating tomorrow, together: consulting on our methodology for PR24. Appendix 5 – Direct procurement for customers, July 2022

Teddington. A 'Very Late' DPC model could be considered as construction is progressed, however it is not clear what value refinancing post construction would deliver.

7.47. We have also considered whether individual components of the Teddington scheme (other than the TTP) could be competitively tendered using DPC. However, the only component that can be considered 'discrete' is the treated effluent pipeline from the TTP to the Thames, which would not meet the PR19 £100m DPC totex threshold. Even when packaged with the new abstraction and pipeline connection to the TLT (£135m totex in total), it would fall significantly short of the proposed £200m totex threshold in draft PR24 guidance. As noted above, we have significant concerns regarding the discreteness of the connection to the TLT; these risks, and the small size, mean the combined package is considered unlikely to be attractive to the market in light of other much larger DPC schemes being progressed in parallel.

7.48. In the event that a DPC procurement were to be pursued, our analysis has also highlighted risks to achieving the delivery date for a Teddington scheme by 2031. It may be possible to mitigate these risks for example, through undertaking procurement activities in parallel however, in light of our conclusions on discreteness, we have not investigated this further.

7.49. The Beckton and Mogden schemes are potentially able to be made discrete. We recommend (based on the PR24 draft guidance) that DPC procurement should be adopted as the central procurement assumption, subject to confirming value for money at future gates or Ofwat Control Points should either scheme progress. The value for money assessment will be informed by a programme of market testing, the pace of which would depend on the required timeline for these schemes to be in-service.

7.50. Should a Beckton or Mogden scheme be adopted in place of Teddington, we recommend that further investigation of potential opportunities to drive value under a DPC approach progress at pace, to inform the value for money analysis. This includes in-depth risk and opportunity analysis, market engagement to test the likely structure of DPC models and the pricing of critical risks.

7.51. On SIPR, we conclude that none of the four schemes are of a size or complexity that threatens the incumbent undertaker's ability to provide services for its customers, and so are not considered eligible for SIPR under current regulations. However, Ofwat has made a recommendation[9] to the Secretary of State for Business, Energy and Industrial Strategy (BEIS) that the 'size or complexity' test be removed from SIPR legislation, so that SIPR can be applied to a broader range of schemes where a licensed approach would offer value for money.

7.52. Our initial modelling suggests that the Beckton scheme may be of sufficient scale to deliver better value to customers under a SIPR model, and we therefore recommend that, should a Beckon scheme be progressed, this should be considered further in the event that SIPR legislative changes are adopted.

Ownership, operating and commercial arrangements

7.53. Thames Water would be best placed to continue as the scheme promoter, leading the further work on scheme development and procurement. This is because Thames Water is the sole provider, the sole beneficiary of Teddington scheme (and the primary beneficiary of Beckton or Mogden schemes) and has all assets for each proposed scheme located within its region. Should any scheme be taken forward and be needed to meet other water companies' water

[9] Competition stocktake report final (ofwat.gov.uk)

resource requirements, then Thames Water may need to involve these other beneficiaries as funder and sponsor.

7.54. Thames Water would maintain ultimate control of scheme operations for all schemes.

- For Teddington, Thames Water would be the operator of the scheme under the proposed in-house delivery model.
- Should Beckton or Mogden be delivered under DPC or SIPR, Thames Water will be the contractual counterparty to the DPC CAP or SIPR IP. Should a supply be required for any other water companies in the future, this will be contracted under a bi-lateral bulk supply agreement (BSA) to be agreed at the time the need arises. We anticipate the BSA will be operated under a principle of 'commercial neutrality'[10], and will comprise both 'capacity'[11] and 'volumetric'[12] charging elements.

Procurement risks and issues

7.55. Key procurement risks are summarised in paragraph 7.11 and discussed in detail in annex E.

8. Solution costs and benefits

Solution cost estimates

8.1. The cost methodology adopted for Gate 2 is aligned to ACWG methodology and is consistent across SROs and non-SRO options. An assessment of capital expenditure (Capex), operating expenditure (Opex), costed risk and optimism bias (OB) costs for the four schemes was completed.

8.2. The scope of work updated the Gate 1 costing assessment to reflect the schemes as developed in the conceptual design for Gate 2. This has ensured stakeholder comments were addressed whilst optimising Gate 2 cost. To develop the Capex/ Opex cost estimates, the following activities have been undertaken:

- Review of the feasibility design information currently available, updates of cost algorithms selected and yardsticks using Thames Water costing tools (generates Capex and Opex), including for optimism bias adjustments (based on ACWG methodology and the HM Treasury Green Book).
- Quantitative Costed Risk Assessment with initial risk scoring and Monte Carlo simulations to develop associated costs for project risks.
- Development of OB taking cognisance of the updated scope and costed risk and scaling back where appropriate in line with the ACWG cost consistency methodology.

8.3. Capex and Opex estimates have been then processed to generate the Net Present Value (NPV) and AIC using a calculation tool provided by ACWG, which aligns with the Treasury Green book methodology, with a declining schedule of discount rates and for an 80-year period. All costs have been adjusted for inflation/ deflation to 2020/21 cost base. At Gate 3 the inflation index

[10] Whereby neither Thames Water nor the other party to the BSA will be favoured when delivering water supply.
[11] To contribute towards the fixed costs of the Beckton scheme, including upfront capital and ongoing, non-volume-dependent maintenance.
[12] To contribute towards variable, volume-dependent operating costs of the Beckton scheme.

rates will be reassessed for the divergence and high inflation in the current market. The cost of electricity will be reviewed again at Gate 3 based on current inflation in prices.

8.4. The estimated Capex, Opex, NPV and AIC for each of the options at the maximum and the minimum capacities are shown in table 8-1 and table 8-2. Details of costing methodologies, assumptions, exclusions and estimated costs, including cost profile information can be found in annex A5.

8.5. As for Teddington DRA scheme, Capex for conveyance elements decreased in 50 Ml/d and 75 Ml/d options because a smaller-diameter tunnel and river intake structures with 75 Ml/d conveyance capacity was proposed for these options in Gate 2 while a 150 Ml/d-capacity larger tunnel had been assumed in Gate 1. Conveyance elements with 150 Ml/d-capacity were used for estimation for 100 Ml/d and 150 Ml/d Teddington DRA option. As Gate 2 environmental investigation showed that a 100 Ml/d Teddington DRA scheme is likely acceptable, conveyance options for 100 Ml/d capacity will be reviewed in Gate 3. Demolition and reconstruction of existing storm tanks in the Mogden STW were estimated higher in Capex for plant elements as a result of Gate 2 site visit and record drawing review.

8.6. Gate 2 Capex estimates for Beckton and Mogden water recycling schemes stayed approximately at the same level as Gate 1 estimates though review of design details such as hydraulics, pump sizes and power requirements made some increases and reductions in costs. Capex for the Mogden South Sewer scheme raised significantly reflecting increased land requirement for plant construction.

8.7. Opex was generally increased for all options because it was assumed that the plants would operate on 'hot standby' at 25% of full capacities during non-drought periods to generate sweetening flow, while at Gate 1 it was assumed plants would operate on 'hot standby' at 20% full capacity for only three months of the year, in preparedness, during non-drought periods and in care and maintenance mode at other times. There is an opportunity to reduce this capacity and cost when the optimal flow rate for sweetening flow has been determined as the design matures. However, the Opex for the some Teddington DRA options decreased in Gate 2 because chemical dosing costs which used to be included in fixed costs in Gate 1 were moved to variable costs resulting in lower fixed Opex.

Table 8-1: Capex and Opex for London water recycling schemes (2020/21 base date)

Cost Element	Units	**Teddington** 50Ml/d TTP + conveyance	**Teddington** 75Ml/d TTP + conveyance	**Teddington** 100Ml/d TTP + conveyance	**Teddington** 150Ml/d TTP + conveyance	**Beckton** 50 Ml/d AWRP + conveyance	**Beckton** 100 Ml/d AWRP + conveyance	**Beckton** 150 Ml/d AWRP + conveyance	**Beckton** 300 Ml/d AWRP + conveyance	**Mogden** 50 Ml/d AWRP + conveyance	**Mogden** 100 Ml/d AWRP + conveyance	**Mogden** 200 Ml/d AWRP + conveyance	**South Sewer** 50 Ml/d AWRP + conveyance
Option Benefit	MLD	46	67	89	134	46	89	130	252	46	88	169	46
CAPEX													
Base Capex	£m	138	143	204	214	494	553	620	848	308	366	519	252
Costed Risk	£m	33	37	55	63	115	144	174	272	84	111	178	77
Optimism Bias	£m	55	57	84	88	189	216	246	349	118	146	221	117
Total G2 Capex	£m	226	237	343	365	798	913	1,041	1,469	510	624	918	446
Total G1 Capex	£m	223	253	290	350	774	907	1,059	1,539	493	635	982	330
Change G1 to G2	%	1.4%	-6.8%	15.5%	4.1%	3.0%	0.7%	-1.7%	-4.7%	9.0%	4.3%	-6.9%	25.9%
OPEX													
G2 Fixed	£m/yr.	0.55	0.59	0.93	0.99	2.89	3.65	4.51	8.12	2.60	3.81	7.02	2.75
G2 Variable	£/ML	162	166	282	291	527	508	565	1,098	578	530	1,016	703
G1 Fixed	£m/yr.	1.53	1.67	1.85	2.12	2.52	3.50	4.22	7.48	4.17	3.10	5.70	2.27
G1 Variable	£/ML	42	52	72	91	357	369	378	741	373	416	801	434
Change (Min Flow)	%	-20%	-4%	74%	114%	102%	122%	166%	346%	21%	160%	298%	151%

Note 1) CAPEX and OPEX for multiple sub-options were combined to obtain values as following:

- Teddington DRA – 100 Ml/d yield: 2 phases of 50 Ml/d treatment stage and the Mogden to Teddington tunnel and from River Abstraction to TLT connection sub-options.
- Teddington DRA – 150 Ml/d yield: 2 phases of 75 Ml/d treatment stage and the Mogden to Teddington tunnel and from River Abstraction to TLT connection sub-options.
- Beckton water recycling – 300 Ml/d yield: 2 phases of 150 Ml/d treatment stages and the Beckton to Lockwood tunnel and Lockwood to KGV tunnel sub-options.
- Mogden water recycling – 200 Ml/d yield: 2 phases of 100 Ml/d treatment stages and the conveyance (all streams) sub-option.

Table 8-2: NPV and AIC for London water recycling schemes (2020/21 prices)

Teddington DRA	Units	**Teddington** 50Ml/d TTP + conveyance	**Teddington** 75Ml/d TTP + conveyance	**Teddington** 100Ml/d TTP + conveyance	**Teddington** 150Ml/d TTP + conveyance	**Beckton** 50 Ml/d AWRP + conveyance	**Beckton** 100 Ml/d AWRP + conveyance	**Beckton** 150 Ml/d AWRP + conveyance	**Beckton** 300 Ml/d AWRP + conveyance	**Mogden** 50 Ml/d AWRP + conveyance	**Mogden** 100 Ml/d AWRP + conveyance	**Mogden** 200 Ml/d AWRP + conveyance	**South Sewer** 50 Ml/d AWRP + conveyance
Option Benefit (max flow)	MLD	46	67	89	134	46	89	130	252	46	88	169	46
Min Flow (Gate 2)	MLD	11.50	16.75	22.25	33.50	11.50	22.25	32.50	63.00	11.50	22.00	42.25	11.50
Min Flow (Gate 1)	MLD	-	-	-	-	-	-	-	-	-	-	-	-
Total planning period option benefit (NPV)	Ml	335,087	488,061	641,036	946,985	360,157	696,826	1,017,835	1,973,035	387,013	740,372	1,421,850	360,157
Total planning period indicative capital cost of option (CAPEX NPV)	£m	229	242	357	383	794	942	1,112	1,674	460	611	1,007	504
Minimum Flow													
Total planning period indicative operating cost of option (OPEX NPV)	£m	25	32	66	91	110	167	241	819	104	167	469	125
Total planning period indicative option cost (NPV)	£m	228	247	383	431	815	1,007	1,234	2,323	514	715	1,380	575
AIC	p/m³	68	51	59	44	226	144	121	118	133	97	97	160
Gate 1 AIC	p/m³	73	61	40	40	157	109	120	88	149	117	92	118
Maximum Flow													
Total planning period indicative operating cost of option (OPEX NPV)	£m	65	93	201	303	252	433	672	2,341	255	431	1,442	315
Total planning period indicative option cost (NPV)	£m	269	308	518	644	957	1,272	1,665	3,844	665	980	2,352	765
AIC	p/m³	80	63	80	66	266	183	164	195	172	132	165	212
Gate 1 AIC	p/m³	78	66	45	45	190	142	157	123	184	158	131	151

Note 1) NPV and AIC for multiple sub-options were combined to obtain values as following:

- Beckton water recycling – 300 Ml/d yield: 2 phases of 150 Ml/d treatment stages and the Beckton to Lockwood tunnel and Lockwood to KGV tunnel sub-options.
- Mogden water recycling – 200 Ml/d yield: 2 phases of 100 Ml/d treatment stages and the conveyance (all streams) sub-option.
- Teddington DRA – 100 Ml/d yield: 2 phases of 50 Ml/d treatment stage and the Mogden to Teddington tunnel and from River Abstraction to TLT connection sub-options.
- Teddington DRA – 150 Ml/d yield: 2 phases of 75 Ml/d treatment stage and the Mogden to Teddington tunnel and from River Abstraction to TLT connection sub-options.

Note 2) Minimum flow is 25% of the option benefit.

8.8. The design life of any civil structures, such as buildings and tanks in the AWRP/TTP, is generally 60 years, and for the tunnels and alternative pipeline for recycled water transfer the design life would be 120 years. The lifetime of mechanical and electrical and control equipment varies. Maintenance requirements for the water recycling schemes include items listed in table 3-4.

8.9. These asset life expectancies assume that assets are maintained following a maintenance profile that helps them to stay operational for the expected asset duration. Since the treatment facilities are intended to be operated intermittently, the maintenance regime of the mechanical equipment needs to be considered carefully. Periods out of use can affect the asset life of equipment such as pumps/membranes.

8.10. The majority of capex items were estimated using Thames Water's Engineering Estimating System (EES) cost curves. The EES cost curves were derived from over 6,500 projects totalling £12 billion in value, which had been implemented within Thames Water's operational regions. The costs derived from this data base are benchmarked and validated through Thames Water's Performance Review 2019 (PR19) process with updates since then.

8.11. Unit rate benchmarking has been carried out for the project-specific items, such as process equipment for AWRP, which could not be derived from the EES cost curves, with unit rates compared against industry standards and budget quotations from UK Suppliers. Percentage differences of the sub-option costs with and without the benchmark unit rates were not greater than 10%.

8.12. Additionally, benchmarking of the AWRP construction costs against seven water recycling and desalination projects overseas has been undertaken. Percentage differences between the average of the seven overseas projects and AWRP construction costs for the Beckton and Mogden water recycling schemes was from 4.2% to 10.0% for 100 Ml/d or 150 Ml/d plants, whilst the difference was up to 32.8% for 50 Ml/d plant, when comparing in costs per plant size (£/Ml/d). Thus, estimated prices would be competitive when the plants are developed in larger units.

8.13. The estimated costs in Gate 2 formed a basis of the WRSE regional modelling. The model carried out comparison of solution's costs with alternatives with consideration of inter-regional and systems impacts. This includes consideration of cost scalability and tipping points of each scheme. Outcome of the WRSE regional modelling is summarised below.

Best value and solution benefits

8.14. A 'Best Value' water resource plan is one that delivers wider benefits to society and the environment. It considers a range of factors alongside economic cost in the identification of the preferred water resource programme that will form the basis of the plan. The development of a best value plan is promoted by the EA, Ofwat and Natural Resources Wales in the Water Resources Planning Guideline.

8.15. WRSE is carrying out best value analysis to develop the Best Value Regional Plan. Details of WRSE's best value evaluation methodologies including metrics can be found in the Method Statement: Best Value Planning (WRSE, January 2022)[13]. The Thames Water WRMP is cascaded from and fully aligned with the WRSE Regional Plan, and so the same best value metrics have been considered in both plans.

8.16. The WRSE best value metric scores have been applied to the SRO schemes and its sub-components. The metrics considered in addition to cost and carbon emissions are Natural

[13] https://www.wrse.org.uk/media/sy1bu4to/method-statement-best-value-planning.pdf

Capital (NC), Biodiversity Net Gain (BNG), SEA benefit, SEA disbenefit, resilience: reliability, evolvability and adaptability, and customer preference.

8.17. The methodology for the metrics utilised at a regional level, consistent with the Thames Water's draft WRMP and London recycling schemes, is provided in annex 1, part 3 of the WRSE draft regional plan. A summary of the best value metrics is included within Thames Water's draft WMRMP, alongside other SROS and non-SROs for context.

8.18. The draft WRSE regional plan shows:

- Teddington DRA scheme at 75 Ml/d needs to deliver water into supply from 2031. To achieve this date the scheme would need to be consented in 2025 and construction activities started in early 2027.

8.19. As part of Thames Water's draft WRMP24 a number of London water recycling schemes are selected as part of an alternative plan to the best value adaptive regional plan.

- Beckton water recycling scheme could provide an alternative source to Teddington if this preferred scheme did not progress for any reason. Beckton has also been identified as an alternative source for Affinity Water.
- Mogden water recycling scheme also provides a viable alternative to the Teddington or Beckton schemes.

8.20. The Mogden South Sewer scheme is not selected under any scenario. Work through Gate 2 has highlighted escalating costs and a significant reduction in the DO (see paragraph 3.15). The scheme does provide a wastewater benefit; however, to date the contribution and joint benefits between wastewater and water resource has not been quantified. Thames Water is therefore recommending that the Mogden South Sewer scheme does not continue development under the RAPID process into Gate 3. Instead, any future investigations and development will be undertaken as part of business-as-usual work by Thames Water.

9. Stakeholder and customer engagement

9.1. This section provides an overview of the engagement completed with stakeholders and customers. It provides a summary of stakeholders' and customers' views and how these have been considered in the development of the scheme. It also sets out the next steps.

Stakeholder engagement overview

9.2. During Gate 1 we engaged with regulators and stakeholders to design the monitoring, modelling and assessments required in Gate 2. Our Gate 2 programme continued this engagement, working collaboratively and sharing information in a timely way. We also took account of the stakeholder representations submitted to RAPID at Gate 1, as well as direct feedback from RAPID and other regulators, and extended discussions to include local planning authorities and other stakeholder organisations.

Feedback from RAPID at Gate 1

9.3. In RAPID's final decision at Gate 1 a number of actions and recommendations were made. These are listed in tables 9-1 and 9-2 respectively with commentary on how these points have been addressed and where further information can be found.

Table 9-1 Actions set out by RAPID at Gate 1

Ref	Action – Detail	Response and signpost
1	Develop utilisation figure to be determined by regional modelling and to consider impacts of in-combination effects.	Work at Gate 2 examined the frequency and duration of scheme operation with Pywr modelling and included the development of operational philosophy including stand-by modes. This information is presented in each scheme concept design report (annex A1-A4) Consideration of in-combination effects have been reported in the IEA report (annex B5) and follows the ACWG methodology prepared for Gate 2.
2	Use outcomes from the regional modelling to determine drought resilience.	Output from the draft regional model demonstrates resilience to droughts against a range of modelled stochastic drought scenarios. This is presented in section 4 of this report.
3	Ensure a best value analysis, following relevant guidelines and including environmental/social/economic costs, is undertaken and presented for all of the sub-options within this SRO.	Best value assessments are in line with the "Water Resources Planning Guideline" and Ofwat's "Public value in the water sector: A supporting set of principles (July 2021)". This is supplemented with information from the regional modelling which incorporates a variety of best value metrics to ensure consistency in all assessment outputs. A summary of the regional modelling outputs can be found in section 8.
4	Review the scope of environmental impacts and ensure engagement with regulatory partners to identify where mitigation can be built into solution design.	A programme of technical engagement was implemented at the start of Gate 2 to share the approach, scope, modelling outputs and assessments. Where the risk of significant impacts has been identified mitigation has been proposed. This has either been embedded within the design (annex A) or included as additional mitigation in assessments (annex B). In some instances, where impacts are deemed to be high, we have recommended amendments to the size options of schemes or written to RAPID mid-gate to remove whole sub-options[3,4].
5	Review the scope of any future statutory Strategic Environmental Assessment (SEA) to agree objectives and recommendation additions/subtractions (for example, the guide questions in SEA focus on reducing carbon emissions and the longevity of the option, and less so on the impacts on the environment in light of climate change).	We prepared a bespoke approach to impact assessment for Gate 2 which goes beyond the SEA approach adopted at Gate 1. This approach, called Initial Environmental Appraisal (annex B5), supports the work required for a formal SEA as part of the WRMP but also advances the understanding of specific impacts from schemes for Gate 2 and allows future EIA scoping of a scheme to be more robust with less uncertainty in the identification of pathways to effects.
6	Update environmental annexes to reflect comments and agreed actions as a priority, including consideration of Swanscombe MCZ in the SEA.	Gate 2 work has taken into consideration all comments made by stakeholders at Gate 1. The approach and scope of work undertaken through Gate 2 has been shared with the NAU, EA and NE and feedback incorporated into the work completed and reports prepared as part of our Gate 2 submission. Specifically, we have provided a screening assessment of the Swanscombe MCZ (annex B7) at Gate 2.

Table 9-2 Recommendations set out by RAPID at Gate 1

Ref	Recommendation - Detail	Response and signpost
1	Produce a detailed stakeholder engagement plan, including identification of wider / local stakeholders.	We have built on our Gate 1 engagement and developed a stakeholder plan that identified the key stakeholders who we engaged with through Gate 2 and prior to any public consultation on the outputs of the draft regional plan. Our engagement plan, in annex D, includes the identified stakeholders, the approach of engagement and key areas and topics for engagement. Through Gate 2 we have focussed engagement in two areas; specific technical engagement of water recycling schemes; and, wider customer engagement.
2	Further consider social and amenity value, if this is limited due to type of solution, this can be explained in the submission.	We have considered social and amenity value throughout the environmental reports, specifically in the BNG and NCA report (annex B6). We have also completed work with customers to seek their preferences on public value, this is presented in annex D, which will be taken into account in more detailed design of the schemes.
3	Carry out a detailed assessment of inter-dependencies and in combination impacts with other SRO and non-SRO options, including Deephams reuse, following outputs of regional modelling.	Through the ACWG an in-combination methodology has been prepared and has been applied to understand potential cumulative impacts between SROs and other developments that might interact with schemes. This assessment is presented in the IEA report (annex B5).
4	Explain how Thames Water will seek to influence the supply chain to reduce scope 3 carbon emissions and outline how the root cause of the issues ties in with the SRO behaviour change/consumption/wastewater disposal etc	The carbon assessment uses the PAS 2080 approach for whole life assessment and mitigation planning. This is in line with Thames Water's aim to be net zero carbon by 2030. We aim to provide a project that is compatible with the budgeted science-based UK trajectory, and which complies with up-to-date policy and good practice reduction measures. A carbon report is provided in annex A5.
5	Particular attention should be paid to the recommendations and learning from previous Drinking Water Inspectorate (DWI) events where effluent discharge impacted on drinking water supplies.	We have worked closely with RAPID through Gate 2 to understand the key issues relating to drinking water supplies and have undertaken research with customers to understand their attitudes towards water recycling and changes in water supplies and communications needed to explain these changes and address concerns and issues. This work is presented in annex D. Thames Water will ensure lessons learnt within the industry are captured and reflected in future engagement around changing water sources.

Gate 2 activity

9.4. Our engagement activity built on previous engagement and consisted of:

- Regional and company-led engagement to inform the development of the WRSE regional plan to ensure customers and stakeholders understood the planning challenge, range of solutions identified and considered, how water recycling and other SRO schemes fit within the strategic planning framework.
- Technical scheme-specific discussions on London water recycling schemes.
- Engagement with customers on best value, wider benefits of schemes and specific engagement with Thames Water customers on changes to source water and to understand views on changing drinking water supply.

9.5. We have been committed to working openly and transparently through Gate 2. We have engaged and communicated with stakeholders at the appropriate project programme junctures to share information and provide the opportunity to give feedback that can inform future decisions and planning.

Regional and company-led engagement

9.6. Since 2019, WRSE has delivered an engagement and consultation programme to inform the development of the regional plan for the south-east. This has included a wide range of water users, customers, businesses, stakeholders and regulators. WRSE has worked openly and transparently sharing information in a timely way across a range of channels and activities.

9.7. WRSE has worked with established stakeholder groups to help guide the development of the regional plan and has also held regular meetings and webinars with the wide stakeholder community to share information throughout the development of the regional plan. Thames Water has also continued to host regular Water Resources Forums for stakeholders as part of this ongoing engagement.

9.8. WRSE held a consultation on the emerging regional plan between January to March 2022. WRSE and the water companies proactively raised awareness of the consultation including holding pre-briefings with the Council for Protection of Rural England (CPRE, now known as The Countryside Charity), National Farmers Union (NFU), National Infrastructure Commission (NIC), Blueprint for Water and Consumer Council for Water (CCW). Furthermore, dedicated meetings were held with Group Against Reservoir Development (GARD) to discuss technical aspects of the plan.

9.9. WRSE received over 1,150 responses to the consultation on the WRSE emerging plan. WRSE published a response in May 2022 which provided a summary of the consultation responses, highlighted the main themes and issues raised in the responses and provided WRSE's consideration of the points and resultant action. The main points in relation to water recycling were:

- risks associated with treatment, including the challenge of remineralisation, blending (and associated changes to taste or feel), existing and emerging contaminants,
- potential network impacts from corrosivity,
- the environmental impacts such as the disposal of waste products
- the carbon impacts.
- Some considered that water recycling (and desalination) should be options of 'last resort' in the plan, whereas others considered them to represent secure solutions that would be resilient to drought.

9.10. Annex D provides further information on the comments received related to recycling schemes.

Scheme-specific engagement

9.11. Engagement was embedded throughout our Gate 2 programme of work and included technical discussions with regulators, water companies, and other key stakeholders, and broader scheme engagement with LPAs. Annex D provides further detail of the engagement activity through Gate 2.

9.12. Technical meetings and workshops were held through Gate 2 to facilitate collaborative working with regulators and stakeholders, these focused on developing consistent approaches and sharing technical information. Technical Working Groups (TWGs) were set up with the NAU, EA, NE and Port of London Authority (PLA) where we developed scopes of work, agreed methods and shared outputs on critical topics. Over 35 technical workshops were held through Gate 2 covering the following topics:

- Engineering design
- Terrestrial ecology and Biodiversity net gain
- Fisheries
- Water quality

- Aquatic modelling
- Aquatic ecology
- Regulatory assessments
- Temperature
- Navigation

9.13. Feedback from the TWGs was taken into account in the on-going programme of works and the outputs are reflected in the reports prepared as part of Gate 2.

9.14. Introductory briefing sessions were held with each LPA who could potentially be affected by the water recycling schemes under investigation. In total we engaged with 10 LPAs through spring and summer 2022. The approach adopted consisted of two parts:

- An introduction to the SRO, RAPID's gated process and expectations and the role of WRSE, regional modelling and its interdependencies with development of the need case for a scheme.
- Scheme specifics that allowed each LPA to understand how a scheme would interact within its, and neighbouring authority, boundaries and the potential construction and operation impacts of a scheme.

9.15. The key themes and feedback from the LPAs is set-out in annex D, but overall the initial engagement was positively received, relevant local information was shared and a commitment made to continue the engagement through Gate 3.

9.16. We engaged closely with RAPID throughout Gate 2 which included fortnightly liaison calls, regular 'check-in' calls and a site visit to Mogden STW and parts of the Teddington DRA scheme.

9.17. All major decisions taken by the SRO team through Gate 2 were shared with RAPID and where appropriate their approval was sought.

Customer engagement overview

9.18. During Gate 1 we explored customers' views on resilience planning, supply and demand options, sharing resources and the SROs. This work highlighted that water recycling tended to draw mixed views from customers driven by a low level of understanding of water supply and concerns focused on safety and hygiene. It highlighted the need to improve communication to ensure successful promotion of water recycling. This section summarises the research with customers during Gate 2.

Gate 2 activity

9.19. The Gate 2 programme was designed to address three themes:

- "Best value" – to understand what customers view as "best value" and how they weight and prioritise attributes to inform the WRSE regional plan.
- Wider benefits or public value – to seek customers' views on potential "wider benefits" in the context of water infrastructure, what added benefits are the most important, what they would be willing to pay for and how their views alter depending on their proximity to the scheme.
- Changes to source water – to understand customers' views on changing their drinking water supply and how we would need to communicate such changes as well as communications to explain, and alleviate concerns on, water recycling specifically.

9.20. We worked collaboratively with other water companies to ensure both a consistent and efficient programme of customer engagement to support the development of all the SROs. Where practical we utilised regionally led work, while for other areas we have formed 'club' projects which involved collaborative working across several of the SROs and using the

expertise across the companies. The work was delivered by independent market research agencies and with scrutiny from the south-east regional Customer Challenge Group, bringing representatives from the CCW and the company independent challenge groups, on the regional work, and CCW and DWI on the SRO "club" projects.

9.21. These studies are presented in full in annex D and the headline results are summarised in table 9-3.

Table 9-3: Summary results from customer engagement

Best Value	Over 300 household customers were engaged to explore their preferences regarding the 'best value' criteria developed by WRSE. Overall customers place more weight on the delivery of a secure supply of water, followed by cost, environmental improvements, and then resilience of the water supply system. This insight has been used in the development of the draft regional best value plan.
Wider benefits	Over 6,000 customers were engaged to understand what added value customers perceive is important as part of water infrastructure development and their preferences for the added value i.e. what should be the balance between options such as economy, jobs, apprenticeships, leisure, education and carbon sequestration and how much are customers prepared to pay for the added benefit. The research found that overall environmental additions were valued highly such as the creation of wildlife/new wetlands/habitats. For water recycling opportunities for the creation of wildlife habitat, walking paths and cycle trails and local employment were identified to be important.
Changing source water	Over 2,000 customers were engaged in the research to explore customers' views and attitudes towards water source changes and the implications for communications. The research showed that despite customers being unlikely to engage with communications on source change, it is still important to explain any change. Whilst there is a need to communicate on any source change, water recycling and desalination in particular need more engagement due to a higher level of spontaneous concerns. For recycling these concerns centre on safety, quality and the environment. Key points to successful communications on water recycling are: • the clear steer that recycled water is safe to drink. • information on the process - customers want to know about the process • information on whether the water would be harder or softer • any possible changes to taste for recycled water Drawing on the conclusions of this study a further stage of research was undertaken with customers in London who could potentially receive recycled water as their water supply if a recycling scheme is taken forwards. This work provided a clear steer on how to construct and deliver messaging on water recycling.

Next steps beyond Gate 2

9.22. There will be ongoing engagement with the stakeholder community as part of the development of the WRSE regional plan and consultations on the draft regional plan and draft WRMP24's in autumn 2022, this will include local communities who could potentially be affected by the development of new water infrastructure.

9.23. Further to confirmation of the timing of London water recycling schemes in the regional plan a full stakeholder engagement strategy will be developed, building on the work completed to date, to identify those organisations and individuals potentially affected and to ensure that

they have opportunities to engage with, and influence, the proposals before any firm and final decisions are taken.

9.24. The engagement strategy will include, but not be limited to, landowners, local communities or other potentially affected stakeholders. It will also include: Historic England and the County Archaeologist; infrastructure providers, as the infrastructure will involve road, rail and utility crossings; and the Wildlife Trust, to discuss the conveyance corridors and opportunities for mitigation and enhancements.

9.25. There are opportunities for social, economic, and environmental benefits, beyond providing a resilient and sustainable water resource. We will look to extend the engagement to share, and seek input to, the design of the scheme including opportunities for partnership working to enhance the wide potential benefits and mitigate as far as possible issues. This will include organisations such as local government, community, education, economic and growth organisations to discuss opportunities for amenity and recreation, education, local employment and skill creation.

9.26. We will also develop a communication plan drawing on the insight gained from the research completed to date and collaborate on this with other companies who are also looking at water recycling schemes, to ensure the scheme, and what this means for a communities' water supply, can be clearly explained and communicated at a timely point.

10. Board statement and assurance

10.1. Thames Water board statement for this Gate 2 submission is provided in the associated covering letter.

10.2. The assurance framework used for this submission is based on a risk-based assurance approach and is based on the three lines of assurance model shown in figure 10-1. It is also consistent with the assurance requirements laid out in Ofwat's Company Monitoring Framework[14] and meets the assessment criteria defined by RAPID.

10.3. This approach provides an effective programme of assurance which considers areas that are known to be of prime importance to customers and regulators; or may have a significant financial value, alongside the likelihood or reporting issues. Areas of higher risk receive three lines of assurance while other areas, where the risk is lower, may be targeted with first and second lines only.

10.4. A detailed risk assessment was completed against each report to identify the lines of assurance required. Following procurement, Jacobs UK Ltd were appointed for technical assurance of the environmental aspects (Line 2), Thames Water assured the engineering aspects and AECOM were appointed as the external assurers (Line 3) and their findings are set-out in paragraph 10.6.

[14] The latest iteration of Ofwat's Company Monitoring Framework can be found on their website through the following link: http://www.ofwat.gov.uk/publication/company-monitoring-framework-final-position/

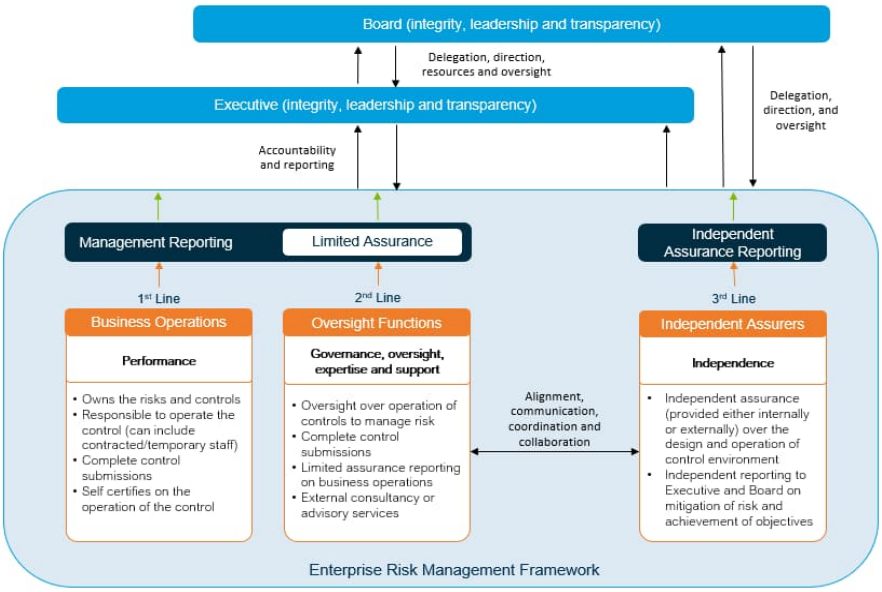


Figure 10-1 Assurance approach to Gate 2 submission

10.5. Thames Water confirm that this submission has been prepared in accordance with the following RAPID assessment criteria:

- Robustness: all Gate 2 activities have been completed and reported with appropriate evidence provided in accompanying annexes (annex A – H). The scope of works and evidence provided supports the recommendations made for scheme progression, where applicable, into Gate 3. We are satisfied that schemes can be construction ready within AMP8 and there is clear evidence showing good progress and proportionate progression of activities aligned to the requirements of RAPID. Close engagement with regulators and relevant stakeholders has also ensured the progression of work has been focussed on key areas of interest and tailored to the specifics of each scheme. We are also satisfied there has been efficient expenditure through Gate 2.
- Consistency: all work has been undertaken following national policy, guidance and agreed methodologies and is consistent with other plans and SROs. This has included ACWG and WRSE methodologies to ensure consistency across the SROs. This has been ensured through a robust assurance approach.
- Uncertainty: Assumptions, key risks and mitigation measures have been reported on for delivery of the schemes and our costing methodology has included for optimism bias and costed risk, appropriate to the stage of the scheme's development.

10.6. AECOM has challenged and independently assured this Gate 2 submission. At the completion of the assurance work AECOM confirm that:

- the Gate 2 report is consistent and aligned with the regulatory requirements as set out in RAPID Gate 2 guidance;
- the Gate 2 work has been of sufficient scope, details and quality which is expected for a large infrastructure project in the early design phase and supports the recommendations;
- the scope, detail and quality of annex H (efficiency of Gate 2 expenditure) meets the objectives of RAPIDs submission template in that the costs incurred are broken-down per activity and are appropriately evidenced as being benchmarked and efficient;
- the Gate 2 work follows the methodologies set out by ACWG and WRSE where relevant, and meets the expectations set by RAPID;
- the scheme costs have been generated using consistent methodologies and appropriate costing mechanisms, benchmarked where defined appropriate;

- the scheme delivery programme presented in the submission aligns with being construction ready in AMP8; and
- evidence of regular engagement with key regulators and stakeholders ensures the Gate 2 submission provides trust and confidence in the viable development of the schemes where recommended to progress.

11. Efficiency of expenditure for Gate 2 and forecast

Gate 2 Expenditure

11.1. The Final Determination maximum cost allowance for the SRO was £62.9m, with a 15% allocation to Gate 2 equating to £9.4m. RAPID confirmed in the Final Decision at Gate 1 that savings made against Gate 1 allowance could be carried over into Gate 2. Our Gate 1 expenditure was £2.5m against a Gate 1 allowance of £6.2m. Therefore, our combined Gate 2 allowance totals £13.1m.

11.2. Our anticipated expenditure through Gate 2 totals £5.7m based on 2017/18 price base[15] and represents expenditure of 44% of the combined allowance, representing a saving of £7.4M on the Final Determination allowance. The breakdown of expenditure against RAPIDs work breakdown structure (WBS) is shown in table 11-1.

11.3. All work planned for Gate 2 has been completed and results used to inform the conceptual designs, modelling and assessments presented in our submission. Our work has built on work undertaken for WRMP19 and Gate 1 and has not included any WRMP24 business as usual activities.

11.4. In discussion with RAPID a number of additional activities have been progressed through summer and autumn 2022 to enhance future scheme delivery and support early planning and procurement activities within Gate 3. This work termed Gate 2+ has been incorporated within the WBS costs shown in table 11-1 as the activities are not regarded as Gate 3 activities. Our Gate 2+ work has not been reported within our Gate 2 submission owing to the period of time required to assure deliverables. Our intention is to provide a summary report upon request of these activities and outputs during the Gate 2 representation period early in 2023.

11.5. In preparation for Gate 3 we have progressively recruited a Project Management Office (PMO) team to support the delivery of all Thames Water SROs through the assurance processes at Gate 2 and support delivery from Gate 3. The cost allocation for the assurance work has been reported within the WBS structure based on team activities up to August 2022. Work undertaken from August by the PMO team has been linked to Gate 3 preparations and as agreed with RAPID will be captured within our Gate 3 costs and therefore not included in table 11-1.

11.6. Principally, the PMO has been established to provide a consistent approach across the Thames Water's SRO projects across programme controls including governance, risk, cost management, change, assurance and performance reporting and to provide support to the other core functions including Regulation, Commercial Strategy, Scheme Development, Consents & Stakeholder Engagement and Legal. This team is required, based upon collective

[15] Actual costs were deflated back to a 2017/18 cost base using Thames Water's Internal Business Plan (IBP) deflationary factors, based upon the CPIH (November 2019 dataset) index.

and corporate experience of similar sized projects in both the water sector and elsewhere, to ensure efficient and effective robust delivery of subsequent project stages.

11.7. Costs assigned to a number of WBSs have exceeded a threshold expenditure of £0.5m and in-line with RAPID's requirements we have broken these items down in figure 11-1 with further detail provided in annex H.

Evidence of efficient spend

11.8. In delivering the Gate 2 submission, Thames Water has adhered to the criteria provided by RAPID for efficient expenditure, namely that activities should be relevant, timely, complete and of high quality, and that this should be backed by benchmarking and assurance.

11.9. To demonstrate our efficiency, we have ensured alignment between the work completed for Gate 2 with the activities listed in annex 2 of PR19 Final Determination, RAPIDs Gate 2 guidance and feedback from stakeholders. We drove efficiency by:

- Implementing a continuous programme of technical engagement throughout Gate 2 to ensure the approach taken for surveys, modelling and assessment activities were appropriate.
- Implementing a standardised procurement process across SROs and clearly scoped work packages using consistent methodologies.
- Running competitive procurement exercises wherever possible, and undertaking joint procurement across SROs, for aligned work packages.
- Ensuring robust project management, change control processes, and delivery to estimated budgets.
- Benchmarking through competitive tender and a cost comparison exercise within and across other Thames Water SROs.

11.10. Further explanation of our processes and activities to ensure efficient spend is contained within annex H.

Table 11-1: Gate 2 expenditure shown by WBS in 2017/18 price base

Category	Activity	Expenditure	% of total	Description of activity
Programme & Project Management	**Sub-Total**	**£516,220**	**9%**	
	Programme manager and cost control	£245,205		Programme, project and cost management of SRO
	PMB and executive mgmt.	£167,772		Company PMB governance, management activities and Thames Water assurance of Gate 2 deliverables
	Assurance activity	£103,244		External 2nd line and 3rd line assurance consultants
Feasibility assessment and concept design	**Sub-Total**	**£1,105,322**	**19%**	
	Engineering lead and Principal Designer (PD) for schemes	£110,532		Engineering lead consultant managing workstream, supporting engagement and reviewing deliverables. PD in compliance with CDM regs
	Beckton Concept Design Report (CDR)	£165,798		Production of concept design with supporting process engineering for Beckton
	Mogden CDR	£132,639		Production of concept design with supporting process engineering for Mogden
	Mogden South Sewer CDR	£88,426		Update of Gate 1 concept design for South Sewer
	Teddington CDR	£154,745		Production of concept design with supporting process engineering for Teddington
	Cost and carbon analysis	£121,585		Calculation, analysis and reporting of cost and carbon for the SRO
	Assessment of alternatives	£88,426		Investigation of option configurations and site and route selection appraisal
	GIS implementation	£33,160		Hosting a GIS system for the SRO
	Gate 2+ engineering activities	£210,011		Development of engineering understanding to support EIA scoping for Teddington
Options benefit development and appraisal	**Sub-Total**	**£86,859**	**2%**	Water resources modelling, DO assessment, WRSE investment modelling
Environmental assessment	**Sub-Total**	**£1,553,289**	**27%**	
	Third party costs - NAU, EA, NE	£432,533		Regulator cost for Gate 2
	Environmental and engagement lead	£207,340		Environmental lead consultant managing workstream, leading technical engagement and reviewing deliverables.
	Environmental assessments and mitigations	£297,000		Evidence based reporting and assessment including in-combination and identification of risk and mitigations. Scope of work influenced by NAU.
	Regulatory assessment and reporting	£179,321		Gate 2 regulatory reports
	Modelling activities	£240,962		Aquatic modelling activities to provide evidence-base for impact assessment
	Pre- EIA scoping activities (Gate 2+)	£196,132		Development of scheme understanding to support EIA scoping for Teddington
	Sub-Total	**£1,721,602**	**30%**	

Category	Activity	Expenditure	% of total	Description of activity
Data collection, sampling and pilot trials	Water quality sampling	£860,801		Water quality sampling relating to 4 schemes covering the fluvial Thames, Tideway, River Lee and reservoirs. Methods, sites and determinands agreed with NAU and DWI
	Algae sampling and experiments	£103,296		Summer 2022 algae surveys and lab experiments to provide evidence for INNS assessments
	Fisheries surveys	£292,672		Fisheries surveys in Thames, Lee and reservoirs which including smelt investigations and eDNA. Methods, durations and sites agreed with NAU
	Other aquatic surveys	£206,592		Invert, macrophytes, benthic surveys for the SRO. Methods and sites agreed with the NAU
	Terrestrial ecology surveys	£258,240		Ecology surveys and reports for key infrastructure sites across the 4 schemes
Procurement	**Sub-Total**	**£202,622**	**4%**	Strategic review of procurement routes, client governance, external advisory services and steering group on commercial matters
Planning	**Sub-Total**	**£279,140**	**5%**	Development of strategic planning, land access and engagement strategy. Support with planning engagement with local authorities
Stakeholder engagement	**Sub-Total**	**£163,634**	**3%**	Customer research and preference studies for the SRO, including customer engagement on changes to source water supply
Legal	**Sub-Total**	**£68,378**	**1%**	Legal advice on various issues and policies including review of documentation for Gate 2
Other: Gate 3 preparation works	**Sub-Total**	**£11,580**	**<1%**	Preparation of technical specifications for Gate 3 procurement
Total		£5,708,645	100%	

Forecast spend for Gate 3 and beyond

11.11. Subject to further guidance and agreement with RAPID, it is proposed that the full SRO Final Determination funding, less Gate 1 and Gate 2 expenditure, is made available for future gates.

11.12. Our analysis shows there is sufficient funding in the current Final Determination allowance for Teddington DRA to progress through full planning and procurement to Gate 3 and other schemes to continue with investigations to a mid-Gate 3 checkpoint. However, should a further water recycling scheme be required to progress through to Gate 3 with planning and procurement activities there would be insufficient funds available.

11.13. For Gate 3 we recommend the SRO is split into its different schemes and each one progresses based on the need identified and with their own budget allocation.

11.14. Our cost estimates for Gate 3 have been developed from a detailed activity list presented in annex H. Estimates include for risks identified within this submission during the next phase of works.

11.15. Table 11-2 summarises the estimated cost for Gate 3 for each scheme. Annex H provides more detailed breakdown of the Gate 3 forecast by WBS and includes key assumptions and exclusions.

Table 11-2: Forecast spend for each scheme through Gate 3

Scheme	Estimated total (17/18 price base)
Teddington DRA SRO	£14.4m
Beckton water recycling SRO	£1.5m*
Mogden water recycling SRO	£1.3m*
Total Estimated Gate 3 spend	**£17.2m**

*Costs for Beckton and Mogden are to a mid-Gate 3 checkpoint as set-out in annex H.

11.16. It is expected that once the regional modelling and WRMP24 is finalised schemes not selected or selected beyond AMP10 will be deferred at a mid-Gate 3 checkpoint releasing any underspend and future allowances.

11.17. For schemes progressing, i.e., Teddington DRA, through planning in Gate 4 the total SRO budget for Gate 4 would need to be re-allocated. At this early stage we do not envisage requiring additional funding beyond the Final Determination allowance for the SRO and combining any underspend to progress a single scheme through to planning consent.

11.18. No changes to the proposed penalty scale, delivery incentives or assessment criteria are proposed for Gate 3 for schemes.

12. Conclusions and recommendations

12.1. London water recycling schemes can provide a provide a reliable, sustainable and new supply of water to the London WRZ during critical times of drought.

12.2. Investigations through Gate 2 has determined the maximum size of schemes based on either available effluent or risks to the environment. Schemes sizes posing a high environmental risk are recommended to be removed as options and no showstoppers have been identified for those schemes and options recommended to progress into Gate 3.

12.3. London water recycling schemes could provide significant raw water sources with up to 300 Ml/d total yield from Beckton in east London and up to 200 Ml/d from west London, through a combination of schemes involving Teddington DRA (max 100 Ml/d) and Mogden (max 150 Ml/d).

12.4. All schemes can be "construction ready" in AMP8 allowing water to be available from 2031 if planning commenced immediately.

12.5. The draft WRSE regional modelling has selected the Teddington DRA (75 ml/d) scheme to provide water to Thames' customers from 2031. Thames Water's draft WRMP24 sets-out an adaptive plan which includes Beckton and Mogden schemes. Finalisation of the regional plan and WRMP24 is expected between Q4 2023 and Q1 2025.

12.6. As a result, Thames Water is recommending Teddington DRA, Beckton and Mogden schemes progress into Gate 3 as individual SROs. We envisage a core set of activities through Gate 3 that will advance the design and environmental understanding of these schemes. Key differences in outputs will be in the level of design development and environmental investigation which will be governed by when or if a scheme is required.

12.7. We are recommending that Mogden South Sewer exits the RAPID gated process owing to a reduction in DO and being below the threshold criteria for an SRO. The scheme however, is still considered viable and provides a wastewater benefit as well as provides a raw water source.

12.8. Our engineering design at Gate 2 has been refined, and we have removed options wherever possible based on evidence. The ACWG costing methodology has been applied in our Gate 2 submission refining those presented at Gate 1. This latest information was provided to WRSE for the regional modelling in February 2022.

12.9. All capital costs have been benchmarked and care has been taken to ensure spend through Gate 2 has been proportionate and efficient. We estimate that £7.4m savings has been achieved against our budget allowance.

12.10. We have broadened and extended our stakeholder engagement activities, engaging with local planning authorities and working with the NAU, EA, NE and PLA to address concerns from Gate 1. We have engaged with customers on best value and wider benefits and undertaken specific engagement in the Thames Water region on changes to source water.

12.11. We have developed a procurement and commercial strategy for schemes and as a result recommend that Teddington DRA be delivered 'in-house'. DPC remains viable and the preferred procurement route for all other schemes.

12.12. The Teddington scheme does not pass the discreteness test of Ofwat's DPC criteria. The construction of the scheme includes features that require complex interfaces with existing operational Thames Water assets. We have also considered whether individual components of the Teddington scheme could be competitively tendered using DPC, but those components that can be considered 'discrete' do not meet the financial threshold. We recommend that based on the evidence provided in our Gate 2 submission the scheme formally exits the DPC process at Gate 2.

12.13. We have developed our planning and lands strategy for schemes through Gate 2 and our preferred approach is to promote schemes under the TCPA (1990) with a planning application to each local authority that a scheme interacts with.

12.14. Thames Water are ready and committed to proceed to Gate 3 and in particular progress Teddington DRA through the planning and procurement processes to achieve the key milestones required for a WAFU date from 2031.

13. Supporting documentation

13.1. The following supporting information is provided to this Gate 2 submission

Supporting annex ref	Document title
Annex A1	Beckton Water Recycling Scheme CDR
Annex A2	Mogden Water Recycling Scheme CDR
Annex A3	Mogden South Sewer Scheme CDR
Annex A4	Teddington DRA Scheme CDR
Annex A5	Cost and Carbon Reports
Annex B1	Scope discussion document
Appendix B2.1	Physical Environment Assessment Report
Appendix B2.2	Water Quality Assessment Report
Appendix B2.3	Fish Assessment Report
Appendix B2.4	Aquatic Ecology Report
Appendix B2.5	INNS Assessment Report
Appendix B2.6	Terrestrial Ecology Assessment Report
Appendix B2.7	Navigation Assessment Report
Annex B3	Habitats Regulations Assessment
Annex B4	Water Framework Directive Compliance Assessment
Annex B5	Initial Environmental Appraisal
Annex B6	Biodiversity Net Gain, Natural Capital and Renewables Assessment Report
Annex B7	Swanscombe MCZ Assessment Report
Annex C	Strategic Water Quality Risk Assessment for London Water Recycling Schemes
Annex D	Stakeholder and Customer Engagement
Appendix D.2	WRSE research to test customer preferences for best value outcomes
Appendix D.3	Changing water resources
Appendix D.4	Water recycling communications
Appendix D.5	Research to explore customers preferences for public or added value
Annex E	Gate 2 Procurement Strategy Report for London Water Recycling Schemes
Annex F	Scheme Delivery Plan
Annex G	Planning and Lands Strategy
Annex H	Efficiency of Gate 2 Expenditure